SOIL SURVEY

Wabasha County
Minnesota

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

Series 1959, No. 41

Issued June 1965

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Wabasha County, Minn., will serve several groups of readers. It will help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; aid foresters in managing woodlands; and add to our knowledge of soil science.

Locating soils

Use the index to map sheets at the back of this report to locate areas on the large map. The index is a small map of the county numbered to show where each sheet of the large map is located. When the correct sheet of the large map has been found, it will be seen that boundaries of the soils are outlined, and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they occur on the map. The symbol is inside the area if there is enough room; otherwise, it is outside the area, and a pointer shows where the symbol belongs.

Finding information

This report contains sections that will interest different groups of readers, as well as some sections that may be of interest to all.

Farmers and those who work with farmers can learn about the soils in the section "Descriptions of the Soils" and then turn to the section "Use and Management of the Soils." In this way, they first identify the soils on their farm and then learn how these soils can be managed and what yields can be expected. The "Guide to Mapping Units, Capability Units, and Woodland Suitability Groups" at the back of the report will simplify use of the map and report. This guide lists each soil and land type mapped in the county, and the page where each is described. It also lists, for each soil and land type, the capability unit and woodland suitability group, and the pages where each of these is described.

Foresters and others interested in woodland can refer to the section "Woodland, Windbreaks, and Shelterbelts." In that section the soils in the county are grouped according to their suitability for trees, and factors affecting the management of woodland are explained.

Engineers will want to refer to the section "Use of the Soils for Engineering." Tables in that section show characteristics of the soils that affect engineering.

Scientists and others who are interested will find information about how the soils were formed and how they were classified in the section "Formation, Morphology, and Classification of Soils."

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

Newcomers in Wabasha County will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Facts About the County."

* * * * *

Fieldwork for this survey was completed in 1959. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time. The soil survey of Wabasha County was made as part of the technical assistance furnished by the Soil Conservation Service to the Wabasha County Soil and Water Conservation District.

Cover picture: Part of soil association 1 along Snake Creek, showing narrow ridges, bluffs, and sloping valleys.

For sale by the Superintendent of Documents, U.S. Government Printing Office Washington, D.C., 20402

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SOIL SURVEY OF WABASHA COUNTY, MINNESOTA

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

WABASHA COUNTY, in the southeastern part of Minnesota (fig. 1), has a total land area of 333,440 acres. It contains 17 townships or parts of townships.

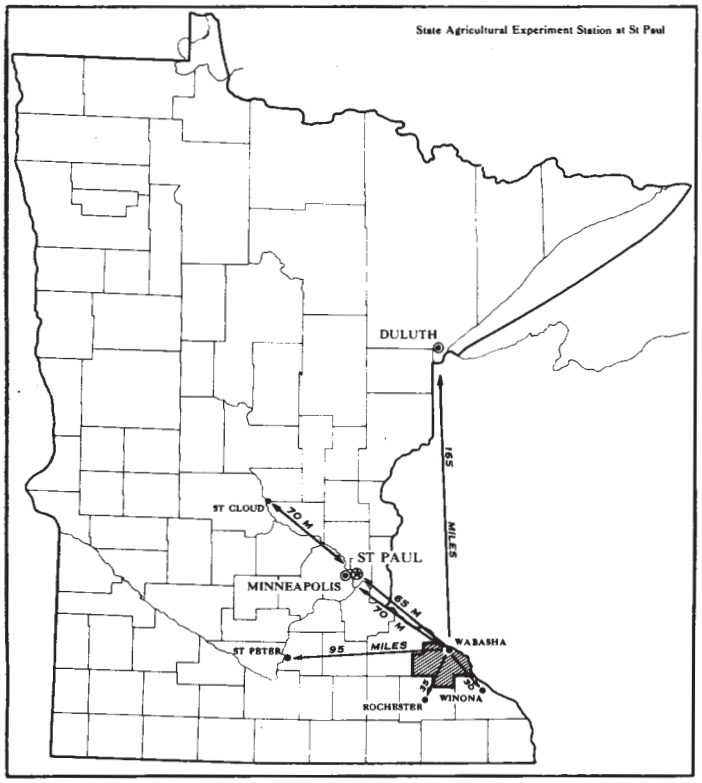

Figure 1.—**Location of Wabasha County in Minnesota.**

The town of Wabasha is the county seat. Other important towns and settlements are Lake City, Oak Center, Bellechester, Mazeppa, Zumbro Falls, Hammond, Jarrett, Millville, Theilman, Dumfries, Reads Landing, Weaver, Minneiska, Plainview, and Elgin.

The first settlement was at a trading post, which was set up in 1833 at the site of the present city of Wabasha by a nephew of the famous chief of the Sioux, Wapashaw. The city and the county were named after that chief, whose principal camping ground was in this part of the valley of the Mississippi River.

Most of the French traders married women of the Sioux tribe, and a total of 450 square miles was set aside in 1837 for those families. The land that was set aside extended 15 miles back from the Mississippi River and 30 miles along the river, from a point 3 miles below Wabasha to Red Wing. In 1857 these people or their descendants each received 480 acres of land scrip in place of their land on the reservation.

The population of the county was only 243 in 1853, but it had grown to an estimated 20,000 by 1874. In that year the city of Wabasha had a population of 2,000. In 1960 the population of the county was 17,007, and the population of the town of Wabasha was 2,500.

This county is part of a maturely dissected plateau that extends through a number of counties in the southeastern part of Minnesota. The elevation of the plateau is remarkably uniform, ranging from 1,100 to 1,200 feet above sea level. The top of the plateau is more than 500 feet above the floor of the valley of the Mississippi River (*4*).[1]

The county is cut from east to west by the valley of the Zumbro River. The lower part of that valley is 500 feet below the level of the upland plateau. It is between 1 and 2 miles wide and is bordered by conspicuous terraces.

The county is bordered on the east by the Mississippi River, and the numerous tributaries of that river have cut steep-sided valleys that resemble canyons. These valleys extend back several miles from the main valley of the Mississippi River.

Along the northeastern margin of the county, Lake Pepin has modified the physiography of the valley of the Mississippi River. This lake originated as a result of the aggradational work of the Zumbro and Chippewa Rivers. These rivers deposited a large amount of alluvial material, which formed a dam that blocked part of the channel of the Mississippi River. The dam caused the water to pond, and as a result, Lake Pepin was formed.

How Soils Are Mapped and Classified

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

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

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

[1] Italic numbers in parentheses refer to Literature Cited, p. 129.

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

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

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Fayette silt loam, uplands, 0 to 2 percent slopes, is one of several phases of Fayette silt loam, a soil type that ranges from nearly level to steep.

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 greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

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

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Gale-Hixton complex. Also, two or more soils may be mapped as an undifferentiated unit if the differences between them are too slight to justify separation. For example, Downs and Mt. Carroll soils are mapped in undifferentiated units in Wabasha County. The major difference between the Downs and Mt. Carroll soils is the content of clay in the subsoil.

On most soil maps, some areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Dune land or Riverwash, and are called land types rather than soils.

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

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

General Soil Map

After study of the soils in a locality and the way they are arranged, it is possible to make a general map that shows several main patterns of soils, called soil associations. Such a map is the colored soil map in the back of this report. In Wabasha County there are five soil associations. Each association, as a rule, contains a few major soils and several minor soils, in a pattern that is characteristic, although not strictly uniform.

The soils within any one association are likely to differ among themselves in some or in many properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general soil map shows, not the kind of soil at any particular place, but several distinct patterns of soils.

Each soil association is named for the major soil series in it, but as already noted, soils of other series may also be present. The major soils of one soil association may also be present in another association, but in a different pattern.

The general map is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use. The map is not detailed enough to be used for planning specific practices for a single farm.

The general soil map in the back of the report shows the five soil associations in Wabasha County. Association 1, which is made up mainly of gently sloping to moderately steep soils on narrow upland ridges, makes up roughly three-fifths of the county. Associations 2

and 3 occupy broader ridges and areas of uplands, and associations 4 and 5 are on stream terraces and bottom lands. In the following pages these associations are described.

1. Fayette-Dubuque-Steep, Stony, and Rocky Land Association

Gently sloping to moderately steep soils on narrow upland ridges, very steep soils on bluffs, and steep soils in narrow valleys

This association consists of narrow upland ridges, very steep bluffs, and of narrow, steep-sided valleys (fig. 2). In some of the wider valleys are long, narrow stream terraces and areas of bottom land. The association occupies approximately 312 square miles, about three-fifths of the county.

On ridgetops in the uplands are light-colored, deep soils that are well drained and silty. Next to the bluffs, on the steep side slopes of the ridges, are well-drained, silty soils that are moderately deep to shallow over limestone. The soils on the face of the bluffs are shallow over limestone or sandstone, and there are some rock outcrops. The soils of the valley slopes are light colored and vary greatly in depth over bedrock. They range from silty to sandy in texture and from good to excessive in drainage.

Fayette soils on the ridgetops and valley slopes make up about 50 percent of the association; Dubuque soils on the steeper ridgetops, about 15 percent; and Steep, stony, and rocky land, from 15 to 20 percent. Soils that occupy a minor acreage on the ridges are the Renova, Gale, and Whalan, which are in small areas. Boone, Hixton, Gale, and Lindstrom soils occupy small areas on the valley slopes; the Medary soils and the bench phases of the Fayette soils occupy small areas on the stream terraces; and the Chaseburg soils occupy small areas on the bottoms of narrow valleys.

Most farms in this association are "two story," that is, part of the cropland is on the ridges, and part is in the valleys at the foot of the bluffs. Because of the differences in the location, there is wide variation in the kinds of soils and slopes, as well as in the severity of erosion where the soils are used for crops. Management is more difficult than on farms where the soils and slopes are more uniform.

Erosion is serious in some cultivated fields. Also, some pastures have been overgrazed, and some woodland has been poorly managed. The silty, deep soils of the ridges and valley slopes, however, are excellent for corn, oats, and hay if they are properly farmed. Of these silty soils,

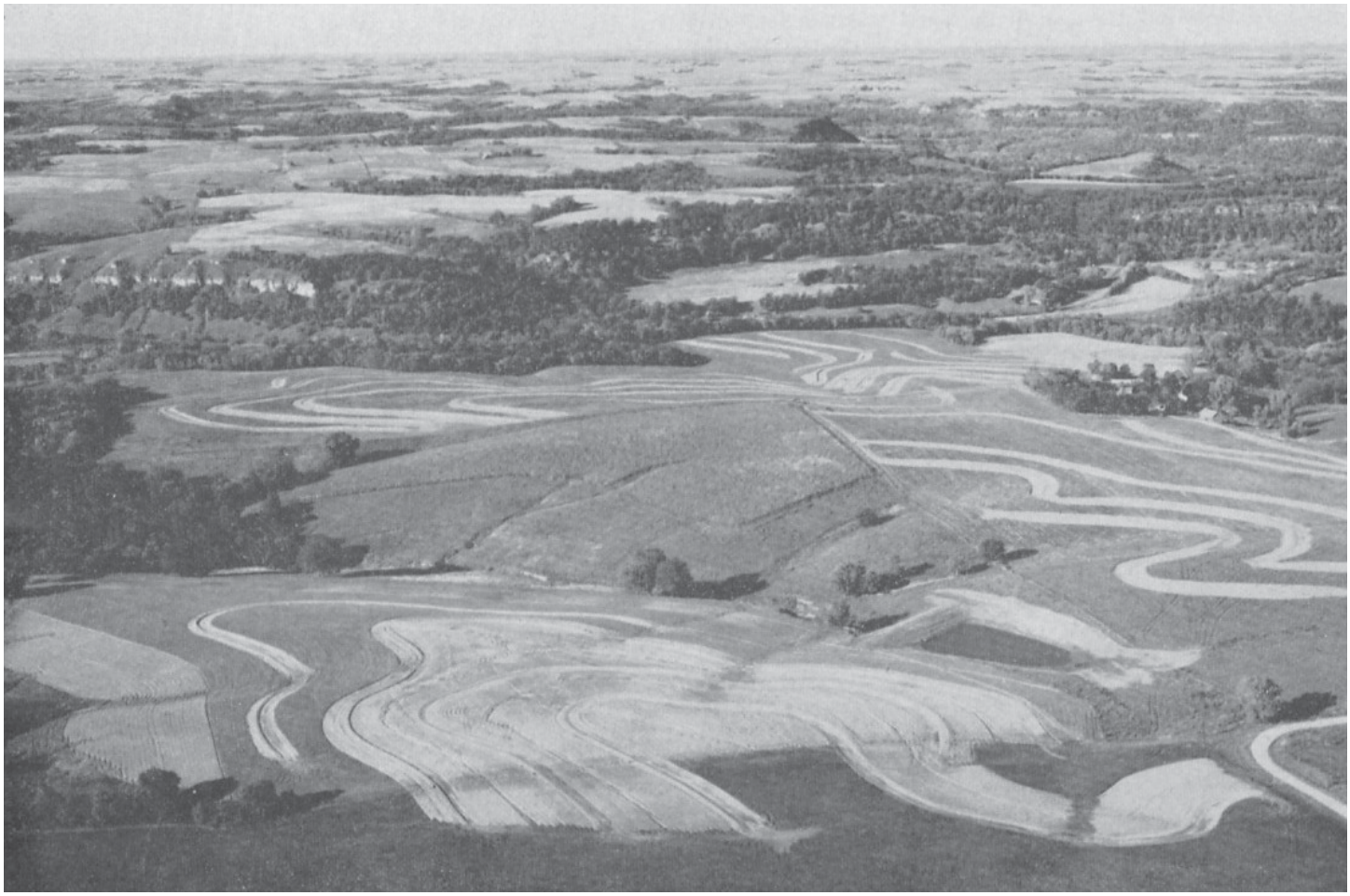

Figure 2.—View of Fayette soils. Newly built terraces and a detention structure are in the foreground.

the Fayette and the deeper Dubuque soils are more productive than the shallow phases of the Dubuque soils, and they are less susceptible to erosion. A system to divert water is needed to protect the soils below areas of Fayette and Dubuque soils on the ridges. If the water that flows from these areas is not diverted to a stabilized channel, it runs down the sides of the bluffs and forms large gullies at the base of the slope.

Most of the north- and east-facing slopes of the bluffs are timbered, and the south- and west-facing slopes are generally in native grass. Some bluffs are pastured, but they provide only a small amount of forage for cattle.

2. Fayette-Renova-Chaseburg Association

Light-colored, gently sloping to moderately steep soils of broad upland ridges, slopes, and drainageways

In this soil association are light-colored soils of broad upland ridges, mainly in the northwestern part of the county. The soils are gently sloping to moderately steep. The association occupies about 79 square miles.

Deep, well-drained Fayette soils occupy about 65 percent of the association (fig. 3). They are silty and formed in loess. Well-drained Renova soils that formed in medium-textured glacial till occupy about 15 percent. Deep, well drained or moderately well drained Chaseburg soils occupy from 5 to 10 percent. The Chaseburg soils are silty and formed in material washed from the uplands and deposited in drainageways. Soils that occupy a minor acreage are the Downs, Mt. Carroll, Racine, and Wykoff.

Approximately 85 percent of this association is used for field crops, and small areas are in permanent pasture or trees. Excellent yields of corn, oats, and hay are obtained on the Fayette and Renova soils under good management. Soybeans can be grown on some of the gentle slopes.

On many areas that have been cultivated in this association, erosion is fairly serious; good tilth and productivity are hard to maintain. Also, some of the permanent pastures have been overgrazed.

***Figure 3.*—Typical landscape in association 2 showing gently sloping Fayette soils.**

***Figure 4.*—A typical landscape of Port Byron, Downs, and Mt. Carroll soils in association 3.**

3. Port Byron-Downs-Mt. Carroll Association

Moderately dark colored and dark colored, nearly level to moderately sloping soils of broad uplands

This association occupies broad uplands in the southern part of the county. In general the soils are nearly level to moderately sloping (fig. 4). South and west of Elgin, however, there are some old landforms that rise about 200 feet above the normal level of the uplands. St. Peter sandstone is exposed on the steep, blufflike sides of these hills. The hills are capped with Platteville and Galena limestones that have been covered by loess. This association occupies about 64 square miles.

The soils in this association are deep, well drained, and silty. About 50 percent of the association is occupied by moderately dark colored Downs and Mt. Carroll soils, and about 25 percent, by dark-colored Port Byron soils. Light-colored Fayette soils occupy a small acreage.

Erosion is the major problem in this association. Nevertheless, excellent yields of corn, oats, hay, soybeans, peas for canning, and sweet corn are obtained under good management.

4. Waukegan-Sparta-Plainfield Association

Nearly level and gently sloping, loamy, silty, or sandy soils of stream terraces

This association consists of nearly level and gently sloping, loamy, silty, or sandy soils of the stream terraces. Steep terrace escarpments separate the nearly level tops of the terraces from the bottom lands below. The association occupies approximately 22 square miles.

The Waukegan soils make up about 25 percent of the association. They are mostly along the Zumbro River, but they also occupy a few areas along the Mississippi River. The Waukegan soils are dark colored and medium textured to a depth of 24 to 42 inches. Below

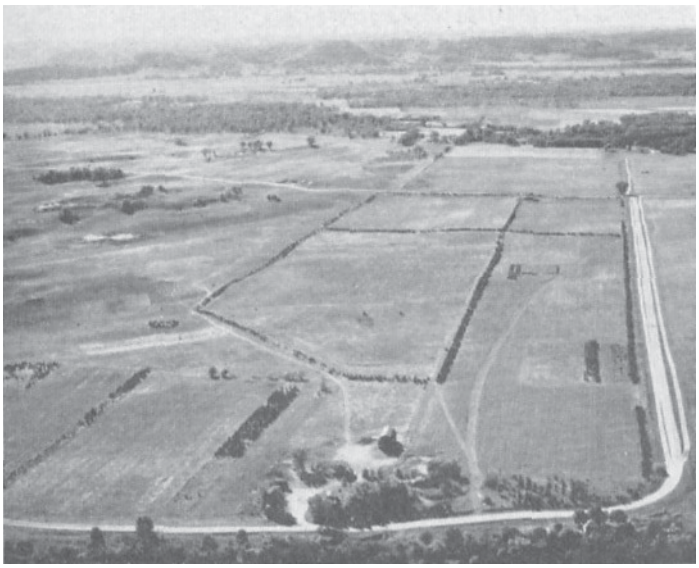

Figure 5.—**A large sandy terrace in association 4, known locally as Sand Prairie. The field windbreaks in the foreground are on the Sparta and Plainfield soils; the blowouts and dunes to the left are Dune land. In the background are the bottom lands and bluffs along the Zumbro River.**

that depth, they are underlain by stratified sand and gravel.

East of Kellogg, and along the Mississippi River, is a sandy stream terrace that covers about 10 square miles. This terrace is known locally as Sand Prairie (fig. 5). The soils on this terrace—the dark-colored Sparta and the light-colored Plainfield soils—are sandy throughout. In those places where wind erosion has mixed the soil material and no soil profiles remain, there are areas of Dune land.

The Burkhardt soils occupy a minor acreage in this association. They are mostly on terraces along the Mississippi River. The Burkhardt soils have a surface layer and a subsoil of dark-colored loam or sandy loam. They are underlain at a depth of 12 to 24 inches by stratified gravel and sand.

Melons and squash are grown on the Plainfield and Sparta soils. Corn, oats, and soybeans are grown on the Waukegan and Burkhardt soils, and alfalfa and bromegrass are grown for hay. Productivity ranges from very good for the deep soils, which have 3 to 4 feet of silty material over sand and gravel, to very poor for the sandy soils. Some factors that cause problems in management are wind erosion, droughtiness, low natural fertility of the gravelly and sandy soils, and gullying of the terrace escarpments. Some of the idle or unprofitable cropland should be planted to pines.

5. Arenzville-Genesee-Minneiska-Alluvial Land Association

Soils of bottom lands along the Zumbro and Mississippi Rivers

This association consists of nearly level soils on flood plains. It occupies approximately 44 square miles.

Alluvial land, wet, occupies about 40 percent of the association. In this land type the water table is high. The areas are also subject to flooding, largely because of dams in the river that are used to control the depth of the channel. As a result of the poor drainage, this land has little agricultural value, but it can be used for recreation and to provide food and cover for wildlife.

Most areas of Arenzville and Genesee soils are farther away from the Mississippi River than Alluvial land, wet. These soils occupy about 30 percent of the association. They are light colored, deep, silty, and well drained or moderately well drained. The Minneiska soils, which occupy about 10 percent of the association, are dark colored and silty, but they are underlain by sand at a depth of about 24 inches.

The Arenzville, Genesee, and Minneiska soils are used for cultivated crops, primarily corn and soybeans. Damaging floods occur about once in 5 years, but crop yields are generally very good.

Alluvial land not named as wet is mostly along the channel of the Zumbro River and occupies about 10 percent of the association. Better drainage distinguishes it from Alluvial land, wet, and it is suitable for pasture crops and trees.

Descriptions of the Soils

This section is provided for those who want fairly detailed descriptions of the soil series and mapping units in Wabasha County. For more general information about the soils of the county, the reader can refer to the section "General Soil Map," in which broad patterns of soils are described; or if he wants detailed, technical descriptions of the soil series, he can refer to the section "Formation, Morphology, and Classification of Soils." The acreage and proportionate extent of the soils are given in table 1. Their location is shown on the soil map at the back of the report.

In the pages that follow, the soil series and mapping units in the county are described in alphabetic order, by the name of the series. Each series is described, and then the individual mapping units in that series. As a general rule, only one soil profile is described for each series, and that profile is considered typical for all the mapping units of the series. Some mapping units in a series have a profile that differs somewhat from the typical profile, but these differences are evident in the name of the mapping unit or are pointed out in the description. Unless otherwise stated, the profile is that of a moist soil.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map in the back of the report. The description of each mapping unit ends with a reference to the capability unit and the woodland suitability group in which the mapping unit has been placed. The capability units and woodland suitability groups are described in the section "Use and Management of the Soils."

Descriptions of the soil series and mapping units contain some technical terms because there are no nontechnical terms that convey precisely the same meaning. Most of these terms are defined in the Glossary.

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

Map symbol	Soil	Acres	Percent
Ad	Alluvial land	10,479	3.1
Aw	Alluvial land, wet	17,279	5.2
Az	Arenzville silt loam	4,482	1.3
BbA	Bixby loam, 0 to 2 percent slopes	117	(1)
BbB	Bixby loam, 2 to 6 percent slopes	42	(1)
BbB2	Bixby loam, 2 to 6 percent slopes, moderately eroded	39	(1)
BfE	Boone loamy fine sand, 18 to 35 percent slopes	206	.1
BhB	Boone and Chelsea loamy fine sands, 2 to 6 percent slopes	130	(1)
BhC	Boone and Chelsea loamy fine sands, 6 to 12 percent slopes	186	.1
BhD	Boone and Chelsea loamy fine sands, 12 to 18 percent slopes	110	(1)
BkA	Burkhardt gravelly sandy loam, 0 to 2 percent slopes	118	(1)
BkB2	Burhkardt gravelly sandy loam, 2 to 6 percent slopes, moderately eroded	129	(1)
BrA	Burkhardt loam, 0 to 2 percent slopes	1,552	.5
BrB	Burkhardt loam, 2 to 6 percent slopes	154	(1)
BtA	Burkhardt sandy loam, 0 to 2 percent slopes	1,047	.3
BtB	Burkhardt sandy loam, 2 to 6 percent slopes	249	.1
BtB2	Burkhardt sandy loam, 2 to 6 percent slopes, moderately eroded	198	.1
BtC2	Burkhardt sandy loam, 6 to 12 percent slopes, moderately eroded	142	(1)
CaB	Chaseburg fine sandy loam, 2 to 6 percent slopes	191	.1
ChA	Chaseburg silt loam, 0 to 2 percent slopes	4,811	1.4
ChB	Chaseburg silt loam, 2 to 6 percent slopes	6,325	1.9
Co	Colo silty clay loam	1,203	.4
DdC2	Dodgeville silt loam, 6 to 12 percent slopes, moderately eroded	184	.1
DdD2	Dodgeville silt loam, 12 to 18 percent slopes, moderately eroded	157	(1)
DgC2	Dodgeville silt loam, shallow, 6 to 12 percent slopes, moderately eroded	88	(1)
DgD	Dodgeville silt loam, shallow, 12 to 18 percent slopes	51	(1)
DgD2	Dodgeville silt loam, shallow, 12 to 18 percent slopes, moderately eroded	292	.1
DgE2	Dodgeville silt loam, shallow, 18 to 35 percent slopes, moderately eroded	163	(1)
DhA	Downs and Mt. Carroll silt loams, 0 to 2 percent slopes	348	.1
DhB	Downs and Mt. Carroll silt loams, 2 to 6 percent slopes	11,749	3.5
DhB2	Downs and Mt. Carroll silt loams, 2 to 6 percent slopes, moderately eroded	10,676	3.2
DhC	Downs and Mt. Carroll silt loams, 6 to 12 percent slopes	193	.1
DhC2	Downs and Mt. Carroll silt loams, 6 to 12 percent slopes, moderately eroded	5,242	1.6
DhD	Downs and Mt. Carroll silt loams, 12 to 18 percent slopes	48	(1)
DhD2	Downs and Mt. Carroll silt loams, 12 to 18 percent slopes, moderately eroded	364	.1
DmA	Downs and Mt. Carroll silt loams, benches, 0 to 2 percent slopes	377	.1
DmB	Downs and Mt. Carroll silt loams, benches, 2 to 6 percent slopes	179	.1
DnB	Dubuque silt loam, 2 to 6 percent slopes	68	(1)
DnB2	Dubuque silt loam, 2 to 6 percent slopes, moderately eroded	113	(1)
DnC	Dubuque silt loam, 6 to 12 percent slopes	144	(1)
DnC2	Dubuque silt loam, 6 to 12 percent slopes, moderately eroded	576	0.2
DnD	Dubuque silt loam, 12 to 18 percent slopes	925	.3
DnD2	Dubuque silt loam, 12 to 18 percent slopes, moderately eroded	1,426	.4
DnE	Dubuque silt loam, 18 to 25 percent slopes	3,282	1.0
DnF	Dubuque silt loam, 25 to 35 percent slopes	252	.1
DrB	Dubuque silt loam, shallow, 2 to 6 percent slopes	83	(1)
DrB2	Dubuque silt loam, shallow, 2 to 6 percent slopes, moderately eroded	108	(1)
DrC2	Dubuque silt loam, shallow, 6 to 12 percent slopes, moderately eroded	562	.2
DrD	Dubuque silt loam, shallow, 12 to 18 percent slopes	1,676	.5
DrD2	Dubuque silt loam, shallow, 12 to 18 percent slopes, moderately eroded	1,858	.6
DrE	Dubuque silt loam, shallow, 18 to 25 percent slopes	3,312	1.0
DrF	Dubuque silt loam, shallow, 25 to 35 percent slopes	1,919	.6
DsD3	Dubuque soils, 12 to 18 percent slopes, severely eroded	375	.1
DtD3	Dubuque soils, shallow, 12 to 18 percent slopes, severely eroded	202	.1
DtE3	Dubuque soils, shallow, 18 to 25 percent slopes, severely eroded	975	.3
Du	Dune land	1,198	.4
FaA	Fayette silt loam, uplands, 0 to 2 percent slopes	1,767	.5
FaB	Fayette silt loam, uplands, 2 to 6 percent slopes	6,118	1.8
FaB2	Fayette silt loam, uplands, 2 to 6 percent slopes, moderately eroded	34,229	10.3
FaC	Fayette silt loam, uplands, 6 to 12 percent slopes	1,729	.5
FaC2	Fayette silt loam, uplands, 6 to 12 percent slopes, moderately eroded	39,479	11.8
FaC3	Fayette silt loam, uplands, 6 to 12 percent slopes, severely eroded	753	.2
FaD	Fayette silt loam, uplands, 12 to 18 percent slopes	1,421	.4
FaD2	Fayette silt loam, uplands, 12 to 18 percent slopes, moderately eroded	29,152	8.7
FaD3	Fayette silt loam, uplands, 12 to 18 percent slopes, severely eroded	1,851	.6
FaE2	Fayette silt loam, uplands, 18 to 25 percent slopes, moderately eroded	2,084	.6
FaE3	Fayette silt loam, uplands, 18 to 25 percent slopes, severely eroded	704	.2
FaF2	Fayette silt loam, uplands, 25 to 35 percent slopes, moderately eroded	134	(1)
FbA	Fayette silt loam, benches, 0 to 2 percent slopes	2,915	.9
FbB	Fayette silt loam, benches, 2 to 6 percent slopes	882	.3
FbB2	Fayette silt loam, benches, 2 to 6 percent slopes, moderately eroded	429	.1
FbC	Fayette silt loam, benches, 6 to 12 percent slopes	102	(1)
FbC2	Fayette silt loam, benches, 6 to 12 percent slopes, moderately eroded	387	.1
FcB	Fayette silt loam, valleys, 2 to 6 percent slopes	122	(1)
FcB2	Fayette silt loam, valleys, 2 to 6 percent slopes, moderately eroded	103	(1)
FcC	Fayette silt loam, valleys, 6 to 12 percent slopes	382	.1

See footnote at end of table.

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

Map symbol	Soil	Acres	Percent
FcC2	Fayette silt loam, valleys, 6 to 12 percent slopes, moderately eroded	929	0.3
FcD	Fayette silt loam, valleys, 12 to 18 percent slopes	476	.1
FcD2	Fayette silt loam, valleys, 12 to 18 percent slopes, moderately eroded	1,457	.4
FcE2	Fayette silt loam, valleys, 18 to 25 percent slopes, moderately eroded	1,797	.5
FcF	Fayette silt loam, valleys, 25 to 35 percent slopes	1,887	.6
FrB2	Fayette-Renova silt loams, 2 to 6 percent slopes, moderately eroded	391	.1
FrC2	Fayette-Renova silt loams, 6 to 12 percent slopes, moderately eroded	1,392	.4
FrD2	Fayette-Renova silt loams, 12 to 18 percent slopes, moderately eroded	2,572	.8
GaB2	Gale silt loam, 2 to 6 percent slopes, moderately eroded	81	(1)
GaC2	Gale silt loam, 6 to 12 percent slopes, moderately eroded	106	(1)
GaD2	Gale silt loam, 12 to 18 percent slopes, moderately eroded	83	(1)
GhC2	Gale-Hixton complex, shallow, 6 to 12 percent slopes, moderately eroded	101	(1)
GhD2	Gale-Hixton complex, shallow, 12 to 18 percent slopes, moderately eroded	111	(1)
GhE2	Gale-Hixton complex, shallow, 18 to 25 percent slopes, moderately eroded	102	(1)
Gm	Garwin silt loam	122	(1)
Gn	Genesee sandy loam	168	.1
Gs	Genesee silt loam	5,340	1.6
HfB	Hixton fine sandy loam, 2 to 6 percent slopes	139	(1)
HfC	Hixton fine sandy loam, 6 to 12 percent slopes	135	(1)
HfD	Hixton fine sandy loam, 12 to 18 percent slopes	159	(1)
HfE	Hixton fine sandy loam, 18 to 35 percent slopes	122	(1)
Hu	Huntsville silt loam	1,087	.3
JuA	Judson silt loam, 0 to 2 percent slopes	2,427	.7
JuB	Judson silt loam, 2 to 6 percent slopes	1,240	.4
LnB	Lindstrom silt loam, 2 to 6 percent slopes	205	.1
LnC	Lindstrom silt loam, 6 to 12 percent slopes	195	.1
LnC2	Lindstrom silt loam, 6 to 12 percent slopes, moderately eroded	134	(1)
LnD	Lindstrom silt loam, 12 to 18 percent slopes	119	(1)
LnD2	Linstrom silt loam, 12 to 18 percent slopes, moderately eroded	207	.1
LnE2	Lindstrom silt loam, 18 to 25 percent slopes, moderately eroded	65	(1)
MbA	Medary silt loam, brown variant, 0 to 2 percent slopes	168	.1
MbB	Medary silt loam, brown variant, 2 to 6 percent slopes	239	.1
MdA	Meridian sandy loam, 0 to 2 percent slopes	417	.1
MdB	Meridian sandy loam, 2 to 6 percent slopes	395	.1
MdB2	Meridian sandy loam, 2 to 6 percent slopes, moderately eroded	110	(1)
MdC	Meridian sandy loam, 6 to 12 percent slopes	49	(1)
MdC2	Meridian sandy loam, 6 to 12 percent slopes, moderately eroded	78	(1)
Mn	Minneiska silt loam	2,453	.7
MuA	Muscatine silt loam, 0 to 2 percent slopes	569	.2
MuB	Muscatine silt loam, 2 to 6 percent slopes	933	0.3
Os	Osseo silt loam	299	.1
PaA	Plainfield fine sand, 0 to 2 percent slopes	1,155	.3
PaB	Plainfield fine sand, 2 to 6 percent slopes	2,045	.6
PaC	Plainfield fine sand, 6 to 12 percent slopes	584	.2
PbA	Port Byron silt loam, 0 to 2 percent slopes	1,954	.6
PbB	Port Byron silt loam, 2 to 6 percent slopes	2,995	.9
PbB2	Port Byron silt loam, 2 to 6 percent slopes, moderately eroded	2,815	.8
PbC	Port Byron silt loam, 6 to 12 percent slopes	93	(1)
PbC2	Port Byron silt loam, 6 to 12 percent slopes, moderately eroded	1,313	.4
PoA	Port Byron silt loam, benches, 0 to 2 percent slopes	881	.3
PoB	Port Byron silt loam, benches, 2 to 6 percent slopes	271	.1
RaA	Racine silt loam, 0 to 2 percent slopes	77	(1)
RaB	Racine silt loam, 2 to 6 percent slopes	238	.1
RaB2	Racine silt loam, 2 to 6 percent slopes, moderately eroded	282	.1
RaC2	Racine silt loam, 6 to 12 percent slopes, moderately eroded	367	.1
RaD2	Racine silt loam, 12 to 18 percent slopes, moderately eroded	149	(1)
ReB	Renova silt loam, 2 to 6 percent slopes	95	(1)
ReB2	Renova silt loam, 2 to 6 percent slopes, moderately eroded	854	.3
ReC	Renova silt loam, 6 to 12 percent slopes	59	(1)
ReC2	Renova silt loam, 6 to 12 percent slopes, moderately eroded	1,026	.3
ReD	Renova silt loam, 12 to 18 percent slopes	50	(1)
ReD2	Renova silt loam, 12 to 18 percent slopes, moderately eroded	1,064	.3
ReE2	Renova silt loam, 18 to 25 percent slopes, moderately eroded	125	(1)
ReF2	Renova silt loam, 25 to 35 percent slopes, moderately eroded	34	(1)
RkB2	Renova-Wykoff loams, 2 to 6 percent slopes, moderately eroded	75	(1)
RkC2	Renova-Wykoff loams, 6 to 12 percent slopes, moderately eroded	165	(1)
RkD2	Renova-Wykoff loams, 12 to 18 percent slopes, moderately eroded	149	(1)
Rv	Riverwash	2,703	.8
SbD2	Seaton-Bold soils, 12 to 18 percent slopes, moderately eroded	42	(1)
So	Sogn soils	52	(1)
SpA	Sparta loamy fine sand, 0 to 2 percent slopes	505	.2
SpB	Sparta loamy fine sand, 2 to 6 percent slopes	532	.2
Sr	Steep, stony, and rocky land	45,796	13.7
St	Stony colluvial land	763	.2
ThA	Tell silt loam, 0 to 2 percent slopes	262	.1
ThB	Tell silt loam, 2 to 6 percent slopes	58	(1)
ThB2	Tell silt loam, 2 to 6 percent slopes, moderately eroded	90	(1)
Tm	Terrace escarpments, loamy	583	.2
Ts	Terrace escarpments, sandy	4,191	1.2
WaA	Waukegan silt loam, 0 to 2 percent slopes	2,496	.7
WaB	Waukegan silt loam, 2 to 6 percent slopes	228	.1

See footnote at end of table.

733-993 O—65——2

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

Map symbol	Soil	Acres	Percent	Map symbol	Soil	Acres	Percent
WaB2	Waukegan silt loam, 2 to 6 percent slopes, moderately eroded	85	(1)	WsE2	Whalan silt loam, shallow, 18 to 25 percent slopes, moderately eroded	294	0. 1
WaC2	Waukegan silt loam, 6 to 12 percent slopes, moderately eroded	35	(1)	WsF2	Whalan silt loam, shallow, 25 to 35 percent slopes, moderately eroded	348	. 1
WhB2	Whalan silt loam, 2 to 6 percent slopes, moderately eroded	78	(1)	WvB	Wykoff gravelly loam, 2 to 6 percent slopes	24	(1)
WhC2	Whalan silt loam, 6 to 12 percent slopes, moderately eroded	172	. 1	WvC2	Wykoff gravelly loam, 6 to 12 percent slopes, moderately eroded	45	(1)
WhD2	Whalan silt loam, 12 to 18 percent slopes, moderately eroded	491	. 1	WvD2	Wykoff gravelly loam, 12 to 18 percent slopes, moderately eroded	42	(1)
WsB2	Whalan silt loam, shallow, 2 to 6 percent slopes, moderately eroded	93	(1)	WvE2	Wykoff gravelly loam, 18 to 35 percent slopes, moderately eroded	39	(1)
WsC	Whalan silt loam, shallow, 6 to 12 percent slopes	63	(1)	Zb	Zumbro loamy fine sand	1, 072	. 3
WsC2	Whalan silt loam, shallow, 6 to 12 percent slopes, moderately eroded	233	. 1	ZgA	Zwingle silt loam, 0 to 2 percent slopes	221	. 1
WsD	Whalan silt loam, shallow, 12 to 18 percent slopes	79	(1)	ZgB	Zwingle silt loam, 2 to 6 percent slopes	22	(1)
WsD2	Whalan silt loam, shallow, 12 to 18 percent slopes, moderately eroded	600	. 2	ZgB2	Zwingle silt loam, 2 to 6 percent slopes, moderately eroded	32	(1)
					Total	333, 440	98. 7

[1] Less than 0.05 percent.

Alluvial Land

Alluvial land consists of unconsolidated alluvium that has been deposited recently by streams. It is subject to frequent change because of flooding. The layers are generally stratified, and they vary widely in texture.

Alluvial land (Ad).—The soil texture in this land type ranges from sand to clay, and the color ranges from light to dark. Drainage is good in some places, but it ranges to somewhat poor. This land type is not normally used for crops, but it can be used for pasture or trees. (Capability unit VIw–1; woodland suitability group 14)

Alluvial land, wet (Aw).—This land type generally lies only slightly above the level of streams, and drainage is poor or very poor. The texture and color vary greatly.

The land is subject to flooding, which causes ponding and leaves many small, marshy spots. It is not suitable for crops, unless drainage and protection from flooding are provided. Artificial drainage is not feasible. This land type has some value for growing trees, and it can be used to provide food and cover for wildlife. (Capability unit VIIw–1; woodland suitability group 15)

Arenzville Series

In the Arenzville series are nearly level, light-colored, well drained to moderately well drained soils of the bottom lands. The surface layer is underlain by a buried dark-colored soil at a depth ranging from 15 to 48 inches. These soils formed in recent alluvial deposits washed from silty, light-colored soils of the uplands. The following describes a typical profile of Arenzville silt loam in a pasture:

0 to 27 inches, very dark grayish-brown to brown, very friable silt loam.
27 to 40 inches, dark-brown and brown, very friable silt loam.
40 to 72 inches, very dark brown, very friable silt loam.
72 to 84 inches, dark-brown to brown, very friable silt loam.

The soil material above a depth of 40 inches contains darker, thin layers that range from one-fourth of an inch to 3 inches in thickness. These thin layers are alternately light and dark colored.

These soils are moderately permeable. They are high in available moisture capacity and in natural fertility. The soils are subject to occasional flooding, which may damage crops; however, the floodwaters also deposit plant nutrients. As a rule, no lime is required, because the soils are normally neutral to mildly calcareous. Fertilizer should be applied only if soil tests show the need for it.

Arenzville silt loam (Az).—This is the only Arenzville soil mapped in this county. It is nearly level and is on bottom lands. Occasional floods add deposits of fresh soil material washed from the surrounding hills.

This soil is generally used for corn or soybeans, but some grain and hay are also grown. Flooding is a slight to moderate hazard. In areas that are flooded frequently, this soil is used for pasture or trees. In the more frequently flooded areas, old channels are present in the bottom lands. (Capability unit IIw–3; woodland suitability group 14)

Bixby Series

Soils of the Bixby series are light colored, well drained, and medium textured. They are moderately deep. These soils developed on stream terraces under a cover of hardwoods. The principal areas are mainly nearly level, but some are gently sloping.

The following describes a typical profile of a Bixby loam in a plowed field:

0 to 11 inches, dark grayish-brown, friable loam.
11 to 23 inches, dark yellowish-brown, firm clay loam.
23 to 28 inches, yellowish-brown, firm sandy clay loam.
28 to 100 inches +, dark-brown, brown, or yellowish-brown, loose sand, in places stratified with fine gravel.

Depth to the underlying sand ranges from 24 to 42 inches. In some places the sand contains thin bands of sandy loam, loam, or sandy clay loam.

The available moisture capacity and natural fertility are moderate. Permeability is moderately rapid. Below the surface layer, the soil material is normally strongly acid, but it ranges from very strongly acid to medium acid. These soils are suited to all the crops grown locally.

Bixby loam, 0 to 2 percent slopes (BbA).—This soil is on stream terraces. Included in mapping are a few small areas where the surface layer is somewhat darker colored than that in the profile described for the series. Surface runoff is slow, but internal drainage is moderately rapid. This soil is subject to a slight hazard of drought. (Capability unit IIs–1; woodland suitability group 16)

Bixby loam, 2 to 6 percent slopes (BbB).—In most places this soil adjoins Terrace escarpments or is along drainageways that extend into nearly level areas. The hazards of erosion and drought are slight. (Capability unit IIe–5; woodland suitability group 1)

Bixby loam, 2 to 6 percent slopes, moderately eroded (BbB2).—This soil has short, gentle slopes. In most places it lies between the Terrace escarpments and the nearly level Bixby soils. Erosion has removed from 3 to 5 inches of the surface layer. As a result, the content of organic matter, the natural fertility, and the available moisture capacity have been somewhat reduced. In places tillage has mixed the soil material in the two uppermost layers, and as a result, the surface layer is browner than that in areas that have not been tilled. The plow layer is also less friable, and good tilth is more difficult to maintain.

Both crop yields and soil tilth can be improved by building up the content of organic matter and by adding lime and fertilizer. The hazard of further erosion is slight to moderate; the hazard of drought is slight. (Capability unit IIe–5; woodland suitability group 1)

Bold Series

Deep, light-colored, well-drained soils of the uplands make up the Bold series. The Bold soils are generally strongly sloping to steep, and they have complex, irregular slopes. These soils developed under hardwood forest in deep, coarse-textured loess that contains a large proportion of coarse silt. The loess is of more recent origin than that underlying the Fayette soils.

The Bold soils occur as yellow or light yellowish-brown spots that are similar to eroded areas of other soils. Little or no development has taken place in their subsoil, and unleached (calcareous) loess is at or near the surface.

In this county the Bold soils are mapped only with the Seaton soils in a mapping unit described under the Seaton-Bold complex. The following describes a typical profile of a Bold silt loam:

0 to 6 inches, dark-brown, very friable silt loam streaked with brown.
6 to 50 inches +, brown, very friable silt loam.

The Bold soils are like the Seaton soils in that they are moderately permeable and have moderate available moisture capacity. In addition, they have moderate natural fertility, are free of stones, and are easy to work. Surface runoff is rapid because of the steep slope. The hazard of sheet erosion is severe. Normally, the Bold soils are mildly to moderately calcareous throughout the profile.

Boone Series

In the Boone series are light-colored, excessively drained soils underlain by St. Peter or Jordan sandstone. The sandstone is generally within 36 inches of the surface. These soils lie immediately below the sandstone outcrops of the bluffs in the eastern part of the county and wherever there are sandstone outcrops in more gently sloping areas. The soils developed under an oak forest, predominantly of bur oak and black oak.

The following describes a typical profile of Boone loamy fine sand in a plowed field:

0 to 5 inches, dark-brown, loose loamy fine sand.
5 to 19 inches, dark-brown, loose fine sand.
19 to 28 inches, dark-brown to yellowish-brown, loose fine sand.
28 to 36 inches, light yellowish-brown to brownish-yellow, loose fine sand.
36 inches +, sandstone.

The Boone soils are rapidly permeable and are low to very low in natural fertility and in available moisture capacity. They are very droughty and are generally strongly acid.

Boone loamy fine sand, 18 to 35 percent slopes (BfE).—This soil is generally on the upper parts of valley slopes just below outcrops of sandstone on the bluffs. In places boulders, outcrops of sandstone, and fragments of sandstone are on the surface. Some boulders and fragments of sandstone are beneath the surface. Depth to sandstone bedrock ranges from 12 to 42 inches. Erosion has removed part of the surface layer where vegetation was sparse or the soil had been disturbed by cultivation. Water soaks into this soil rapidly, but because of the steep slopes, there is some runoff during heavy storms.

This soil is unsuitable for crops, because it is droughty and steep. Gullies form rapidly, and they are difficult to control if the vegetation is disturbed by cultivation or if the pastures are heavily grazed. Sod is difficult to establish and maintain. This soil is probably best suited to pine trees. The hazards of erosion and drought are severe. (Capability unit VIIs–1; woodland suitability group 13)

Boone and Chelsea loamy fine sands, 2 to 6 percent slopes (BhB).—The soils in this undifferentiated soil group are in the uplands where sandstone bedrock is exposed above the cover of loess and glacial till. They are also in less sloping areas on the lower parts of valley slopes.

The soils are not well suited to crops, because they are droughty and fertilizer cannot be readily absorbed by plants. Yields are low. The hazard of erosion is moderate, but cultivation encourages erosion by both wind and water. The hazard of drought is severe. (Capability unit IVs–1; woodland suitability group 8)

Boone and Chelsea loamy fine sands, 6 to 12 percent slopes (BhC).—These moderately sloping soils are in the uplands or on the sides of valleys. In places fragments of sandstone are on the surface and throughout the profile.

These soils are not well suited to cultivated crops, because they are droughty. They are better suited to pines and other perennial vegetation. The hazard of erosion is moderate, and the hazard of drought is severe. Large

areas in which the surface layer is sand are included in the areas mapped. (Capability unit VIIs–1; woodland suitability group 13)

Boone and Chelsea loamy fine sands, 12 to 18 percent slopes (BhD).—These soils are in the uplands and on the sides of valleys. In places there are outcrops of sandstone; some fragments of sandstone are on the surface and in the profile.

These soils are not suitable for crops, because they are droughty and steep. Cultivation makes them subject to erosion by both wind and water. Sod is difficult to establish and maintain. The soils are probably best suited to pine trees. The hazards of erosion and drought are severe. (Capability unit VIIs–1; woodland suitability group 13)

Burkhardt Series

In the Burkhardt series are dark-colored, excessively drained soils on terraces along the Mississippi River and along the major tributaries. The soils are shallow over gravel. Depth of the finer textured material over gravel ranges from 10 to 24 inches. These soils developed in moderately coarse textured material under prairie vegetation.

The following describes a typical profile of a Burkhardt loam:

0 to 9 inches, black, friable loam.
9 to 14 inches, very dark brown, friable loam that contains some fine gravel.
14 to 24 inches, dark reddish-brown, friable to firm gravelly loam.
24 to 100 inches +, dark yellowish-brown and dark-brown, loose sand and gravel.

The following describes a typical profile of a Burkhardt gravelly sandy loam:

0 to 5 inches, very dark brown, friable gravelly sandy loam.
5 to 9 inches, dark-brown, friable gravelly sandy loam.
9 to 13 inches, dark-brown to dark yellowish-brown, loose gravelly loamy sand.
13 to 100 inches, dark yellowish-brown, loose sand and gravel.

Permeability is moderately rapid in the loams and rapid in the sandy loams and gravelly sandy loams. In the nearly level soils, surface runoff is slow, but it is medium in the sloping soils. Internal drainage is rapid. Natural fertility and the available moisture capacity are low or very low. These soils are medium to strongly acid to a depth of about 100 inches. The loams and sandy loams do not scour when wet. The soil material in the sandy and gravelly soils contains enough clay to make it cohere when moist, but it is loose when dry.

Burkhardt gravelly sandy loam, 0 to 2 percent slopes (BkA).—On slight rises throughout most of the acreage of this soil, there are gravelly spots. The natural fertility and available moisture capacity are low.

Corn, soybeans, and winter grains are grown, but yields are low. Generally, this soil is not suitable for permanent pasture, because sod is hard to establish. The hazard of drought is very severe. (Capability unit IVs–2; woodland suitability group 9)

Burkhardt gravelly sandy loam, 2 to 6 percent slopes, moderately eroded (BkB2).—This soil has gravelly spots in many places. The natural fertility and available moisture capacity are very low.

Corn, soybeans, and winter grains are grown, but yields are low. Generally, this soil is not suitable for permanent pasture, because sod is hard to establish and maintain. The hazard of erosion is slight to moderate; the hazard of drought is very severe. (Capability unit IVs–2; woodland suitability group 9)

Burkhardt loam, 0 to 2 percent slopes (BrA).—The profile of this soil is thicker than that of the Burkhardt gravelly sandy loams. This soil is low in natural fertility and in available moisture capacity. However, it contains more plant nutrients and has a higher available moisture capacity than the Burkhardt sandy loams.

All of the crops normally grown in the county can be grown. The hazard of drought is moderate. (Capability unit IIIs–1; woodland suitability group 6)

Burkhardt loam, 2 to 6 percent slopes (BrB).—This soil is somewhat deeper over gravel than the Burkhardt gravelly sandy loams. Also, the natural fertility and available moisture capacity are slightly higher.

All of the crops normally grown in the county can be grown on this soil. The hazard of drought is moderate. (Capability unit IIIs–2; woodland suitability group 6)

Burkhardt sandy loam, 0 to 2 percent slopes (BtA).—This soil is similar to the Burkhardt loams, but gravel is at a depth of about 12 to 18 inches, rather than at a depth of 18 to 24 inches. This soil is low in natural fertility and in available moisture capacity. It contains more plant nutrients and has higher available moisture capacity, however, than the Burkhardt gravelly sandy loams.

All of the crops normally grown in the county can be grown on this soil. The hazard of drought is moderately severe. (Capability unit IIIs–1; woodland suitability group 6)

Burkhardt sandy loam, 2 to 6 percent slopes (BtB).—The texture in the uppermost layers of this soil is sandy loam. Gravel is closer to the surface than it is in the Burkhardt loams. The natural fertility and available moisture capacity are low, but this soil contains more plant nutrients and has a higher available moisture capacity than the Burkhardt gravelly sandy loams.

All of the crops normally grown in the county can be grown on this soil. The hazard of erosion is slight, but the hazard of drought is moderately severe. (Capability unit IIIs–2; woodland suitability group 6)

Burkhardt sandy loam, 2 to 6 percent slopes, moderately eroded (BtB2).—More than 25 percent of the surface layer of this soil has been removed by erosion. Therefore, gravel is nearer the surface than it is in the Burkhardt loams. The texture of the uppermost layers is sandy loam. The natural fertility and available moisture capacity are low, but they are higher than in the Burkhardt gravelly sandy loams.

All of the crops normally grown in the county can be grown on this soil. The hazard of erosion is slight to moderate, and the hazard of drought is moderately severe. (Capability unit IIIs–2; woodland suitability group 6)

Burkhardt sandy loam, 6 to 12 percent slopes, moderately eroded (BtC2).—This soil has lost more than 25 percent of the original surface layer through erosion. Mapped with it are small areas of a Burkhardt loam and a Burkhardt gravelly sandy loam.

All of the crops normally grown in the county can be grown, but yields are low. The hazard of erosion is

moderate, and the hazard of drought is moderately severe. (Capability unit IVe–6; woodland suitability group 10)

Chaseburg Series

The Chaseburg series consists of light-colored soils that are deep and well drained to moderately well drained. These soils formed in silty material that washed down from higher areas occupied by Fayette and other soils. The soils are in upland drainageways and on gentle slopes between the bottom lands or terraces and the uplands. They are also at the upper ends of deep, narrow valleys in which no stream channel has developed.

The following describes a typical profile of a Chaseburg silt loam:

0 to 13 inches, very dark grayish-brown, friable silt loam streaked with dark grayish brown.
13 to 48 inches, very dark gray and very dark grayish-brown, friable silt loam streaked with dark grayish brown.
48 to 78 inches +, very dark gray and very dark grayish-brown, friable silt loam streaked with dark grayish brown and mottled with dark yellowish brown.

These soils are moderately permeable. Surface runoff is medium. Natural fertility and available moisture capacity are moderately high. These soils are slightly acid to neutral.

Chaseburg fine sandy loam, 2 to 6 percent slopes (CaB).—The profile of this soil contains more fine sand than the profile of the Chaseburg silt loams. Below the surface layer, the texture is fine sand in some areas, and in other areas it is silt loam or loam. The available moisture capacity is somewhat lower than that of the silt loams.

This soil is suited to all of the crops adapted to the climate, but it is generally kept in meadow because it is in waterways. The hazard of flooding is moderate, but it is somewhat greater than on the Chaseburg silt loams. (Capability unit IIw–4; woodland suitability group 14)

Chaseburg silt loam, 0 to 2 percent slopes (ChA).—This soil is highly productive, and it is suited to all of the crops generally grown in the county. It is usually left in meadow, however, because of its location in waterways.

This soil can be farmed with the adjoining soils of uplands, and the same kinds of crops and rotations can be used. The hazard of flooding is slight to moderate. (Capability unit IIw–3; woodland suitability group 14)

Chaseburg silt loam, 2 to 6 percent slopes (ChB).—All of the crops grown in the county can be grown on this highly productive soil. This soil is normally left in meadow, however, because it is in waterways. Flooding is a slight to moderate hazard, but the floods are usually of short duration. (Capability unit IIw–4; woodland suitability group 14)

Chelsea Series

The Chelsea series consists of soils that formed in sand on the tops of bluffs. This sand was probably deposited by wind; it is unlikely that it weathered from sandstone. The Chelsea soils have brown bands of a fine-textured material that contains iron or a small amount of clay. These bands are thin—generally not more than one-eighth of an inch wide—and they are more than 42 inches beneath the surface.

In this county a few small areas of Chelsea soils occur with the Boone soils, and they are mapped with the Boone soils in undifferentiated units. The characteristic brown bands and the greater depth of the Chelsea soils are the major differences between the soils of the two series. A representative profile is not given for the Chelsea soils, because those soils are similar to the Boone.

Colo Series

The Colo series consists of dark-colored, somewhat poorly drained to poorly drained, moderately fine textured soils of the bottom lands. The soils developed in silty material washed from dark-colored soils of the upland. They are on first bottoms, principally along the Mississippi and the lower Zumbro Rivers.

The following describes a typical profile of a Colo silty clay loam:

0 to 26 inches, black, friable to firm silty clay loam.
26 to 34 inches, black to very dark gray, friable to firm, faintly mottled silt loam.
34 to 54 inches, dark-gray, friable to firm, prominently mottled silt loam.
54 to 72 inches +, dark grayish-brown, loose fine sand.

Colo silty clay loam (Co).—This is the only Colo soil mapped in the county. It is on nearly level bottom lands. This soil is high in natural fertility and in available moisture capacity. It is normally neutral, but in places it is slightly acid. Surface drainage is slow, and permeability is moderately slow.

Corn and soybeans are suitable crops. This soil is subject to flooding, but the hazard of flooding is slight to moderate. Flooding may be severe enough to damage crops once in 5 years. Drainage is generally not feasible, because there are not enough outlets. (Capability unit IIw–3; woodland suitability group 14)

Dodgeville Series

The Dodgeville series consists of dark-colored, moderately deep, well-drained soils of the uplands. These soils formed under prairie vegetation in a thin mantle of silty loess over limestone or reddish or yellowish clay weathered from limestone. The clay or limestone is at a depth ranging from 24 to 42 inches. Slopes range from gentle to steep.

The following describes a typical profile of a Dodgeville silt loam in a pasture:

0 to 5 inches, very dark brown, very friable silt loam.
5 to 10 inches, very dark brown, very friable silt loam streaked with dark brown.
10 to 13 inches, very dark grayish-brown and dark-brown, friable silt loam.
13 to 32 inches, brown to dark-brown, friable, heavy silt loam.
32 to 34 inches, brown to dark-brown, firm silty clay loam and very pale brown broken limestone.
34 inches +, limestone bedrock.

These soils are moderately permeable, and their available moisture capacity is moderate to moderately low. They are moderate in natural fertility. The surface layer is slightly acid to medium acid, but the layer of heavy silt loam is medium acid to strongly acid. In places

fragments of limerock are on the surface and in the soil profile.

Dodgeville silt loam, 6 to 12 percent slopes, moderately eroded (DdC2).—In some places erosion has removed 4 to 7 inches of the surface layer of this soil. Tillage has mixed part of the subsoil with material in the surface layer. As a result, the present surface layer is browner than the original one. The available moisture capacity is slightly lower than is typical for the series.

This soil is suited to all of the crops adapted to the climate. The hazard of further erosion is moderate, and the hazard of drought is slight. (Capability unit IIIe–3; woodland suitability group 1)

Dodgeville silt loam, 12 to 18 percent slopes, moderately eroded (DdD2).—In places this soil has lost 4 to 7 inches of its surface layer through erosion. Tillage has mixed part of the subsoil with material in the surface layer. As a result, the present surface layer is browner than the original one. The content of organic matter, the natural fertility, and the available mositure capacity are lower than is typical for the series. The plow layer is also less friable, and good tilth is more difficult to maintain.

This soil is moderately productive, but careful management is needed to control further erosion. It is not suited to soybeans, but under good management it can be used for all other crops commonly grown in the county. The hazard of further erosion is moderately severe, and the hazard of drought is slight. (Capability unit IVe–3; woodland suitability group 2)

Dodgeville Series, Shallow Phases

Dark-colored, shallow, well-drained soils of the uplands make up the shallow phases of the Dodgeville series. These soils formed under prairie vegetation in a thin mantle of silty loess over limestone or reddish or yellowish clay weathered from limestone. The clay or limestone is at a depth ranging from 12 to 24 inches. Fragments of limestone are on the surface and in the soil profile. In places there are outcrops of limestone. The slopes range from gentle to steep.

The following describes a typical profile of a Dodgeville silt loam, shallow phase:

0 to 10 inches, black to very dark brown, very friable silt loam.
10 to 12 inches, very dark grayish-brown and dark-brown, friable silt loam.
12 to 18 inches, dark-brown, friable to firm, heavy silt loam.
18 to 20 inches, dark yellowish-brown and light yellowish-brown, firm clay loam.
20 inches +, soft, gritty limestone.

The shallow Dodgeville soils are moderately permeable and are moderately low in available moisture capacity. They are low to moderate in natural fertility. Surface runoff is medium to rapid, and internal drainage is medium. Normally, these soils are medium acid.

Dodgeville silt loam, shallow, 6 to 12 percent slopes, moderately eroded (DgC2).—This soil is on upland ridges. Erosion has removed from 3 to 6 inches of its surface layer. In places tillage has mixed part of the subsoil with the material in the surface layer, and in those places the plow layer is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity are lower than typical for the series. In places clay weathered from limerock is exposed, and fragments of limerock are on the surface.

Because this soil is shallow, it is important to protect it from further erosion. This soil is not suited to soybeans, but it can be used to grow all other crops adapted to the climate. The hazards of further erosion and drought are moderate. (Capability unit IVe–5; woodland suitability group 11)

Dodgeville silt loam, shallow, 12 to 18 percent slopes (DgD).—Part of this soil is in pasture or is wooded, and little or no erosion has taken place. Since this soil is shallow, it is important to protect it from erosion. The soil ought to be kept in pasture or trees and should not be used for row crops. The hazards of erosion and drought are moderately severe. (Capability unit VIe–2; woodland suitability group 11)

Dodgeville silt loam, shallow, 12 to 18 percent slopes, moderately eroded (DgD2).—Erosion has removed from 3 to 6 inches of the surface layer of this soil. In places tillage has mixed part of the subsoil with the material in the surface layer, and in those places the surface layer is browner than the original one. Fragments of limestone are on the surface in some places. In those areas the content of organic matter is lower and the soil is less productive than in other areas. The available moisture capacity is lower than is typical for the series.

Using this soil for pasture or trees helps to reduce further erosion. The hazard of further erosion is moderately severe, and there is a moderately severe hazard of drought. (Capability unit VIe–2; woodland suitability group 11)

Dodgeville silt loam, shallow, 18 to 35 percent slopes, moderately eroded (DgE2).—A few areas of this soil are in pasture or trees, and in those places this soil is less eroded than in areas that have been cultivated. The areas that have been used for row crops have lost from 2 to 8 inches of the surface layer. In those places tillage has mixed part of the subsoil with the surface layer, and the present surface layer is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity are lower than is typical for the series. In some places clay weathered from limerock is exposed, and some fragments of limerock are on the surface.

This steep, shallow soil is probably best suited to perennial vegetation. The hazard of further erosion and the hazard of drought are severe. (Capability unit VIIe–1; woodland suitability group 5)

Downs Series

The Downs series consists of moderately dark colored, deep soils that are well drained. Most of the soils are in the uplands and have slopes of 4 to 12 percent. The bench phases, however, are on high terraces along streams and are nearly level to gently sloping. The Downs soils developed under mixed forest and prairie grasses in loess that is 6 to 8 feet thick. The loess is underlain by limestone or by loam and clay loam glacial till.

In this county the Downs soils are so intermingled with the Mt. Carroll soils that it is impractical to map them separately. The soils of the two series are therefore mapped together as undifferentiated units of Downs and Mt. Carroll silt loams. The major difference between

the profile of the Downs and Mt. Carroll soils is in the content of clay in the subsoil. The subsoil of the Downs soils contains more than 26 percent clay, or a greater content of clay than is in the subsoil of the Mt. Carroll soils. The content of clay in the undifferentiated units of Downs and Mt. Carroll soils ranges from 24 to 28 percent (*7*).

A representative profile of a Mt. Carroll silt loam is described under the Mt. Carroll series. The following describes a typical profile of a Downs silt loam:

0 to 6 inches, very dark brown, very friable silt loam.
6 to 15 inches, very dark grayish-brown to dark grayish-brown, friable silt loam.
15 to 22 inches, dark-brown, firm, heavy silt loam.
22 to 33 inches, brown to dark-brown, firm, light silty clay loam.
33 to 41 inches, brown to dark-brown, friable, heavy silt loam.
41 to 75 inches, brown, very friable silt loam.
75 to 100 inches +, brown to pale-brown, very friable coarse silt loam.

The Downs soils are similar to the Mt. Carroll soils in that they are moderately permeable and have high available moisture capacity. In addition their natural fertility is high, they are free of stones, and they are easy to work. Internal drainage is medium, and surface runoff ranges from rapid to slow. The surface layer is slightly acid to medium acid. The subsoil is strongly acid.

Downs and Mt. Carroll silt loams, 0 to 2 percent slopes (DhA).—These soils are on the crests of upland ridges. Little or no erosion has taken place, and the hazard of erosion is slight. The soils are highly productive; there are no serious limitations to their use for row crops. Yields are higher than on the other Downs and Mt. Carroll silt loams. Included in mapping are a few small areas that are moderately well drained. (Capability unit I–1; woodland suitability group 16)

Downs and Mt. Carroll silt loams, 2 to 6 percent slopes (DhB).—These gently sloping soils are in the uplands. They have lost less than 25 percent of their original surface layer through erosion, and there is a slight hazard of further erosion. The soils are highly productive and may be used for all of the crops adapted to the climate. (Capability unit IIe–1; woodland suitability group 16)

Downs and Mt. Carroll silt loams, 2 to 6 percent slopes, moderately eroded (DhB2).—These gently sloping soils of uplands have lost from 2 to 4 inches of their surface layer through erosion. The hazard of further erosion is slight to moderate. In some places tillage has mixed part of the subsoil with the material in the surface layer. In those places the surface layer is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced as the result of erosion. Under good management, however, these soils are highly productive. (Capability unit IIe–1; woodland suitability group 16)

Downs and Mt. Carroll silt loams, 6 to 12 percent slopes (DhC).—These soils are in the uplands. They have lost less than 25 percent of the original surface layer through erosion, but there is a moderate hazard of further erosion. The solum is thinner than that of the less sloping Downs and Mt. Carroll soils.

Under good management these soils are productive; they are suited to all of the crops grown locally. (Capability unit IIIe–1; woodland suitability group 1)

Downs and Mt. Carroll silt loams, 6 to 12 percent slopes, moderately eroded (DhC2).—Erosion has removed from 5 to 9 inches of the surface layer of these soils of the uplands, and there is a moderate hazard of further erosion. In some places tillage has mixed part of the subsoil with the material in the surface layer, and as a result, the present plow layer is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have also been reduced. In addition, the plow layer is less friable and is more difficult to keep in good tilth.

Under good management these soils are productive, but it is important to protect them from further erosion. They are suited to all of the crops grown locally. (Capability unit IIIe–1; woodland suitability group 1)

Downs and Mt. Carroll silt loams, 12 to 18 percent slopes (DhD).—These strongly sloping soils are productive, but careful management is needed to protect them from erosion if they are used for cultivated crops. In most places the solum is less than 40 inches thick. All of the layers are thinner than those in the less sloping Downs and Mt. Carroll silt loams. These soils are in the uplands.

Much of the acreage is in pasture, and little or no erosion has taken place where the soils have been kept in pasture. These soils are not suited to soybeans, but they can be used for other crops adapted to the climate. The hazard of erosion is moderately severe. (Capability unit IVe–1; woodland suitability group 3)

Downs and Mt. Carroll silt loams, 12 to 18 percent slopes, moderately eroded (DhD2).—Erosion has removed from 5 to 10 inches of the surface layer of these soils of the uplands. Tillage has mixed part of the subsoil with the material in the surface layer in as much as two-thirds of the acreage. In those places the plow layer is browner than the original one. In most places the solum is less than 40 inches thick, and all the layers are thinner than those in the gently sloping Downs and Mt. Carroll silt loams.

Careful management is needed to protect these soils from further erosion. The content of organic matter, natural fertility, and available moisture capacity are lower than in the gently sloping Downs and Mt. Carroll soils. Also, the surface layer is less friable, and good tilth is more difficult to maintain. These soils are not suited to soybeans, but they can be used for other crops that are adapted to the climate. (Capability unit IVe–1; woodland suitability group 3)

Downs and Mt. Carroll silt loams, benches, 0 to 2 percent slopes (DmA).—These soils are on high stream terraces. They are underlain at a depth of 48 to 96 inches by stratified material, mainly silt and very fine sand. In some places the underlying material is clay, coarse sand, and gravel.

These soils are highly productive, and they have no serious limitations for row crops. Little or no erosion has taken place, and the hazard of erosion is very slight. Yields are higher than on the steeper soils of this series. In places a few areas of moderately well drained soils were included in mapping. (Capability unit I–1; woodland suitability group 16)

Downs and Mt. Carroll silt loams, benches, 2 to 6 percent slopes (DmB).—These soils have lost less than 25 percent of their surface layer through erosion, but there is a slight hazard of further erosion. The soils are on

high stream terraces. They are underlain at a depth of 48 to 96 inches by stratified material, mostly silt and very fine sand. In some places the underlying material is clay, coarse sand, and gravel.

Under good management these soils are highly productive. They are suited to all of the crops normally grown in the county. (Capability unit IIe–1; woodland suitability group 16)

Dubuque Series

In the Dubuque series are light-colored, moderately deep, well-drained soils of the uplands. These soils formed in a thin mantle of loess underlain by limestone or by red or brown cherty clay weathered from limestone. The clay or limestone is at a depth ranging from 24 to 42 inches. In places fragments of limestone or chert are on the surface and in the soil profile. The original vegetation was a hardwood forest, dominantly oak. The soils range from gently sloping to steep. They are on ridgetops adjoining the deep Fayette soils and the shallow phases of the Dubuque soils.

The following describes a typical profile of a Dubuque silt loam:

0 to 3 inches, very dark grayish-brown to dark grayish-brown, friable silt loam.
3 to 8 inches, dark grayish-brown, friable silt loam.
8 to 13 inches, brown to dark-brown, friable silt loam.
13 to 24 inches, brown to dark-brown, friable silt loam.
24 to 32 inches, dark yellowish-brown, friable to firm, heavy silt loam.
32 to 34 inches, very dark grayish-brown, firm clay.
34 inches +, limestone bedrock.

The layer of clay ranges from red or brown to yellow, and it varies in thickness. In some places this layer is absent.

The Dubuque soils are moderately permeable. They are moderate to moderately low in available moisture capacity and moderate in natural fertility. Their surface layer is slightly acid to medium acid, and their subsoil is strongly acid.

Dubuque silt loam, 2 to 6 percent slopes (DnB).—This soil is in upland areas. Under good management it is productive, and it is suited to all of the crops commonly grown in the county. There is a slight hazard of erosion, but less than 25 percent of the original surface layer has been lost through erosion. The hazard of drought is slight. (Capability unit IIe–3; woodland suitability group 1)

Dubuque silt loam, 2 to 6 percent slopes, moderately eroded (DnB2).—Erosion has removed from 2 to 5 inches of the surface layer of this soil. In places tillage has mixed part of the subsoil with the material in the surface layer, and as a result, the present plow layer is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced as a result of erosion.

Under good management this soil is productive. It is suited to all of the crops commonly grown in this county. (Capability unit IIe–3; woodland suitability group 1)

Dubuque silt loam, 6 to 12 percent slopes (DnC).—Less than 25 percent of the surface layer of this soil has been removed by erosion, but there is a moderate hazard of further erosion.

Under good management this soil is productive. It is not suited to soybeans, but it can be used for all the other crops adapted to the climate. The hazard of drought is slight. (Capability unit IIIe–3; woodland suitability group 1)

Dubuque silt loam, 6 to 12 percent slopes, moderately eroded (DnC2).—This soil has lost from 2 to 8 inches of its surface layer through erosion, and the hazard of further erosion is moderate. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. In some places tillage has mixed part of the subsoil with the material in the surface layer. In those places the present plow layer is browner and less friable than the original one. It is also more difficult to keep in good tilth.

Under good management this soil is productive. It is not suited to soybeans, but it can be used for all the other crops adapted to the climate. The hazard of drought is slight. (Capability unit IIIe–3; woodland suitability group 1)

Dubuque silt loam, 12 to 18 percent slopes (DnD).—This soil is moderately productive. Careful management is needed, however, to protect it from erosion if it is used for cultivated crops.

Much of the acreage is in pasture or trees, and little or no erosion has taken place in those areas. This soil is not suited to soybeans, and it should be used for cultivated crops only occasionally. It is better suited to perennial vegetation, such as meadow, pasture, or trees. The hazard of erosion is moderately severe, and the hazard of drought is slight. (Capability unit IVe–3; woodland suitability group 2)

Dubuque silt loam, 12 to 18 percent slopes, moderately eroded (DnD2).—This soil has lost from 2 to 8 inches of its surface layer through erosion, and the hazard of further erosion is moderately severe. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. In some places tillage has mixed part of the subsoil with material in the surface layer. In those places the surface layer is browner than the original one. The present surface layer is less friable than the original one, and it is more difficult to keep in good tilth.

This soil is not suitable for soybeans, but corn may be grown occasionally. The soil is better suited to perennial vegetation, such as meadow, permanent pasture, or trees, than to cultivated crops. The hazard of drought is slight. (Capability unit IVe–3; woodland suitability group 2)

Dubuque silt loam, 18 to 25 percent slopes (DnE).—This soil is subject to severe erosion because it is moderately steep. The hazard of drought is slight.

Much of the acreage is in pasture or trees, and in those areas little or no erosion has taken place. Keeping this soil in perennial vegetation helps to protect it from further erosion. The acreage now used for cultivated crops should be converted to use for perennial vegetation. (Capability unit VIe–1; woodland suitability group 4)

Dubuque silt loam, 25 to 35 percent slopes (DnF).—The hazard of erosion on this steep soil is severe. As much as 8 inches of the surface layer has already been lost in areas that have been used for cultivated crops. Much of the acreage is used for pasture or trees, and there are occasional gullies in those areas. This steep soil is better suited to

perennial vegetation than to cultivated crops. The cultivated areas should be converted to use for pasture or trees. The hazard of drought is slight. (Capability unit VIe–1; woodland suitability group 4)

Dubuque Series, Shallow Phases

Soils of the Dubuque series, shallow phases, are light colored and well drained. They are in the uplands. These soils formed in a thin mantle of loess over cherty, reddish clay that is at a depth of 12 to 24 inches. They are underlain by limestone. These soils range from gently sloping to steep. They are generally on the lower edges of ridges just above the bluffs. The natural vegetation was hardwood forest, dominantly oak. Some fragments of limestone are on the surface, and there are outcrops of bedrock in places.

The following describes a typical profile of a shallow phase of Dubuque silt loam:

0 to 3 inches, very dark grayish-brown, very friable silt loam.
3 to 7 inches, dark-brown, friable silt loam.
7 to 12 inches, dark yellowish-brown, friable silt loam.
12 to 16 inches, brown to dark-brown, very firm clay.
16 inches +, limestone bedrock.

The color of the clay ranges from reddish brown to brown or light yellowish brown, and the thickness ranges from 3 to 12 inches. In some places the layer of clay is absent, and the silt loam lies directly over limestone.

The shallow Dubuque soils are moderately permeable, and the available moisture capacity is moderately low. Natural fertility is low to moderate. The surface layer is slightly acid to medium acid, and the subsoil is strongly acid.

Dubuque silt loam, shallow, 2 to 6 percent slopes (DrB).—This soil has lost less than 25 percent of the original surface layer through erosion. Because it is shallow, careful management is needed to protect it from further erosion.

This soil is moderately productive and is suited to all the crops commonly grown in the county. The hazard of drought is slight to moderate, and the hazard of further erosion is slight. (Capability unit IIIe–5; woodland suitability group 7)

Dubuque silt loam, shallow, 2 to 6 percent slopes, moderately eroded (DrB2).—This soil has lost from 2 to 5 inches of its surface layer through erosion. As a result, the content of organic matter, the natural fertility, and the available moisture capacity have been reduced. In some places fragments of limerock are on the surface and reddish clay that has weathered from limestone is exposed. Where the clay is exposed, this soil is hard to work and good tilth is difficult to maintain.

This soil is subject to a slight to moderate hazard of further erosion, and careful management is needed to protect it. It can be used for all of the crops commonly grown in the county. The hazard of drought is slight to moderate. (Capability unit IIIe–5; woodland suitability group 7)

Dubuque silt loam, shallow, 6 to 12 percent slopes, moderately eroded (DrC2).—Erosion has removed from 2 to 8 inches of the surface layer of this soil, and there is a moderate hazard of further erosion. In some places fragments of limestone are on the surface, and reddish clay weathered from limestone is exposed. Tillage has mixed part of the subsoil with material in the surface layer in places, and in those areas the present surface layer is redder or browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

It is important to protect this soil from further erosion because it is shallow. It is not well suited to soybeans, but all other crops adapted to the climate are suitable. The hazard of drought is moderate. (Capability unit IVe–5; woodland suitability group 11)

Dubuque silt loam, shallow, 12 to 18 percent slopes (DrD).—Much of this soil is used for pasture or trees. As a result, little erosion has taken place. Less than 25 percent of the original surface layer has been removed.

This steep, shallow soil is better suited to perennial vegetation than to cultivated crops. If the areas are cleared, the hazard of erosion is moderately severe. The hazard of drought is moderately severe. (Capability unit VIe–2; woodland suitability group 11)

Dubuque silt loam, shallow, 12 to 18 percent slopes, moderately eroded (DrD2).—Erosion has removed from 2 to 8 inches of the surface layer of this soil of the uplands. In some places tillage has mixed part of the subsoil with material in the surface layer, and in those areas the surface layer is browner or redder than the original one. In some places fragments of limerock are on the surface and reddish clay is exposed. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced as the result of erosion.

Because it is shallow and steep, this soil should not be used for cultivated crops. The hazards of further erosion and of drought are moderately severe. (Capability unit VIe-2; woodland suitability group 11)

Dubuque silt loam, shallow, 18 to 25 percent slopes (DrE).—Erosion has removed from 2 to 8 inches of the surface layer is some areas of this soil that have been used for cultivated crops. There is a severe hazard of further erosion. The hazard of drought is moderately severe.

Much of the acreage has been kept in pasture or trees, and in those areas little erosion has taken place. It is suggested that the cultivated areas be converted to use for permanent pasture or trees. (Capability unit VIIe–1; woodland suitability group 5)

Dubuque silt loam, shallow, 25 to 35 percent slopes (DrF).—This soil of the uplands is subject to severe erosion. The hazard of drought is severe.

Much of the acreage is in pasture or trees. In those areas little or no erosion has taken place, except that there are some shallow gullies. Where this soil has been used for cultivated crops, erosion has removed from 2 to 8 inches of the surface layer. In those areas tillage has mixed part of the subsoil with material in the surface layer. As a result, tilth is poor, fragments of limestone are on the surface in some places, and the reddish clay or bedrock is exposed. The content of organic matter, the natural fertility, and the available moisture capacity are low.

This shallow, steep soil should be used only for perennial vegetation. Areas that are cultivated should be retired from cultivation. (Capability unit VIIe–1; woodland suitability group 5)

Dubuque soils, 12 to 18 percent slopes, severely eroded (DsD3).—Erosion has removed most of the surface layer and part of the subsoil of these soils. The hazard of further erosion is very severe, and there is a moderate hazard of drought. Where these soils have been cultivated, part of the subsoil has been mixed with material from the surface layer. As a result, the present surface layer is browner than the original one, and the texture is heavy silt loam or silty clay loam.

Runoff is more rapid on these soils than on less sloping soils, and the content of organic matter is lower. The available moisture capacity is low or moderately low because the surface bakes or crusts readily and less rainfall enters the soils.

These soils are not suited to cultivated crops. If they are cultivated, they are harder to work than the other Dubuque soils, and yields are lower than average for the other soils. These soils should be used instead for permanent vegetation. (Capability unit VIe–1; woodland suitability group 2)

Dubuque soils, shallow, 12 to 18 percent slopes, severely eroded (DtD3).—Erosion has removed most of the surface layer and part of the subsoil of these strongly sloping soils. The hazards of further erosion and of drought are severe to very severe. Fragments of chert and limerock are on the surface. If these soils are cultivated, bedrock is within plow depth in places. The present surface layer is a mixture of surface soil and subsoil or a mixture of subsoil and reddish clay. Shallow gullies are formed easily. The content of organic matter and the available moisture capacity are low.

These soils are not suited to cultivated crops, because of the severe erosion and steep slopes. If they are cultivated, they are hard to work and yields are low. They are better kept in permanent pasture or trees. (Capability unit VIIe–1; woodland suitability group 5)

Dubuque soils, shallow, 18 to 25 percent slopes, severely eroded (DtE3).—Erosion has removed most of the surface layer and part of the subsoil of these soils, and the hazards of further erosion and of drought are very severe. Fragments of chert and limerock are on the surface. If the soils are used for cultivated crops, bedrock is within plow depth in places. The present surface layer is a mixture of subsoil and reddish clay. Shallow gullies are formed easily. The content of organic matter and the available moisture capacity are low.

These soils are not suited to cultivated crops. If they are cultivated, they are hard to work and yields are low. They should be used only for permanent pasture or trees. (Capability unit VIIe–1; woodland suitability group 5)

Dune Land (Du)

Dune land consists of loose, sandy material that is blown about by the wind. The areas are along the Mississippi River, east of Kellogg. They occur within an area of about 10 square miles, which is known locally as Sand Prairie.

Severe blowouts and fresh deposits of sandy material have caused Dune land to be of little or no use for agriculture. Controlling the dunes is difficult, but these areas can be stabilized by planting them to pines or to drought-resistant grasses. The hazard of drought is very severe. (Capability unit VIIs–1; woodland suitability group 13)

Fayette Series

Deep, light-colored, well-drained soils on uplands, valley slopes, and benches make up the Fayette series. The upland phases are on ridges and on broad uplands, the valley phases are on valley slopes, and the bench phases are on high terraces along rivers and other streams.

These soils developed under mixed hardwoods in deep, silty loess that is about 8 to 10 feet thick (*3*). Beneath the loess, in most places, is a thin blanket of loam to clay loam glacial till, and beneath that is sandstone or limestone bedrock. In places the till is absent. The following describes a typical profile of a Fayette silt loam, uplands:

0 to 8 inches, very dark grayish-brown to dark grayish-brown, very friable silt loam.
8 to 11 inches, dark grayish-brown, friable silt loam.
11 to 19 inches, dark yellowish-brown, friable silt loam.
19 to 41 inches, dark yellowish-brown, firm silty clay loam.
41 to 100 inches +, dark yellowish-brown, friable to very friable silt loam.

These soils are moderately permeable; they contain no layers of soil material that will restrict the movement of water. Internal drainage is medium, and surface runoff ranges from rapid to slow. The available moisture capacity is high (*5*), and the soils are moderately high in natural fertility. The content of available phosphorus in the subsoil is high to very high. Normally, the surface layer of these soils is medium acid and the subsoil is strongly acid.

These soils are free of stones and are easy to work. They have high productivity potential.

Fayette silt loam, uplands 0 to 2 percent slopes (FaA).—This soil is on the crests of ridges in the uplands. It is well drained, but a few areas of a moderately well drained soil are mapped with it. Little or no erosion has taken place, and the hazard of erosion is very slight.

This soil is productive; it has no serious limitations for growing row crops. (Capability unit I–2; woodland suitability group 16)

Fayette silt loam, uplands, 2 to 6 percent slopes (FaB).—This soil is near the tops of ridges or on the broader areas of uplands. It has lost less than 25 percent of its surface layer through erosion, and there is a slight hazard of further erosion.

This soil is highly productive. It can be used to grow all the crops adapted to the climate. (Capability unit IIe–2; woodland suitability group 16)

Fayette silt loam, uplands, 2 to 6 percent slopes, moderately eroded (FaB2).—This soil is near the tops of ridges or on the broader areas of uplands. It has lost from 2 to 6 inches of its surface layer through erosion, and there is a slight hazard of further erosion. The plow layer is a mixture of material from the uppermost layers or of material from the surface layer and the subsoil. Where the present surface layer contains material from the subsoil, it is browner than that in less eroded areas. In those places the content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is highly productive. It is suited to all of the crops adapted to the climate. (Capability unit IIe–2; woodland suitability group 16)

Fayette silt loam, uplands, 6 to 12 percent slopes (FaC).—This soil has lost less than 25 percent of its surface layer through erosion, but there is a moderate hazard of further erosion. The soil is productive, but more careful management is required to protect it from erosion than is required for similar, but less sloping, soils. The soil is suited to all of the crops grown locally. (Capability unit IIIe–2; woodland suitability group 1)

Fayette silt loam, uplands, 6 to 12 percent slopes, moderately eroded (FaC2).—This soil has lost from 2 to 8 inches of its surface layer through erosion, and there is a moderate hazard of further erosion. In places part of the subsoil has been mixed with the material in the surface layer, and the surface layer in those areas is browner than the original one. The plow layer is also less friable and is more difficult to keep in good tilth. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

This soil is productive under good management. It is suited to all the crops grown locally. (Capability unit IIIe–2; woodland suitability group 1)

Fayette silt loam, uplands, 6 to 12 percent slopes, severely eroded (FaC3).—Erosion has removed most of the surface layer of this soil, as well as part of the subsoil, and there is a severe hazard of further erosion. The present plow layer is browner than the original one. In most places it is heavy silt loam, but in some places it is silty clay loam.

This soil is harder to work than the less eroded Fayette soils that have similar slopes. Runoff is more rapid, and the content of organic matter, natural fertility, and available moisture capacity have been reduced. The surface layer bakes or crusts readily, and as a result, less rainfall enters the soil than enters the less eroded Fayette soils.

This soil can be made more productive if it is properly managed, but further erosion should be prevented. It is suggested that soybeans not be grown, but all other crops adapted to the climate are suitable. (Capability unit IVe–2; woodland suitability group 1)

Fayette silt loam, uplands, 12 to 18 percent slopes (FaD).—Much of this soil is in pasture or trees, and little or no erosion has taken place in those areas. However, there is a moderately severe hazard of erosion. In most places the solum is less than 40 inches thick, and the layers throughout the entire profile are thinner than those in the less sloping Fayette soils.

This soil is productive, but if it is used for cultivated crops, careful management is needed to protect it from erosion. Except for soybeans, all the crops adapted to the climate can be grown. (Capability unit IVe–2; woodland suitability group 3)

Fayette silt loam, uplands, 12 to 18 percent slopes, moderately eroded (FaD2).—Erosion has removed from 2 to 8 inches of the surface layer of this soil, and there is a moderately severe hazard of further erosion. The solum is less than 40 inches thick in most places, and the soil layers are thinner than those in the less sloping Fayette soils. In places the present plow layer is a mixture of surface soil and subsoil. It is more brownish than the original one, and it is also less friable and more difficult to keep in good tilth. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

This soil is moderately productive. Except for soybeans, all the crops adapted to the climate can be grown. (Capability unit IVe–2; woodland suitability group 3)

Fayette silt loam, uplands, 12 to 18 percent slopes, severely eroded (FaD3).—This soil has lost most of the surface layer and part of the subsoil through erosion, and there is a very severe hazard of further erosion. The present plow layer, a mixture of subsoil and of material from the original surface layer, is more brownish than the original one. In most places the texture of the present surface layer is heavy silt loam, but it is silty clay loam in some places.

This soil is harder to work than the less eroded Fayette soils that have similar slopes. Runoff is more rapid, and the content of organic matter, the natural fertility, and the available moisture capacity have been reduced. The surface layer bakes or crusts readily, and as a result, less rainfall enters the soil than enters the less eroded Fayette soils. This soil should be used only for permanent vegetation. (Capability unit VIe–1; woodland suitability group 3)

Fayette silt loam, uplands, 18 to 25 percent slopes, moderately eroded (FaE2).—Erosion has removed from 2 to 8 inches of the surface layer in most areas of this soil, and the hazard of further erosion is severe in cleared areas. Part of the acreage is in pasture or trees, however, and in those areas little erosion has taken place. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. In places the plow layer is a mixture of subsoil and material from the surface layer, and it is browner than the original one. It is also less friable and is more difficult to keep in good tilth. In most places the solum is less than 40 inches thick, and the layers are thinner than those in less sloping and less eroded Fayette soils.

This soil is better suited to permanent vegetation than to cultivated crops. If the soil is cultivated, careful management is needed to protect it from further erosion. (Capability unit VIe–1; woodland suitability group 4)

Fayette silt loam, uplands, 18 to 25 percent slopes, severely eroded (FaE3).—Most of the surface layer of this soil has been lost through erosion, and part of the subsoil is gone. The hazard of further erosion is very severe. The present plow layer is a mixture of subsoil and of material from the original surface layer, and it is browner than the original one. In most places the texture of the present surface layer is heavy silt loam, but in some places it is silty clay loam.

This soil is harder to work than the less eroded Fayette soils that have similar slopes. Runoff is more rapid, and the content of organic matter, the natural fertility, and the available moisture capacity have been reduced. The surface layer bakes or crusts readily, and as a result, less rainfall enters the soil than enters the less eroded Fayette soils.

This soil should not be used for cultivated crops, because it is steep and severely eroded. It should be used only for permanent vegetation. (Capability unit VIe–1; woodland suitability group 4)

Fayette silt loam, uplands, 25 to 35 percent slopes, moderately eroded (FaF2).—Erosion has removed from 2 to 10 inches of the surface layer in areas of this soil that have been cultivated, and the hazard of further erosion is very severe. In as much as two-thirds of the acreage,

tillage has mixed part of the subsoil with material from the original surface layer. In those areas the present surface layer is browner than the original one. It is also less friable, and it is more difficult to keep in good tilth. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. Surface runoff is also more rapid, which further reduces the supply of moisture. The solum is only 36 to 40 inches thick in most places. The soil layers are thinner than those in the less sloping Fayette soils.

Part of the tilled acreage has been returned to pasture and trees, and now only a small acreage is cultivated. A few gullies have developed in the pastures and wooded areas. All of this soil should be kept in permanent vegetation that can protect it from further erosion. (Capability unit VIe–1; woodland suitability group 4)

Fayette silt loam, benches, 0 to 2 percent slopes (FbA).—Little or no erosion has taken place on this soil, and the hazard of erosion is slight. This soil is on high stream terraces and is underlain at a depth of 4 to 8 feet by stratified silt and very fine to medium sand. The bands of silt and sand are about one-quarter to an inch thick. Part of this soil is moderately well drained.

This soil is highly productive. It has no serious limitations, and it can be used for row crops. (Capability unit I–2; woodland suitability group 16)

Fayette silt loam, benches, 2 to 6 percent slopes (FbB).—Less than 25 percent of the surface layer of this soil has been lost through erosion, and the hazard of further erosion is slight. This soil is on high stream terraces. It is underlain by stratified silt and very fine to medium sand at a depth of 4 to 8 feet. The bands of silt and sand range from about one-quarter to an inch in thickness.

This soil is highly productive. It is suited to all the crops commonly grown in the county. (Capability unit IIe-2; woodland suitability group 16)

Fayette silt loam, benches, 2 to 6 percent slopes, moderately eroded (FbB2).—This soil has lost from 2 to 6 inches of its surface layer through erosion, and there is a slight to moderate hazard of further erosion. In places tillage has mixed part of the subsoil with material in the surface layer, and in those areas the present surface layer is browner than the original one. This soil is underlain by stratified silt and very fine to medium sand at a depth of 4 to 8 feet. The bands of silt and sand range from one-quarter to an inch in thickness. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is highly productive. It can be used for all the crops grown locally. (Capability unit IIe–2; woodland suitability group 16)

Fayette silt loam, benches, 6 to 12 percent slopes (FbC).—Less than 25 percent of the original surface layer of this soil has been lost through erosion, and the hazard of further erosion is moderate. This soil is on high stream terraces. It is underlain by stratified silt and very fine to medium sand at a depth of 4 to 8 feet. The bands of silt and sand are about one-quarter to an inch thick.

Under good management this soil is productive. It is suited to all the crops commonly grown in the county. (Capability unit IIIe-2; woodland suitability group 1)

Fayette silt loam, benches, 6 to 12 percent slopes, moderately eroded (FbC2).—From 2 to 8 inches of the surface layer of this soil has been lost through erosion, and there is a moderate hazard of further erosion. Most of the plow layer is a mixture of material from the subsoil and from the original surface layer. It is browner than the original one, and it is less friable and more difficult to keep in good tilth. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is productive. It is suited to all the crops grown locally. (Capability unit IIIe–2; woodland suitability group 1)

Fayette silt loam, valleys, 2 to 6 percent slopes (FcB).—Less than 25 percent of the original surface layer of this soil has been removed by erosion, and there is a hazard of further erosion. The present surface layer is 4 to 6 inches thicker than that in the typical profile described for the series, and it is slightly darker than the original one. In some places the surface layer contains sandy material from soils on higher slopes.

This soil is highly productive. It is suited to all of the crops grown locally. (Capability unit IIe–2; woodland suitability group 16)

Fayette silt loam, valleys, 2 to 6 percent slopes, moderately eroded (FcB2).—Erosion has removed from 2 to 8 inches of the surface layer of this soil, and there is a slight to moderate hazard of further erosion. In some places the surface layer contains sandy material from soils on higher slopes. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. In some places tillage has mixed part of the subsoil with the material in the surface layer, and the present surface layer in those areas is browner than the original one.

This soil is highly productive under good management. It is suited to all of the crops adapted to the climate. (Capability unit IIe–2; woodland suitability group 16)

Fayette silt loam, valleys, 6 to 12 percent slopes (FcC).—This soil has lost less than 25 percent of its original surface layer through erosion, but there is a moderate hazard of further erosion. In most places the surface layer is 4 to 6 inches thicker than that in the typical profile described for the series. In places it contains sandy material from soils on higher slopes.

This soil is productive under good management. It is suited to all of the crops adapted to the climate. (Capability unit IIIe–2; woodland suitability group 1)

Fayette silt loam, valleys, 6 to 12 percent slopes, moderately eroded (FcC2).—Erosion has removed from 2 to 10 inches of the surface layer of this soil, and the hazard of further erosion is moderate. The layers in the profile are thinner than those in the less sloping valley phases of Fayette soils. In some places the surface layer contains a small amount of sandy material from soils on higher slopes. In places tillage has mixed part of the subsoil with material from the surface layer, and the present plow layer in those areas is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is produc ive, but it is necessary to protect it from further erosion. All of the crops adapted to the climate can be grown. (Capability unit IIIe–2; woodland suitability group 1)

Fayette silt loam, valleys, 12 to 18 percent slopes (FcD).—Most of this soil is in pasture or trees, and little

or no erosion has taken place in those areas. However, there is a moderately severe hazard of erosion. In most places the solum is less than 40 inches thick, and the layers are thinner than those in the less sloping valley phases of Fayette soils. There are occasional chunks or fragments of limestone, broken from outcrops in higher areas, on the surface and throughout the profile. In some places the surface layer contains a small amount of sandy material from soils on higher slopes.

Under good management this soil is productive. It is not suited to soybeans, but other crops adapted to the climate can be grown. (Capability unit IVe–2; woodland suitability group 3)

Fayette silt loam, valleys, 12 to 18 percent slopes, moderately eroded (FcD2).—Erosion has removed from 2 to 10 inches of the surface layer of this soil, and there is a moderately severe hazard of further erosion. The solum is less than 40 inches thick in most places. The layers are thinner than those in less sloping valley phases of Fayette soils. Chunks or fragments of limestone, broken from outcrops in higher areas, are on the surface and throughout the profile. In as much as two-thirds of the acreage, tillage has mixed part of the subsoil with material from the surface layer. In those areas the present plow layer is browner than the original one, and it is less friable and more difficult to keep in good tilth. In some places the surface layer contains a small amount of sandy material from soils on higher slopes. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is productive. It is not suited to soybeans, but other crops adapted to the climate can be grown. (Capability unit IVe–2; woodland suitability group 3)

Fayette silt loam, valleys, 18 to 25 percent slopes, moderately eroded (FcE2).—Erosion has removed from 2 to 10 inches of the surface layer of this soil, and there is a severe hazard of further erosion in areas that have been cleared. Part of the acreage is still in pasture or trees. In those areas little or no erosion has taken place, although occasional gullies have developed. The solum is less than 40 inches thick in most places, and the layers are thinner than those in less sloping valley phases of Fayette soils. In some places the surface layer contains a small amount of sandy material from soils on higher slopes. Chunks or fragments of limestone from outcrops in higher areas are on the surface and throughout the profile.

In from one-third to two-thirds of the acreage, tillage has mixed part of the subsoil with material in the surface layer, and the present surface layer in those areas is browner than the original one. The plow layer is also less friable and is more difficult to keep in good tilth than it formerly was. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

This soil is better suited to permanent vegetation than to cultivated crops. (Capability unit VIe–1; woodland suitability group 4)

Fayette silt loam, valleys, 25 to 35 percent slopes (FcF).—Some areas of this soil have been cultivated, but part of the tilled acreage has been returned to pasture and trees. Now, only a small acreage is cultivated. There are a few gullies in the pastures and wooded areas.

In areas that have been cultivated, erosion has removed from 2 to 10 inches of the surface layer, and the hazard of further erosion is very severe. In places tillage has mixed part of the subsoil with the material in the surface layer, and the present surface layer in those areas is browner than the original one. The plow layer is also less friable than it formerly was, and it is more difficult to keep in good tilth. The solum is 36 to 40 inches thick in most places. The layers are thinner than those in less sloping valley phases of Fayette soils. Chunks or fragments of limestone, broken from outcrops in higher areas, are on the surface and throughout the profile. In some places the surface layer contains a small amount of sandy material from soils on higher slopes.

The content of organic matter, the natural fertility, and the available moisture capacity have been reduced in areas that are eroded. Surface runoff is also more rapid, which further reduces the supply of mositure.

This soil needs protection from further erosion. All of it should be returned to pasture or trees. (Capability unit VIe–1; woodland suitability group 4)

Fayette-Renova Complexes

In these complexes Fayette and Renova soils occur together in such an intricate pattern hat it was not feasible to map them separately. The Fayette soils make up about 80 to 85 percent of the acreage. In most places the Renova soils are in small, round areas within areas of the Fayette soils.

The Renova soils tend to be somewhat more gravelly throughout the profile than is typical for the series. The silt cap is thin in the center of areas of Renova soils, but it gradually becomes thicker toward areas of Fayette soils. Representative profiles of these soils are described separately under the Fayette and Renova series.

Fayette-Renova silt loams, 2 to 6 percent slopes, moderately eroded (FrB2).—Erosion has removed from 2 to 6 inches of the surface layer in much of this complex, and there is a slight hazard of further erosion. In places tillage has mixed part of the subsoil with material in the surface layer, and the surface layer in those areas is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management these soils are highly productive. They are suited to all of the crops grown locally. (Capability unit IIe–2; woodland suitability group 16)

Fayette-Renova silt loams, 6 to 12 percent slopes, moderately eroded (FrC2).—Erosion has removed from 2 to 8 inches of the surface layer in most areas of these soils, but in a few places little or no erosion has occurred. The hazard of further erosion is moderate. In places tillage has mixed part of the subsoil with material in the surface layer, and the surface layer in those areas is browner than the original one. The plow layer is also less friable and is more difficult to keep in good tilth, and the content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management these soils are productive. They are suited to all of the crops adapted to the climate. (Capability unit IIIe–2; woodland suitability group 1)

Fayette-Renova silt loams, 12 to 18 percent slopes, moderately eroded (FrD2).—In this complex erosion has removed from 2 to 8 inches of the surface layer of the soils, and the hazard of further erosion is moderately severe. In as much as two-thirds of the acreage, tillage has mixed part of the subsoil with material in the surface layer. The surface layer in those areas is browner than the original one, and the plow layer is less friable and is more difficult to keep in good tilth. The content of organic matter, the natural fertility, and the available moisture capacity have also been reduced.

Under good management these soils are moderately productive. They are not suited to soybeans, but all other crops adapted to the climate can be grown. (Capability unit IVe–2; woodland suitability group 3)

Gale Series

Soils of the Gale series are moderately deep, light colored, and well drained. They developed in thin deposits of loess, or in similar material, over sandstone or sand that has weathered from sandstone. The depth to sandstone or sand ranges from 24 to 42 inches. These soils developed under a hardwood forest.

The following describes a profile of a typical Gale silt loam:

0 to 7 inches, dark-brown, friable silt loam.
7 to 13 inches, dark yellowish-brown, friable silt loam.
13 to 18 inches, brown to dark-brown, friable to firm heavy silt loam.
18 to 27 inches, brown to dark-brown, friable to firm light silty clay loam.
27 to 29 inches, brown to dark-brown, friable silt loam that contains fragments of chert.
29 to 37 inches, yellowish-brown, loose fine sand.
37 inches +, sandstone.

These soils are moderately permeable and are moderate to moderately low in available moisture capacity. Surface runoff is rapid, and internal drainage is medium. Natural fertility is moderate. Normally, the surface layer is slightly acid to medium acid, and the subsoil is strongly acid.

Gale silt loam, 2 to 6 percent slopes, moderately eroded (GaB2).—From 2 to 4 inches of the surface layer of this soil has been lost through erosion, and there is a slight hazard of further erosion. However, some areas where erosion has been only slight are mapped with this soil. In places tillage has mixed part of the subsoil with material in the surface layer, and the present surface layer is browner than the original one. In those areas the content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is moderately productive. It is suited to all of the crops grown locally. The hazard of drought is very slight. (Capability unit IIe–5; woodland suitability group 1)

Gale silt loam, 6 to 12 percent slopes, moderately eroded (GaC2).—Erosion has removed from 2 to 6 inches of the surface layer of this soil, and there is a moderate hazard of further erosion. However, a few areas where erosion has been only slight are mapped with this soil. In places tillage has mixed part of the subsoil with material in the surface layer, and in those places the surface layer is browner than the original one. It is also less friable and is more difficult to keep in good tilth. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is moderately productive. It is not suited to soybeans, but it can be used for all of the other crops generally grown in this county. The hazard of drought is slight. (Capability unit IIIe–4; woodland suitability group 2)

Gale silt loam, 12 to 18 percent slopes, moderately eroded (GaD2).—Erosion has removed from 2 to 8 inches of the surface layer of this soil, and there is a moderately severe hazard of further erosion. In about two-thirds of the acreage, tillage has mixed part of the subsoil with material in the surface layer, and the present plow layer is browner than the original one. It is also less friable and is more difficult to keep in good tilth. The content of organic matter, the natural fertility, and the available mositure capacity have been reduced.

Under good management this soil is moderately productive. It is not suited to soybeans, but it can be used for all the other crops adapted to the climate. The hazard of drought is slight to moderate. (Capability unit IVe–4; woodland suitability group 2)

Gale-Hixton Complexes

The Gale and Hixton soils in some places are shallow and occur together in such an intricate pattern that it is not feasible to map them separately. In such areas they are mapped as complexes of shallow Gale and Hixton soils. The Gale and Hixton soils in these complexes occur in about equal proportions. The Hixton soil has a somewhat finer textured subsoil and more structural development than is typical for Hixton fine sandy loam.

The soils of these complexes are on small hills or knobs within areas of deeper soils. In most places sandstone or sand is less than 18 inches below the surface, but the depth ranges from 12 to 24 inches. Occasional chunks or fragments of sandstone are on the surface and throughout the profile. A few areas in which loam or sandy loam glacial till is directly above the sand or sandstone are mapped with these soils.

In most places the soils in the Gale-Hixton complexes are easy to work. Normally, their surface layer is slightly acid, and their subsoil is strongly acid.

Profiles that are representative of the soils in these complexes are described separately under the Gale and Hixton series.

Gale-Hixton complex, shallow, 6 to 12 percent slopes, moderately eroded (GhC2).—In most places the Hixton soil in this complex is a loam, and it occurs within areas of a silty Gale soil. Erosion has removed from 2 to 6 inches of the surface layer, and there is a moderate hazard of further erosion. In places part of the subsoil has been mixed with material in the surface layer, and the present surface layer in those areas is browner than the original one. Permeability is moderately rapid, and natural fertility is low. The soils also have low available moisture capacity.

These soils can be used for all of the crops adapted to the climate, except soybeans. The hazard of drought is moderate. (Capability unit IVe–6; woodland suitability group 10)

Gale-Hixton complex, shallow, 12 to 18 percent slopes, moderately eroded (GhD2).—In this complex the Hixton soil is generally a loam, and it occurs within areas of a silty Gale soil. From 2 to 6 inches of the surface layer has been lost through erosion, and there is a severe hazard of further erosion. In places part of the subsoil has been mixed with material in the surface layer, and in those areas the present surface layer is browner than the original one. Permeability is moderately rapid, and natural fertility is low. The soils also have low available moisture capacity.

These soils can be used for permanent vegetation, such as hay, pasture, or trees. They are not suited to cultivated crops. The hazard of drought is severe. (Capability unit VIe–3; woodland suitability group 12)

Gale-Hixton complex, shallow, 18 to 25 percent slopes, moderately eroded (GhE2).—In places the soils of this complex are associated with areas of Boone soils. These soils have lost from 2 to 6 inches of their surface layer through erosion, and the hazard of further erosion is severe. In places part of the subsoil has been mixed with material in the surface layer, and in those areas the present surface layer is browner than the original one. Permeability is moderately rapid, and natural fertility is low. The soils also have low available moisture capacity.

These soils are not suited to cultivated crops and should be kept in permanent pasture or trees. The hazard of drought is moderate to severe. (Capability unit VIIe–1; woodland suitability group 12)

Garwin Series

The soils of the Garwin series are deep, dark colored, and poorly drained to very poorly drained. They occur in depressions in the uplands. These soils formed in deep loess under grasses that tolerate water. In some places they are underlain by glacial till, which is at a depth of 4 feet or more. The following describes a typical profile of a Garwin silt loam:

0 to 11 inches, black to very dark brown, very friable silt loam.
11 to 18 inches, very dark gray, firm silty clay loam.
18 to 28 inches, dark grayish-brown, firm light silty clay loam.
28 to 34 inches, olive-gray, friable silt loam.
34 to 40 inches +, grayish-brown, mottled, friable silt loam.

These soils are moderately permeable and drain satisfactorily if artificial drainage is installed. Tile drainage is very effective. The available moisture capacity and the natural fertility are high. Surface runoff is slow to ponded. These soils are slightly acid to neutral.

Garwin silt loam (Gm).—This is the only Garwin soil mapped in this county. It is in nearly level depressions and is subject to moderately severe flooding because of its low position. This soil is flooded frequently by runoff from surrounding uplands, and a small amount of soil material is deposited at those times. The water table is high during the early part of the growing season.

Unless it is drained, this soil is generally not used for cultivated crops. If it is drained, it is productive and is suited to all the field crops adapted to the climate. This soil is not suited to trees. (Capability unit IIIw–3; woodland suitability group 17)

Genesee Series

The Genesee series consists of light-colored, deep, well-drained soils of bottom lands. The soils developed in silty alluvium washed from light-colored loessal soils of the uplands. The natural vegetation was hardwoods, such as willow, cottonwood, soft maple, and ash. The following describes a profile of Genesee silt loam:

0 to 39 inches, very dark grayish-brown, friable silt loam.
39 to 44 inches, very dark grayish-brown, very friable loam with thin layers of very dark brown.
44 to 60 inches +, very dark grayish-brown, very friable fine sandy loam.

These soils are moderately permeable. They have moderately high available moisture capacity and moderately high natural fertility. Their drainage is good, but they are saturated for brief periods after occasional floods, which occur mainly in spring during snowmelt. Usually, the floods early in spring do not prevent use of these soils for cultivated crops, but later floods may cause considerable damage to crops. Normally, these soils are neutral to mildly calcareous.

Genesee sandy loam (Gn).—The profile of this soil is similar to the one described for Genesee silt loam, except that the surface layer is sandy loam, and alternating layers of sandy loam and silt loam are in the lower part. Flooding is a moderate hazard.

This soil is suited to all of the crops adapted to the climate. Normally, however, only corn and soybeans are grown. (Capability unit IIw–3; woodland suitability group 14)

Genesee silt loam (Gs).—This soil is on bottom lands. Most of it is nearly level, but in a small acreage it is gently sloping. This soil is subject to flooding, and the floodwaters deposit additional soil material. In the areas that are most frequently flooded, there are old stream channels.

Where the areas are flooded only occasionally, this soil can be used for all of the crops adapted to the climate. In practice, however, the only crops normally grown are corn and soybeans. The areas that are flooded frequently are used for pasture. (Capability unit IIw–3; woodland suitability group 14)

Hixton Series

Soils of the Hixton series are light colored, moderately deep, and well drained. They are in sloping areas in valleys below outcrops of sandstone, or in the more nearly level uplands in areas where sandstone is near the surface. The slopes range from gentle to steep. These soils developed under hardwood forest in material weathered from fine-grained sandstone or from other sandy residual material. The depth to sandstone ranges from about 20 inches to several feet, but sandstone bedrock or fragments of sandstone are generally within 42 inches of the surface. The following describes a typical profile of a Hixton fine sandy loam:

0 to 8 inches, very dark grayish-brown, very friable fine sandy loam.
8 to 13 inches, very dark grayish-brown and dark yellowish-brown, friable loam.
13 to 21 inches, brown to dark-brown, friable loam.
21 to 26 inches, brown to dark-brown, friable fine sandy loam.
26 to 31 inches, brown to dark-brown, loose sand.
31 inches +, brownish-yellow and very pale brown sandstone.

Surface runoff is rapid on the steeper slopes, and internal drainage is medium. Permeability is moderately rapid. The natural fertility is low, and the available moisture capacity is moderately low. Normally, these soils are medium acid to strongly acid.

Hixton fine sandy loam, 2 to 6 percent slopes (HfB).—This soil is on the sides of valleys and in the uplands. Mapped with it are a few areas that are nearly level and a few areas where loam or sandy loam glacial till overlies the sandstone or material weathered from sandstone. The hazard of drought is moderate, and the hazard of erosion is slight to moderate.

Fair yields of all the crops commonly grown in the county are obtained on this soil. (Capability unit IIIe–6; woodland suitability group 6)

Hixton fine sandy loam, 6 to 12 percent slopes (HfC).—This moderately sloping soil is on the sides of valleys and in the uplands. Mapped with it are a few areas where loam or sandy loam glacial till overlies the sand or sandstone. The hazard of drought is moderately severe to severe, and the hazard of erosion is moderately severe.

This soil is suited to all the crops grown in the county, and yields are fair. (Capability unit IVe–6; woodland suitability group 10)

Hixton fine sandy loam, 12 to 18 percent slopes (HfD).—About half of the acreage of this soil has been kept in pasture or trees, and in those areas little erosion has taken place. Erosion has removed approximately half of the surface layer in the cultivated areas, however, and the hazard of further erosion is severe.

This soil should be kept in some kind of permanent vegetation, and it is especially well suited to pines. The hazard of drought is severe. (Capability unit VIe–3; woodland suitability group 12)

Hixton fine sandy loam, 18 to 35 percent slopes (HfE).—This soil is in moderately steep or steep areas on the sides of valleys or in the uplands. Mapped with it are a few small areas of a soil that has a dark-colored surface layer. Surface runoff and internal drainage are somewhat excessive, and shallow gullies have formed in a few places.

This soil needs to be kept in permanent vegetation. It is too steep for cultivated crops, and those areas that are being tilled should be retired from cultivation and planted to pines. The hazards of drought and erosion are severe. (Capability unit VIIe–1; woodland suitability group 12)

Huntsville Series

The Huntsville series consists of dark-colored, deep, well drained and moderately well drained soils of the bottom lands. They developed in silty alluvium washed from the dark-colored soils of the uplands. The following describes a profile of Huntsville silt loam:

0 to 50 inches, black to very dark brown, very friable silt loam.
50 to 84 inches +, black, very friable silt loam.

These soils are moderately permeable. They have moderately high available moisture capacity and moderately high natural fertility. Surface runoff is slow. These soils are subject to occasional flooding, most of which occurs in spring during snowmelt. Usually, floods in spring do not interfere with planting, but floods later in the season may cause considerable damage to crops. Flood damage is more likely to occur in areas of narrow bottom lands than in other places. These soils are neutral to mildly calcareous.

Huntsville silt loam (Hu).—This is the only Huntsville soil mapped in the county. It is mainly on wide bottom lands. In most of the acreage, this soil is nearly level, but in a small part it is gently sloping. The texture of the surface layer is silt loam or loam. The hazard of flooding is slight to moderate.

This soil is suited to all the crops adapted to the climate, but corn and soybeans are the major crops. Yields are high unless the crops are damaged by floods. (Capability unit IIw–3; woodland suitability group 14)

Judson Series

The Judson series consists of dark-colored, deep soils that are well drained to moderately well drained. The soils formed in silty material that washed or was carried by gravity from soils in higher positions. The soils are on upland drainageways and in gently sloping areas between the first bottoms or terraces and the uplands. Other areas are at the upper ends of deep, narrow valleys where there is no regular stream channel. The following describes a profile of a Judson silt loam:

0 to 35 inches, very dark brown, friable silt loam.
35 to 45 inches, black, friable silt loam.
45 to 49 inches, very dark grayish-brown and very dark brown, friable silt loam.
49 to 57 inches, dark-brown to dark grayish-brown, friable silt loam.
57 to 68 inches, dark grayish-brown, friable silt loam.
68 to 72 inches +, dark grayish-brown, mottled, friable silt loam.

These soils are moderately permeable. Surface runoff and internal drainage are medium. The soils have high natural fertility and high available moisture capacity. They are subject to flooding for brief periods. These soils are normally slightly acid to neutral.

Judson silt loam, 0 to 2 percent slopes (JuA).—This soil is in nearly level drainageways where there is a slight to moderate hazard of flooding. It is generally farmed with the surrounding soils, but most of the narrow areas are kept in meadow for waterways.

Under good management this soil is highly productive. It is suited to all the crops grown locally. (Capability unit IIw–3; woodland suitability group 14)

Judson silt loam, 2 to 6 percent slopes (JuB).—This soil is in gently sloping drainageways. There is a slight to moderate hazard of flooding, but the floodwaters usually remain for only a short time. Included in mapping are a few areas where the slopes are greater than 6 percent.

This soil is highly productive if it is well managed. It is suited to all the crops grown locally. (Capability unit IIw–4; woodland suitability group 14)

Lindstrom Series

The Lindstrom series consists of moderately dark to dark, well-drained, gently sloping to steep soils on valley slopes. The soils are deep and well drained. They developed under prairie grasses in silty loess that ranges from 4 to 10 feet in depth. The loess is underlain by sand or by sandstone or limestone bedrock. Occasional fragments or large chunks of sandstone or limestone are on the surface or in the soil profile. In places the sur-

face layer is gritty because it contains fine sand that has washed from sandy soils or from sandstone in higher areas. The following describes a profile of a Lindstrom silt loam:

0 to 10 inches, black to very dark brown, very friable silt loam.
10 to 15 inches, very dark gray to very dark brown, very friable silt loam.
15 to 26 inches, very dark grayish-brown to dark-brown, friable, heavy silt loam.
26 to 42 inches, brown to dark yellowish-brown, friable silt loam.
42 to 48 inches, dark yellowish-brown, friable silt loam.
48 to 60 inches, brown to yellowish-brown, friable silt loam.
60 to 84 inches +, yellowish-brown, very friable, coarse silt loam to very fine sandy loam.

These soils are moderately permeable. They have medium to rapid surface runoff, and medium internal drainage. The available moisture capacity is high, and natural fertility is moderately high. These soils are normally free of stones and are easy to work. The areas that are not used for cultivated crops or pasture are mostly in timber. Normally, the soils are medium acid.

Lindstrom silt loam, 2 to 6 percent slopes (LnB).—This soil is on gentle, concave valley slopes. In places the dark-colored material in the surface layer is as much as 18 inches thick. There are few, if any, fragments of sandstone or limestone on the surface. The hazard of erosion is slight.

Under good management this soil is highly productive. It is suited to all the crops grown locally. (Capability unit IIe–1; woodland suitability group 16)

Lindstrom silt loam, 6 to 12 percent slopes (LnC).—This moderately sloping soil is on the sides of valleys. It has lost less than 25 percent of the original surface layer through erosion. There is a moderate hazard of further erosion.

Under good management this soil is productive. It is suited to all the crops grown locally. (Capability unit IIIe–1; woodland suitability group 1)

Lindstrom silt loam, 6 to 12 percent slopes, moderately eroded (LnC2).—This soil is on the sides of valleys; it has lost from 2 to 6 inches of its surface layer through erosion, and there is a moderate hazard of further erosion. There are a few gullies. In places tillage has mixed part of the subsoil with material from the surface layer, and in those spots the present surface layer is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is moderately productive. It is suited to all the crops grown locally. (Capability unit IIIe–1; woodland suitability group 1)

Lindstrom silt loam, 12 to 18 percent slopes (LnD).—This soil of valley slopes has lost less than 25 percent of the original surface layer through erosion, but there is a moderately severe hazard of further erosion.

Under good management this soil is productive. It is suited to all the crops grown locally, except soybeans. Much of the acreage is used for pasture or trees. (Capability unit IVe–1; woodland suitability group 3)

Lindstrom silt loam, 12 to 18 percent slopes, moderately eroded (LnD2).—From 2 to 6 inches of the surface layer of this soil has been removed by erosion, and the hazard of further erosion is moderately severe. In as much as two-thirds of the acreage, tillage has mixed part of the subsoil with material from the surface layer, and in those places the present surface layer is browner than the original one. The soil is also less friable and is more difficult to keep in good tilth. In addition the content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is moderately productive. It is not suited to soybeans, but all the other crops adapted to the climate can be grown. (Capability unit IVe–1; woodland suitability group 3)

Lindstrom silt loam, 18 to 25 percent slopes, moderately eroded (LnE2).—Erosion has removed from 2 to 8 inches of the surface layer of this soil, and the hazard of further erosion is severe. There are occasional gullies. About half of the acreage is in trees or permanent pasture, and little or no erosion has taken place in those areas. In as much as two-thirds of the acreage, however, tillage has mixed part of the subsoil with material in the surface layer, and in those areas the present plow layer is browner than the original one. It is also less friable and is more difficult to keep in good tilth. In addition, the content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

If this soil is used for cultivated crops, careful management is required to protect it from further erosion. It is better suited to permanent vegetation than to row crops. (Capability unit VIe–1; woodland suitability group 4)

Medary Series, Brown Variants

No typical soils of the Medary series are mapped in this county, but two brown variants of that series are mapped. Like the typical Medary soils, these brown variants are light colored, deep, and moderately well drained. They are nearly level or gently sloping and are on high terraces along minor tributaries of the Mississippi River. These soils developed under hardwood forest in slack-water deposits of silt and clay. In most places the clay is reddish, but in a few places it is brown, yellow, or gray. The silt overlies the clay, and its thickness varies. The following describes a profile of a Medary silt loam, brown variant:

0 to 8 inches, dark-gray to dark grayish-brown, friable silt loam.
8 to 14 inches, brown, firm silty clay loam to silty clay.
14 to 24 inches, brown to dark-brown, very firm clay.
24 to 40 inches, grayish-brown to brown, firm clay.
40 to 64 inches +, reddish-brown and grayish-brown bands of very firm clay.

The Medary soils have moderately high available moisture capacity and moderately high natural fertility. Surface runoff is medium, and internal drainage is slow. Permeability is slow to moderately slow. Normally, these soils are medium acid, but in places their subsoil is very strongly acid. The reddish-brown clay below the subsoil is neutral to mildly calcareous.

Medary silt loam, brown variant, 0 to 2 percent slopes (MbA).—Little or no erosion has taken place on this soil of high terraces, and the hazard of erosion is very slight. This soil is underlain by stratified sand, silt, and clay at a depth greater than 6 feet.

This soil is productive. It has no serious limitations that restrict intensive use for row crops. It is suited to all of the crops grown locally. (Capability I–2; woodland suitability group 16)

Medary silt loam, brown variant, 2 to 6 percent slopes (MbB).—Erosion has removed a small part of the original surface layer of this soil of high stream terraces, and there is a slight hazard of further erosion. The soil is underlain by stratified sand, silt, and clay at a depth greater than 6 feet.

Under good management this soil is productive. It is suited to all of the crops normally grown in the county. (Capability unit IIe–2; woodland suitability group 16)

Meridian Series

The Meridian series consists of light-colored, moderately deep, well-drained soils that are nearly level to strongly sloping. The soils are on stream terraces, and they developed under a forest of hardwoods. They are underlain, at a depth of 2 to 3 feet, by stratified sand derived from sandstone. A small amount of loess is mixed with the material from sandstone, and in a few places there is glacial outwash. The following describes a profile of a Meridian sandy loam:

0 to 11 inches, very dark grayish-brown, very friable sandy loam.
11 to 23 inches, dark-brown to brown, friable loam.
23 to 28 inches, dark-brown to brown, friable fine sandy loam.
28 to 44 inches, yellowish-brown, loose fine sand.
44 to 100 inches +, light yellowish-brown, loose fine sand.

These soils are moderately low in natural fertility and in available moisture capacity. Permeability is moderately rapid. Surface runoff and internal drainage are medium. Normally, the surface layer of these soils is medium acid, and the subsoil is strongly acid.

Meridian sandy loam, 0 to 2 percent slopes (MdA).—This soil is on stream terraces. There is a slight hazard of wind erosion and a moderate hazard of drought.

This soil is suited to all of the crops adapted to the climate. Yields are fair. (Capability unit IIIs–1; woodland suitability group 6)

Meridian sandy loam, 2 to 6 percent slopes (MdB).—This soil is on stream terraces. There is a slight hazard of erosion by both wind and water and a moderate hazard of drought.

This soil is suited to all the crops adapted to the climate. Yields are fair. (Capability unit IIIe–6; woodland suitability group 6)

Meridian sandy loam, 2 to 6 percent slopes, moderately eroded (MdB2).—From 2 to 6 inches of the original surface layer of this soil has been removed by erosion, and there is a slight hazard of further erosion by both wind and water. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. The hazard of drought is moderate.

This soil is suited to all of the crops adapted to the climate. Yields are fair. (Capability unit IIIe–6; woodland suitability group 6)

Meridian sandy loam, 6 to 12 percent slopes (MdC).—Little or no erosion has taken place on this soil, but erosion is a moderate hazard. The hazard of drought is also moderate.

This soil is suited to all the crops grown locally. Yields are fair. (Capability unit IVe–6; woodland suitability group 10)

Meridian sandy loam, 6 to 12 percent slopes, moderately eroded (MdC2).—More than one-third of the original surface layer of this soil has been removed by erosion, and there is a moderate hazard of further erosion. In places part of the subsoil has been mixed with material in the surface layer, and in those areas the present surface layer is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. The hazard of drought is moderate.

This soil is suited to all of the crops grown locally. Yields are fair. (Capability unit IVe–6; woodland suitability group 10)

Minneiska Series

The Minneiska series consists of dark-colored, moderately well drained to somewhat poorly drained soils of the bottom lands. These soils are on the flood plains of the larger rivers in the county. They developed in medium-textured material, 18 to 30 inches thick, over fine sand and medium sand. Normally, the medium-textured material is about 21 inches thick. The following describes a profile of Minneiska silt loam:

0 to 21 inches, very dark brown, friable silt loam.
21 to 27 inches, very dark brown to very dark grayish-brown, loose sandy loam to loamy sand.
27 to 33 inches, dark grayish-brown to grayish-brown, loose medium sand.
33 to 60 inches +, dark grayish-brown to grayish-brown, loose fine sand that contains a few coarser fragments.

These soils are moderately high in natural fertility and have moderate available moisture capacity. Surface runoff is slow, but permeability and internal drainage are moderately rapid. The water table fluctuates and is high at times because it is affected by the dams in the Mississippi River. These soils are neutral to mildly calcareous.

Minneiska silt loam (Mn).—This is the only Minneiska soil mapped in the county. It is on bottom lands. Most of the acreage is nearly level, but some areas are gently sloping. Mapped with this soil are a few small areas of a soil that has a surface layer and subsoil of fine sandy loam.

The water table is periodically high in this soil, and there is a slight to moderate hazard of flooding. Damaging floods occur, however, only once in about 5 to 10 years. The hazard of drought is slight.

This soil is highly productive and is suited to all of the crops adapted to the climate. Most of the acreage is used to grow corn and soybeans. (Capability unit IIw–3; woodland suitability group 14)

Mt. Carroll Series

The Mt. Carroll series consists of moderately dark colored, deep, well-drained soils of uplands and benches. The bench phases of these soils are nearly level or gently sloping and are on high terraces along streams. The other Mt. Carroll soils have slopes of 4 to 12 percent. The Mt. Carroll soils developed under mixed forest and

prairie grasses in loess that is 6 to 8 feet thick. Beneath the loess is loam and clay loam glacial till or limestone.

In this county the Mt. Carroll soils are so intermingled with the Downs soils that it is impractical to map them separately. They are mapped in undifferentiated units and named as Downs and Mt. Carroll silt loams. The major difference between the soils of the two series is in the content of clay in the subsoil. The subsoil of the Mt. Carroll soils is less than 26 percent clay, and the subsoil of the Downs soils is more than 26 percent clay. The content of clay in the subsoil of both the Mt. Carroll and the Downs soils ranges from 24 to 28 percent (7).

The following describes a typical profile of a Mt. Carroll silt loam:

0 to 8 inches, very dark brown to very dark grayish-brown, friable silt loam.
8 to 30 inches, dark-brown to brown, friable silt loam.
30 to 62 inches, yellowish-brown, friable silt loam.
62 to 72 inches, yellowish-brown to light yellowish-brown, friable, coarse silt loam that is mottled with brownish yellow.
72 to 84 inches +, light brownish-gray, very friable, coarse silt loam that has splotches of strong brown and reddish yellow.

Muscatine Series

The Muscatine series consists of dark-colored, deep, somewhat poorly drained soils that are nearly level to gently sloping. The soils are mainly at the heads of drainageways in the uplands.

These soils formed in deep to moderately deep loess under mixed forest and grass. In many places glacial till is within 3 or 4 feet of the surface, and recent deposits are on the surface in places. The following describes a profile of a Muscatine silt loam:

0 to 13 inches, black, friable silt loam.
13 to 19 inches, very dark grayish-brown, friable heavy silt loam.
19 to 32 inches, dark grayish-brown and very dark grayish-brown, mottled, friable heavy silt loam.
32 to 40 inches +, grayish-brown, mottled, friable silt loam.

These soils have moderate to moderately slow permeability. Surface runoff is slow to medium, and internal drainage is medium. The natural fertility and the available moisture capacity are moderately high to high. The soils are free of stones and are easy to work. Normally, their subsoil is medium to slightly acid.

Muscatine silt loam, 0 to 2 percent slopes (MuA).—This soil is in the uplands. It has a moderate hazard of wetness, and adequate drainage is needed to make it suitable for cultivation. Included in the mapping are a few areas of a poorly drained soil.

This soil is highly productive and has no serious limitations. Row crops can be grown intensively if drainage has been installed. (Capability unit IIw–1; woodland suitability group 17)

Muscatine silt loam, 2 to 6 percent slopes (MuB).—This soil is mainly in the heads of drainageways. The hazard of erosion is slight, but there is a moderate hazard of wetness. Tile drainage is necessary in part of the acreage.

This soil is highly productive if it is drained and properly managed. It is suited to all the crops adapted to the climate. (Capability unit IIw–2; woodland suitability group 17)

Osseo Series

The Osseo series consists of light-colored, deep, somewhat poorly drained to poorly drained soils of the bottom lands. The soils developed in alluvium washed from light-colored soils of the uplands. The natural vegetation was mainly sedges and willows, but it included some trees in wooded areas. The following describes a profile of Osseo silt loam:

0 to 19 inches, very dark grayish-brown, friable silt loam.
19 to 29 inches, very dark gray, prominently mottled, friable silt loam.
29 to 35 inches, black, firm silty clay loam.
35 to 60 inches +, gray, prominently mottled, firm silty clay loam.

The soil material in the upper part of the profile is moderately permeable, but the underlying clayey material is slowly permeable. The natural fertility and the available moisture capacity are moderately high. The soils are flooded frequently. Floods occur at any time during spring or summer, but they are usually of short duration. Normally, the soils are slightly acid to neutral.

Osseo silt loam (Os).—This is the only Osseo soil mapped in the county. It is nearly level and is on bottom lands. Mapped with this soil are a few small areas of a soil that is similar to the Osseo soil to a depth of 2 to 3 feet, but is underlain by 2 to 3 feet of peat or muck.

The hazard of flooding is severe, and the hazard of wetness is moderately severe. This soil is suited only to permanent pasture. (Capability unit VIw–1; woodland suitability group 15)

Plainfield Series

The Plainfield series consists of light-colored, deep, excessively drained, sandy soils on river terraces. The soils range from nearly level to moderately sloping. The sloping areas contain mounds that resemble dunes. These soils formed under oak forest in fine and medium alluvial sands, chiefly quartz.

The following describes a profile of a Plainfield fine sand:

0 to 7 inches, dark-brown to dark yellowish-brown, loose fine sand to loamy fine sand.
7 to 22 inches, dark-brown, loose fine and medium sand.
22 to 26 inches, dark-brown, loose medium sand.
26 to 60 inches +, dark yellowish-brown, loose medium and coarse sand.

These soils are rapidly permeable and are low to very low in natural fertility and in available moisture capacity. Surface runoff is slow to medium, and internal drainage is rapid. The soils are very droughty. They are normally strongly acid.

Plainfield fine sand, 0 to 2 percent slopes (PaA).—This soil is on stream terraces. The hazard of drought is severe, and there is a slight to moderate hazard of wind erosion. Yields are so low in most areas that it is better to convert this soil to the growing of pines. (Capability unit VIIs–1; woodland suitability group 8)

Plainfield fine sand, 2 to 6 percent slopes (PaB).—This soil is on stream terraces where the slopes are complex and irregular. There is a moderate to severe hazard of drought and a moderate hazard of erosion. Some erosion by both wind and water is taking place. Yields are low

on this soil; therefore, it is better to use the cultivated areas for pines. (Capability unit VIIs–1; woodland suitability group 8)

Plainfield fine sand, 6 to 12 percent slopes (PaC).—This soil is on stream terraces where the topography is like that in areas of dunes. There is a severe hazard of drought and a moderate hazard of erosion by both wind and water. Where this soil is used for cultivated crops, yields are low. The soil is better suited to pines. (Capability unit VIIs–1; woodland suitability group 13)

Port Byron Series

Deep, dark-colored, well-drained soils that are nearly level to moderately sloping make up the Port Byron series. These soils are on uplands. They developed under prairie vegetation in deep, coarse-textured loess that ranges from 4 to 15 feet in thickness. The loess is underlain by loam or clay loam glacial till or by limestone or sandstone bedrock. The following describes a profile of a Port Byron silt loam:

0 to 7 inches, very dark brown, friable silt loam.
7 to 11 inches, very dark grayish-brown to dark-brown, friable silt loam.
11 to 20 inches, dark yellowish-brown, friable silt loam.
20 to 30 inches, dark-brown to brown, friable silt loam.
30 to 60 inches +, dark yellowish-brown, friable silt loam.

These soils are moderately permeable. They have moderately high available moisture capacity and moderate natural fertility. Surface runoff is medium, and internal drainage is moderate. Normally, the surface layer of these soils is neutral to slightly acid, and the subsoil is slightly acid to medium acid. The material below a depth of 4 feet, however, is moderately calcareous. These soils are free of stones and are easy to work.

Port Byron silt loam, 0 to 2 percent slopes (PbA).—Normally, this soil is not subject to erosion. It is productive and is suited to all the crops grown locally. Under good management there are no serious limitations that hinder its intensive use for row crops. (Capability unit I–1; woodland suitability group 16)

Port Byron silt loam, 2 to 6 percent slopes (PbB).—This soil has lost less than 25 percent of its surface layer through erosion, but there is a slight to moderate hazard of further erosion. Under good management this soil is productive. It is suited to all the crops grown locally. (Capability unit IIe–1; woodland suitability group 16)

Port Byron silt loam, 2 to 6 percent slopes, moderately eroded (PbB2).—From 2 to 6 inches of the surface layer of this soil has been lost through erosion, and there is a slight to moderate hazard of further erosion. In places tillage has mixed part of the subsoil with material from the surface layer. In those places the present surface layer is browner than the original one, and the content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is highly productive. It is suited to all the crops grown in the county. (Capability unit IIe–1; woodland suitability group 16)

Port Byron silt loam, 6 to 12 percent slopes (PbC).—This soil of the uplands has lost less than 25 percent of its surface layer through erosion, but there is a moderate hazard of further erosion. Under good management this is a productive soil. It is suited to all the crops grown locally. (Capability unit IIIe–1; woodland suitability group 16)

Port Byron silt loam, 6 to 12 percent slopes, moderately eroded (PbC2).—This soil of the uplands has lost from 2 to 6 inches of its surface layer through erosion, and there is a moderate hazard of further erosion. In places tillage has mixed part of the subsoil with the material in the surface layer, and the present surface layer is browner than the original one. In those areas this soil is less productive than in other places, but it is not harder to work. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is productive. It is suited to all the crops grown locally. (Capability unit IIIe–1; woodland suitability group 16)

Port Byron silt loam, benches, 0 to 2 percent slopes (PoA).—In most places this soil of stream terraces is underlain by stratified sand or gravel at a depth below 8 feet. In places the sand and gravel are mixed.

This soil is productive, and it is not subject to erosion. If it is well managed, it has no serious limitations that hinder intensive use for row crops. This soil is suited to all the crops grown in the county. (Capability unit I–1; woodland suitability group 16)

Port Byron silt loam, benches, 2 to 6 percent slopes (PoB).—Little erosion has taken place on this soil, but there is a slight to moderate hazard of erosion. The soil is underlain at a depth of about 8 feet by stratified sand or gravel. In places the sand and gravel are mixed.

Under good management this soil is highly productive. It is suited to all the crops grown locally. (Capability unit IIe–1; woodland suitability group 16)

Racine Series

The Racine series consists of moderately dark, deep, well-drained soils of the uplands. The soils are nearly level to strongly sloping. They developed in medium-textured glacial till of Iowan age. The till is covered in places by a thin silt cap of loess. The mantle of silt ranges from 0 to 24 inches in thickness, but in most places it is about 18 inches thick. In most of the areas where the silt is less than 6 inches thick, the texture of the surface layer is loam. The glacial till is underlain by limestone or sandstone at a depth of 4 feet or more. The original vegetation was a hardwood forest, alternating with tall prairie grasses. The following describes a profile of a Racine silt loam:

0 to 6 inches, very dark brown, friable loam to silt loam.
6 to 13 inches, very dark brown to very dark grayish-brown, friable loam to silt loam.
13 to 30 inches, dark yellowish-brown, friable to firm loam to clay loam.
30 to 37 inches, dark-brown, friable fine sandy loam.
37 to 40 inches, light olive-brown and brown or dark-brown, friable silt loam.
40 to 43 inches, dark yellowish-brown, friable fine sandy loam.
43 to 51 inches +, yellowish-brown, friable clay loam.

These soils are moderately permeable and have moderately high natural fertility. Their available moisture capacity is high. In places occasional stones or boulders interfere with cultivation. Normally, the surface layer is medium acid, but the subsoil is strongly acid.

Racine silt loam, 0 to 2 percent slopes (RaA).—Little or no erosion has taken place on this soil, and the hazard of erosion is very slight. This soil is productive, and under good management it has no serious limitations that hinder intensive use for row crops. It is suited to all the crops normally grown in the county. (Capability unit I–1; woodland suitability group 16)

Racine silt loam, 2 to 6 percent slopes (RaB).—Less than 25 percent of the surface layer of this soil has been lost through erosion, but there is a moderate hazard of further erosion. Under good management this soil is productive. It is suited to all the crops grown in the county. (Capability unit IIe–1; woodland suitability group 16)

Racine silt loam, 2 to 6 percent slopes, moderately eroded (RaB2).—From 2 to 6 inches of the surface layer of this soil has been lost through erosion, and there is a moderate hazard of further erosion. In places tillage has mixed part of the subsoil with material in the surface layer. In those areas the present surface layer is browner than the original one, and the content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is productive. It is suited to all the crops grown in the county. (Capability unit IIe–1; woodland suitability group 16)

Racine silt loam, 6 to 12 percent slopes, moderately eroded (RaC2).—In most places this soil has lost from 2 to 6 inches of its surface layer through erosion, but erosion has been only slight in a small part of the acreage. The hazard of further erosion is moderate to moderately severe. In some places tillage has mixed part of the subsoil with the material in the surface layer, and the present surface layer is browner than the original one. In such spots this soil is more difficult to work and is less productive than in the less eroded areas. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is moderately productive. It is suited to all the crops grown locally. (Capability unit IIIe–1; woodland suitability group 1)

Racine silt loam, 12 to 18 percent slopes, moderately eroded (RaD2).—From 2 to 8 inches of the surface layer of this soil has been lost through erosion, and the hazard of further erosion is moderately severe. In many places tillage has mixed part of the subsoil with the material in the surface layer. In such spots the present surface layer is browner than the original one, the soil is more difficult to work, and it is less productive than in the less eroded areas. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is moderately productive. Except for soybeans, it is suited to all the crops grown in the county. (Capability unit IVe–1; woodland suitability group 3)

Renova Series

The Renova series consists of light-colored, deep, well-drained glacial soils of the uplands. The slopes range from gentle to steep. These soils developed under mixed hardwood forest in medium-textured glacial till that is covered in places by a thin silt cap of loess that is less than 2 feet thick. The glacial till is underlain by limestone or sandstone at a depth of 4 feet or more. Occasional stones or boulders that interfere with cultivation are on the surface and in the plow layer. The following describes a profile of a Renova silt loam:

0 to 8 inches, very dark grayish-brown to dark grayish-brown, friable silt loam.
8 to 13 inches, dark yellowish-brown to yellowish-brown, friable, heavy silt loam.
13 to 20 inches, brown to dark-brown, firm, light silty clay loam.
20 to 27 inches, dark yellowish-brown to yellowish-brown, firm clay loam.
27 to 36 inches, brown to dark-brown, firm sandy loam to sandy clay loam.
36 to 60 inches +, brown to dark-brown, firm sandy clay loam.

These soils are moderately permeable. They have moderately high available moisture capacity and moderate natural fertility. Normally, the surface layer is medium acid and the subsoil is strongly acid.

Renova silt loam, 2 to 6 percent slopes (ReB).—This soil has lost less than 25 percent of its surface layer through erosion, and there is a slight to moderate hazard of further erosion. Mapped with this soil are a few small areas of a nearly level soil.

Under good management yields are moderately high. This soil is suited to all the crops grown locally. (Capability unit IIe–2; woodland suitability group 16)

Renova silt loam, 2 to 6 percent slopes, moderately eroded (ReB2).—From 2 to 6 inches of the surface layer of this soil has been lost through erosion, and there is a moderate hazard of further erosion. In places tillage has mixed part of the subsoil with material in the plow layer, and the present plow layer is browner than the original one. In such spots this soil is harder to work and is less productive than that in the less eroded areas. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is moderately productive. It is suited to all the crops grown locally. (Capability unit IIe–2; woodland suitability group 16)

Renova silt loam, 6 to 12 percent slopes (ReC).—Less than 25 percent of the surface layer of this soil has been removed by erosion, but the hazard of further erosion is moderate. Some of the acreage has been kept in trees.

Under good management this soil is productive. It is suited to all the crops normally grown in the county. (Capability unit IIIe–2; woodland suitability group 1)

Renova silt loam, 6 to 12 percent slopes, moderately eroded (ReC2).—From 2 to 6 inches of the surface layer of this soil has been removed by erosion, and the hazard of further erosion is moderate. In places tillage has mixed part of the subsoil with material in the surface layer, and the present surface layer is browner than the original one. In such spots the soil is harder to work and is less productive than in the less eroded areas. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Under good management this soil is productive. It is suited to all the crops grown in the county. (Capability unit IIIe–2; woodland suitability group 1)

Renova silt loam, 12 to 18 percent slopes (ReD).—Less than 25 percent of the surface layer of this soil has been removed by erosion, but the hazard of further erosion is moderately severe. Some of the acreage has been kept in trees.

Under good management this soil is productive. It is suited to all the crops grown in the county, except soybeans. (Capability unit IVe–2; woodland suitability group 3)

Renova silt loam, 12 to 18 percent slopes, moderately eroded (ReD2).—From 2 to 8 inches of the original surface layer of this soil has been removed by erosion, and the hazard of further erosion is moderately severe. In places tillage has mixed part of the subsoil with material in the surface layer, and the present surface layer is browner than the original one. In such spots this soil is harder to work and is less productive than in the less eroded areas because the content of organic matter, the natural fertility, and the available moisture capacity have been reduced. It is suited to all the crops grown in the county, except soybeans. (Capability unit IVe–2; woodland suitability group 3)

Renova silt loam, 18 to 25 percent slopes, moderately eroded (ReE2).—In some places this soil has been cultivated. In those areas from 2 to 8 inches of the surface layer has been removed by erosion and the hazard of further erosion is severe. In places tillage has mixed part of the subsoil with the material in the surface layer and the present surface layer is browner than the original one. In those places this soil is also harder to work. It is less productive than it formerly was because the content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

This soil is better suited to permanent hay, pasture, or trees than to cultivated crops. Mapped with it are a few small areas that are only slightly eroded because they have been kept in trees or permanent pasture. (Capability unit VIe–1; woodland suitability group 4)

Renova silt loam, 25 to 35 percent slopes, moderately eroded (ReF2).—From 2 to 8 inches of the surface layer of this soil has been lost through erosion, and the hazard of further erosion is very severe. In places tillage has mixed part of the subsoil with material in the surface layer and the present surface layer is browner than the original one. In those places this soil is also harder to work. It is less productive than it formerly was because the content of organic matter, the natural fertility, and the available mositure capacity have been reduced. Because of its steep slopes, this soil can be protected best if kept in permanent vegetation, such as pasture or trees. Mapped with it are a few gravelly areas. (Capability unit VIe–1; woodland suitability group 4)

Renova-Wykoff Complexes

In some places the Renova and Wykoff soils occur together in such an intricate pattern that it is not feasible to map them separately. The Renova soils occupy about 70 to 75 percent of the acreage, and the Wykoff soils occupy about 25 to 30 percent. In most places the Wykoff soils are in small, round or elongated areas within areas of the Renova soils. They are more permeable than the Renova soils, and they are more subject to drought.

The Renova and Wykoff soils are loams, and the soils of both series are generally underlain by coarse-textured glacial drift. In the Renova soils the coarse-textured material, where it is present, is at a depth of 42 inches or deeper, and it underlies medium-textured till. In the Wykoff soils the coarse-textured material is at a depth ranging from 12 to 42 inches, but it generally is at a depth between 24 and 30 inches. The coarse-textured material is not present in all areas.

A profile that is representative of the Renova soils is described under the Renova series, and a profile that is typical of the Wykoff soils is described under the Wykoff series.

Renova-Wykoff loams, 2 to 6 percent slopes, moderately eroded (RkB2).—These soils of the uplands have gentle, irregular slopes. From 2 to 6 inches of the surface layer has been lost through erosion, and there is a slight to moderate hazard of further erosion. There is also a slight hazard of drought, especially in the areas occupied by the Wykoff soil.

Under good management these soils are moderately productive. They are suited to all the crops normally grown in the county. (Capability unit IIe–5; woodland suitability group 1)

Renova-Wykoff loams, 6 to 12 percent slopes, moderately eroded (RkC2).—These soils of the uplands have moderate, irregular slopes. Erosion has removed from 2 to 6 inches of the surface layer, and there is a moderate hazard of further erosion. There is also a slight hazard of drought in the areas of Wykoff soil.

These soils are suited to all the crops normally grown in the county, except soybeans. Yields are fair. (Capability unit IIIe–4; woodland suitability group 2)

Renova-Wykoff loams, 12 to 18 percent slopes, moderately eroded (RkD2).—These soils are in the uplands and have strong, irregular slopes. From 2 to 8 inches of the surface layer has been removed by erosion, and the hazard of further erosion is moderately severe. The hazard of drought is slight to moderate on the Wykoff soil.

These soils are suited to all of the crops normally grown in the county, except soybeans. Yields are fair. (Capability unit IVe–4; woodland suitability group 2)

Riverwash (Rv)

Riverwash is essentially bare Alluvial land, and it is commonly sandy. It is exposed along streams when the level of the water is low. The materials are likely to be shifted when the level of the water is high.

This miscellaneous land type supports little or no vegetation. It has no value for agriculture, but some areas have value for wildlife. (Capability unit VIIw–1; woodland suitability group 17)

Seaton Series

Deep, light-colored, well-drained soils of the uplands make up the Seaton series. The Seaton soils are strongly sloping to steep. They developed under hardwood forest in deep, silty loess that contains a large proportion of coarse silt. The loess is of more recent origin than that underlying the Fayette soils, and it is less deeply leached.

In this county the Seaton soils are mapped only with the Bold soils in a mapping unit described under Seaton-Bold complexes. The following describes a profile of a Seaton silt loam:

0 to 9 inches, very dark gray to very dark grayish-brown, very friable silt loam.
9 to 18 inches, yellowish-brown, very friable silt loam.
18 to 27 inches, dark yellowish-brown, very friable silt loam.
27 to 50 inches, yellowish-brown, very friable, coarse silt loam.
50 to 60 inches +, pale-brown, very friable very fine sandy loam.

These soils are moderately permeable, and they have moderately high available moisture capacity. Their natural fertility is moderate, they are free of stones, and they are easy to work. Normally, the surface layer and the subsoil are slightly acid to medium acid, but the underlying material is mildly to moderately calcareous.

Seaton-Bold Complexes

The Seaton and Bold soils in this county are too intricately mixed to be mapped separately. The Bold soils are generally on knobs or on points where the slope breaks to steeper soils. They are surrounded by areas of Seaton soils, which grade toward the Fayette soils. Profiles that are representative of these soils are described separately under the Seaton and Bold series.

Seaton-Bold soils, 12 to 18 percent slopes, moderately eroded (SbD2).—In this complex are the only Seaton and Bold soils mapped in this county. The Seaton soils make up about 75 percent of the acreage, and the Bold soils make up about 25 percent. The soils are on uplands where the slopes are strong and irregular. Erosion has removed from 4 to 12 inches of their surface layer, and further sheet erosion is a severe hazard.

These soils are moderately productive. Except for soybeans, all of the crops normally grown in the county can be grown. These soils are well suited to alfalfa. (Capability unit IVe–2; woodland suitability group 3)

Sogn Series

The Sogn series consists of dark-colored, very shallow, excessively drained soils of the uplands. The soils are gently sloping to steep and are on the tops of old landforms, mainly on the hills southwest of Elgin. Outcrops of bedrock and fragments of limerock are on the surface and throughout the soil profile. These soils developed under prairie vegetation in material weathered from limestone of the Platteville and Galena formations. Part of the acreage is now occupied by oak forest. The following describes a profile of Sogn silt loam:

0 to 3 inches, black to very dark brown, friable silt loam.
3 to 7 inches, very dark brown to very dark grayish-brown, friable silt loam that contains many fragments of light yellowish-brown limestone.
7 inches +, platy, fragmented limestone bedrock.

These soils are moderately permeable. They have very low available moisture capacity and low natural fertility. Surface runoff is medium to rapid, and internal drainage is rapid. These soils are very droughty.

Sogn soils (So).—In this unit are the only Sogn soils mapped in the county. The soils are very shallow, and they are on the tops of old landforms that rise about 200 feet above the normal level of the uplands. They are well drained to excessively drained. The hazard of drought is severe to very severe, and the hazard of further erosion is very severe.

These soils are suited to permanent pasture, but their best use is probably for trees. Those areas that are now wooded should be kept in trees. (Capability unit VIIs–1; woodland suitability group 5)

Sparta Series

The Sparta series consists of nearly level or gently sloping, dark or moderately dark soils on river terraces. The soils are deep and excessively drained. They developed under sparse prairie grasses in fine and medium alluvial sands, chiefly quartz. The following describes a profile of a Sparta loamy fine sand:

0 to 30 inches, very dark gray, loose loamy fine sand.
30 to 40 inches, dark-brown, loose loamy fine sand.
40 to 44 inches, dark-brown and yellowish-brown, loose sand.
44 to 72 inches +, yellowish-brown, loose sand.

These soils are rapidly permeable and have low to very low natural fertility and available moisture capacity. Surface runoff is slow, but internal drainage is rapid. These soils are very droughty, and normally they are strongly acid.

Sparta loamy fine sand, 0 to 2 percent slopes (SpA).—The hazard of drought is moderate to severe on this soil of river terraces, and the hazard of wind erosion is slight to moderate. This soil can be used to grow all the crops commonly grown in the county, but yields are only fair to low. (Capability unit IVs–1; woodland suitability group 8)

Sparta loamy fine sand, 2 to 6 percent slopes (SpB).—On this soil of river terraces, the hazard of drought is moderate to severe, and the hazard of erosion is slight to moderate. Erosion by wind and water is active, and both removal of soil material and deposition are taking place.

This soil can be used to grow all of the crops normally grown in the county, but yields are only fair to low. (Capability unit IVs–1; woodland suitability group 8)

Steep, Stony, and Rocky Land (Sr)

This miscellaneous land type has slopes that in most places are steeper than 30 percent. The areas lie between the ridgetops and the lower valley slopes. In most places they border streams and drainageways, but they are also on the steep edges of old landforms near Elgin. A thin layer of silt covers most of the acreage. There are many outcrops of solid limestone and sandstone bedrock, however, and fragments of limestone cover much of the surface in many areas. The soil material is deeper in the coves on the north- and east-facing slopes than in the other areas. Mapped with this land type are a few small, very steep areas of Dubuque, Boone, Gale, Hixton, and Fayette soils.

Most areas of Steep, stony, and rocky land are forested, but the upper parts of the south- and west-facing

slopes are too dry and warm to support timber. If the timber is protected from fire and grazing, the leaves and other plant residues accumulate. They help to reduce runoff and lessen the danger that the streams below will overflow. (Capability unit VIIs–1; woodland suitability group 5)

Stony Colluvial Land (St)

This miscellaneous land type consists of recently deposited soil material, mainly large pieces and fragments of limestone, chert, and sandstone. The areas occur as fans below gullies and at the upper ends of intermittent drainageways. The slopes range from nearly level to steep.

During periods of rapid runoff, the gullies and drainageways in this land type are filled with fast, turbulent water that carries large stones. The stones are deposited on the milder slopes in areas where the course of the water widens. Because of the large number of stones on the surface, this land type is not suitable for tilled crops or renovated pasture. (Capability unit VIIw–1; woodland suitability group 14)

Tell Series

The Tell series consists of light-colored, moderately deep soils that are well drained. These soils are nearly level or gently sloping and are on terraces along the Mississippi, Zumbro, and Whitewater Rivers. They developed in moderately deep alluvial silt that overlies stratified sand at a depth ranging from 24 to 42 inches. The native vegetation was a hardwood forest. The following describes a profile of a Tell silt loam:

0 to 7 inches, very dark grayish-brown, friable silt loam.
7 to 12 inches, dark-brown, mixed with very dark grayish-brown, friable silt loam.
12 to 18 inches, brown to dark yellowish-brown, friable to firm, heavy silt loam or light silty clay loam.
18 to 26 inches, dark-brown to dark yellowish-brown, firm, heavy silt loam.
26 to 36 inches, dark yellowish-brown, friable very fine sandy loam and coarse silt.
36 to 41 inches, dark grayish-brown, very friable very fine sandy loam.
41 to 52 inches +, pale-brown, loose fine sand.

These soils are moderately permeable. They have slow to medium surface runoff and medium internal drainage. The available moisture capacity and natural fertility are moderate. These soils are free of stones and are easy to work. Normally, the surface layer is slightly acid to medium acid and the subsoil is strongly acid.

Tell silt loam, 0 to 2 percent slopes (ThA).—Little or no erosion has taken place on this soil of river terraces, and the hazard of erosion is very slight. There is a slight hazard of drought.

This soil is productive. It has no serious limitations that hinder intensive use for row crops. It is suited to all the crops grown in the county. (Capability unit IIs–1; woodland suitability group 16)

Tell silt loam, 2 to 6 percent slopes (ThB).—Little erosion has taken place on this soil of river terraces. The hazards of erosion and drought are slight.

Under good management this soil is productive. It is suited to all the crops grown in the county. (Capability unit IIe–5; woodland suitability group 16)

Tell silt loam, 2 to 6 percent slopes, moderately eroded (ThB2).—From 4 to 6 inches of the surface layer of this soil of river terraces has been removed by erosion, and there is a moderate hazard of further erosion. In places tillage has mixed part of the subsoil with the material in the surface layer, and the present surface layer is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. The hazard of drought is slight.

Under good management this soil is productive. It is suited to all the crops grown in the county. (Capability unit IIe–5; woodland suitability group 16)

Terrace Escarpments, Loamy (Tm)

In places this miscellaneous land type occupies narrow, steep areas between nearly level terraces and the bottom lands. In other places it lies between one terrace level and another. The slopes are normally steeper than 12 percent. The upper part of the soil material is loam to silt loam or silty clay loam. The loamy material is 24 to 48 inches thick and is underlain by sand and gravel.

The hazard of drought is moderate. The hazard of erosion is very severe, and these areas are highly susceptible to serious gully erosion. The gullies are difficult to control because the loose sand and gravel beneath the surface layer erode easily.

This land type is suited only to trees or pasture. There is a mixture of hardwoods, chiefly oak, in many areas. Some of the areas are pastured. (Capability unit VIIe–1; woodland suitability group 5)

Terrace Escarpments, Sandy (Ts)

Some narrow, steep areas of this miscellaneous land type lie between nearly level terraces and the bottom lands. Other areas lie between one terrace level and another. The slopes are steeper than 12 percent. The soil material in this land type is sandy or gravelly, and there has been little development of a soil profile. The hazards of drought and erosion are very severe. These areas are highly susceptible to serious gully erosion. The gullies are difficult to control because the loose sand and gravel erode easily.

A mixture of hardwoods, chiefly oak, occupies many areas. Sparse grasses form the cover in other places. This land type should be protected from overgrazing, for if it is overgrazed, gullies are likely to form. (Capability unit VIIs–1; woodland suitability group 13)

Waukegan Series

The Waukegan series consists of dark-colored, moderately deep, well-drained soils that are nearly level to moderately sloping. These soils are on stream terraces. They developed under prairie vegetation in alluvial silt that overlies stratified sand and gravel. Above the stratified sand and gravel, these soils normally have 24 to 42

inches of silt loam. Mapped with these soils are small areas of similar soils that have a moderately dark surface layer. The following describes a profile of a Waukegan silt loam:

0 to 11 inches, very dark brown, friable silt loam.
11 to 19 inches, very dark grayish-brown, friable silt loam.
19 to 24 inches, very dark grayish-brown, mixed with dark-brown, friable, heavy silt loam.
24 to 34 inches, brown to dark-brown, friable to firm, heavy silt loam or light silty clay loam.
34 to 47 inches, brown to dark-brown gravelly sandy loam.
47 to 70 inches +, brown to dark-brown, loose sand and gravel.

The subsoil of these soils is moderately permeable, but the underlying sand and gravel are rapidly permeable. Surface runoff is moderately slow. Internal drainage is medium in the subsoil and rapid in the underlying sand and gravel. The soils have moderately high natural fertility and moderate available moisture capacity. They are free of stones and are easy to work. Normally, the surface layer is medium acid and the subsoil is strongly acid.

Waukegan silt loam, 0 to 2 percent slopes (WaA).—Little or no erosion has taken place on this soil of stream terraces, and the hazard of erosion is very slight. There is a slight hazard of drought.

This soil is productive and has no serious limitations that hinder intensive use for crops. It is suited to all the crops grown in the county. (Capability unit IIs–1; woodland suitability group 16)

Waukegan silt loam, 2 to 6 percent slopes (WaB).—Little or no erosion has taken place on this soil of stream terraces, but there is a slight hazard of both erosion and drought. Under good management this soil is highly productive. It is suited to all the crops grown in the county. (Capability unit IIe–4; woodland suitability group 16)

Waukegan silt loam, 2 to 6 percent slopes, moderately eroded (WaB2).—Erosion has removed from 4 to 6 inches of the surface layer of this soil of stream terraces, and the hazard of further erosion is slight to moderate. In places tillage has mixed part of the subsoil with material in the surface layer, and the present surface layer is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. The hazard of drought is slight.

Under good management this soil is productive. It is suited to all the crops grown in the county. (Capability unit IIe–4; woodland suitability group 16)

Waukegan silt loam, 6 to 12 percent slopes, moderately eroded (WaC2).—Erosion has removed from 4 to 6 inches of the surface layer of this soil of stream terraces, and the hazard of further erosion is moderate. In places tillage has mixed part of the subsoil with material in the surface layer, and the present surface layer in those areas is browner than the original one. In such spots the plow layer is also less friable and is more difficult to keep in good tilth. Also, the content of organic matter, the natural fertility, and the available moisture capacity have been reduced. The hazard of drought is slight.

Under good management this soil is productive. It is suited to all the crops grown in the county, except soybeans. (Capability unit IIIe–4; woodland suitability group 16)

Whalan Series

The Whalan series consists of light-colored, moderately deep soils that are well drained. These soils are on uplands. They are underlain by cherty, reddish or brownish clay at a depth of 24 to 42 inches; limestone bedrock is beneath the clay. The slopes range from gentle to steep. These soils formed under hardwood forest in medium-textured glacial till over material weathered from limestone. Some areas are covered by a thin mantle of loess. In most places this silt cap is not more than 12 to 18 inches thick. The following describes a profile of a Whalan silt loam:

0 to 4 inches, very dark grayish-brown, friable silt loam.
4 to 7 inches, dark grayish-brown and dark yellowish-brown, friable, heavy silt loam.
7 to 17 inches, dark yellowish-brown, friable, heavy silt loam.
17 to 28 inches, dark yellowish-brown, friable loam to clay loam.
28 to 31 inches, dark reddish-brown gravelly or cherty clay.
31 inches +, pale-yellow limerock.

These soils are moderately permeable. Their available moisture capacity and natural fertility are moderate. Surface runoff is medium to rapid, and internal drainage is medium. The surface layer is slightly acid to medium acid, and the subsoil is strongly acid.

Whalan silt loam, 2 to 6 percent slopes, moderately eroded (WhB2).—Erosion has removed from 2 to 6 inches of the surface layer of this soil of the uplands, and the hazard of further erosion is slight to moderate. In places tillage has mixed part of the subsoil with the material in the surface layer. The present surface layer in those areas is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. The hazard of drought is slight.

Under good management this soil is moderately productive. It is suited to all the crops grown in the county. (Capability unit IIe–3; woodland suitability group 1)

Whalan silt loam, 6 to 12 percent slopes, moderately eroded (WhC2).—Erosion has removed from 2 to 6 inches of the surface layer of this soil of the uplands, and the hazard of further erosion is moderate. In places tillage has mixed part of the subsoil with the material in the surface layer. In such spots the present surface layer is browner than the original one, and the plow layer is less friable and is more difficult to keep in good tilth. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. The hazard of drought is slight.

Under good management this soil is productive. All the crops grown in the county, except soybeans, are suited to it. (Capability unit IIIe–3; woodland suitability group 1)

Whalan silt loam, 12 to 18 percent slopes, moderately eroded (WhD2).—This soil of uplands has lost from 2 to 8 inches of its surface layer through erosion, and the hazard of further erosion is moderately severe. In as much as two-thirds of the acreage, tillage has mixed part of the subsoil with the material in the surface layer. In such spots the present surface layer is browner than the original one, and the plow layer is less friable and is more difficult to keep in good tilth. The content of organic matter, the natural fertility, and the available moisture

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capacity have been reduced. The hazard of drought is slight.

Under good management this soil is moderately productive. All the crops adapted to the climate, except soybeans, are suited to it. (Capability unit IVe–3; woodland suitability group 2)

Whalan Series, Shallow Phases

Light-colored, shallow, well-drained soils of the uplands make up the shallow phases of the Whalan series. These soils formed under hardwood forest in medium-textured glacial till that is underlain by reddish or brownish gravelly and cherty clay at a depth of 12 to 24 inches. Limestone bedrock is beneath the clay. In some areas a thin silt cap overlies the glacial till. Fragments of limestone are on the surface and in the soil profile. The slopes range from gentle to steep. The following describes a profile of a Whalan silt loam, shallow phase:

0 to 4 inches, very dark grayish-brown, friable silt loam.
4 to 9 inches, very dark grayish-brown to dark-brown, friable silt loam.
9 to 12 inches, yellowish-brown, firm clay loam.
12 to 15 inches, dark-brown to brown, very firm cherty clay.
15 inches +, limestone bedrock.

The shallow Whalan soils are moderately permeable and have moderately low available moisture capacity. Their natural fertility is low to moderate. Runoff is medium to rapid. These soils are slightly droughty to moderately droughty and dry out much more quickly than the deeper Whalan soils. The surface layer is slightly acid, but the subsoil is slightly acid to strongly acid.

Whalan silt loam, shallow, 2 to 6 percent slopes, moderately eroded (WsB2).—Erosion has removed from 2 to 6 inches of the surface layer of this soil of the uplands, and the hazard of further erosion is slight to moderate. In places reddish clay that has weathered from limestone is exposed, and fragments of limerock are on the surface. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. The hazard of drought is slight to moderate.

This soil is moderately productive. It is suited to all the crops normally grown in the county. (Capability unit IIIe–5; woodland suitability group 7)

Whalan silt loam, shallow, 6 to 12 percent slopes (WsC).—Some areas of this soil have been kept in trees. In the areas that have been cultivated, less than 25 percent of the surface layer has been removed by erosion, but there is a moderate hazard of further erosion. The hazard of drought is also moderate.

This soil is fairly productive. All of the crops adapted to the climate, except soybeans, can be grown. (Capability unit IVe–5; woodland suitability group 11)

Whalan silt loam, shallow, 6 to 12 percent slopes, moderately eroded (WsC2).—Erosion has removed from 2 to 6 inches of the surface layer of this soil of the uplands, and there is a moderate hazard of further erosion. In places reddish clay that has weathered from limestone is exposed, and fragments of limerock are on the surface. In some areas tillage has mixed part of the subsoil with material in the surface layer. In those areas the present surface layer is browner than the original one, and the soil is more difficult to work. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

The hazard of drought is moderate. Fair yields of all the crops adapted to the climate, except soybeans, are obtained. (Capability unit IVe–5; woodland suitability group 11)

Whalan silt loam, shallow, 12 to 18 percent slopes (WsD).—Little or no erosion has taken place where this soil has been used for pasture or trees. Erosion has removed less than 25 percent of the surface layer in the areas used for cultivated crops. This soil is subject to moderately severe erosion, however, and there is a moderately severe hazard of drought.

This soil is fairly productive. It is better suited to trees and pasture than to cultivated crops. (Capability unit VIe–2; woodland suitability group 11)

Whalan silt loam, shallow, 12 to 18 percent slopes, moderately eroded (WsD2).—Erosion has removed from 2 to 6 inches of the surface layer of this soil of the uplands, and there is a moderately severe hazard of further erosion. The hazard of drought is also moderately severe. In places the material weathered from reddish clay is exposed, and fragments of limerock are on the surface. In some areas tillage has mixed part of the subsoil with material in the surface layer, and the present surface layer is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. Mapped with this soil are a few areas that are severely eroded. In those areas bedrock is within the plow layer in some places.

Pasture or trees are better uses for this soil than field crops. If field crops are grown, yields are fair to low. (Capability unit VIe–2; woodland suitability group 11)

Whalan silt loam, shallow, 18 to 25 percent slopes, moderately eroded (WsE2).—From 2 to 8 inches of the surface layer of this soil has been lost through erosion, and the hazards of further erosion and of drought are severe. In places tillage has mixed part of the subsoil with material in the surface layer, and the present surface layer is browner than the original one. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

Mapped with this soil are a few areas where little or no erosion has taken place, because the soil has been kept in pasture or trees. Also included are a few severely eroded areas where reddish clay is exposed, where fragments of limerock are on the surface, or where bedrock is within plow depth. These severely eroded areas are harder to work than the less eroded ones.

This moderately eroded, shallow Whalan soil is suited to permanent vegetation and ought to be kept in trees or pasture. Areas that are used for cultivated crops should be retired to permanent vegetation. (Capability unit VIIe–1; woodland suitability group 5)

Whalan silt loam, shallow, 25 to 35 percent slopes, moderately eroded (WsF2).—Where this soil has been cultivated, from 2 to 8 inches of the surface layer has been removed by erosion, and the hazards of further erosion and of drought are severe. Tillage has mixed part of the subsoil with material in the surface layer. In a few places fragments of limestone are on the surface, and limestone bedrock or reddish clay weathered from limestone is

exposed. The content of organic matter, the natural fertility, and the available moisture capacity are low.

This soil is difficult to work and is suited only to permanent vegetation, such as pasture or trees. Part of the acreage has been retired from cultivation and is used for pasture or trees. There are shallow gullies in some of those areas. (Capability unit VIIe–1; woodland suitability group 5)

Wykoff Series

Light-colored, well-drained to excessively drained soils that are shallow over gravel make up the Wykoff series. These soils are in the uplands. They are on gentle to steep, hilly slopes that are mainly irregular and complex. Gravel is on the surface in places. The soils have developed under hardwood forest, chiefly oak, in coarse-textured glacial till. In places a thin silt cap of loess overlies the till. The following describes a profile of a Wykoff gravelly loam:

0 to 4 inches, dark yellowish-brown, very friable gravelly loam.
4 to 12 inches, dark yellowish-brown, friable loam.
12 to 21 inches, yellowish-brown, friable sandy loam to loam.
21 to 60 inches +, yellowish-brown gravel underlain by medium sand that contains some gravel.

These soils have low available moisture capacity and low natural fertility. Permeability is moderately rapid to rapid. Surface runoff is medium, and internal drainage is medium to rapid. Normally, the soils are medium acid to strongly acid.

Wykoff gravelly loam, 2 to 6 percent slopes (WvB).—This soil of the uplands has gentle, complex slopes. It is suited to all the crops adapted to the climate, and yields are fair. There is a moderate hazard of drought, however, and a slight hazard of erosion. (Capability unit IIIe–6; woodland suitability group 6)

Wykoff gravelly loam, 6 to 12 percent slopes, moderately eroded (WvC2).—From 2 to 6 inches of the surface layer of this soil has been lost through erosion, and there is a moderate hazard of further erosion. In places tillage has mixed part of the subsoil with the material in the surface layer. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced. The hazard of drought is moderately severe.

All the crops that are adapted to the climate, except soybeans, are suited to this soil. Yields are only fair. (Capability unit IVe–6; woodland suitability group 10)

Wykoff gravelly loam, 12 to 18 percent slopes, moderately eroded (WvD2).—From 2 to 6 inches of the surface layer of this soil has been lost through erosion, and the hazards of further erosion and of drought are moderately severe. In places tillage has mixed part of the subsoil with the material in the surface layer. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

This soil is better suited to permanent vegetation than to cultivated crops. Areas now in crops should be converted to either pasture or trees. (Capability unit VIe–3; woodland suitability group 12)

Wykoff gravelly loam, 18 to 35 percent slopes, moderately eroded (WvE2).—Erosion has removed from 2 to 6 inches of soil material from the surface layer and subsoil of this steep soil, and the hazards of further erosion and drought are severe. In places tillage has mixed part of the subsoil with the material in the surface layer. The content of organic matter, the natural fertility, and the available moisture capacity have been reduced.

This soil is not suited to cultivated crops. Areas now cultivated should be returned to pasture or trees. (Capability unit VIIe–1; woodland suitability group 12)

Zumbro Series

The Zumbro series consists of dark-colored, moderately well drained soils of the bottom lands. The soils are on flood plains and on very low terraces along the major rivers in the county. They developed in loamy sand and sand that contains some material weathered from sandstone, limestone, and till. The following describes a profile of Zumbro loamy fine sand:

0 to 13 inches, very dark gray, loose loamy fine sand.
13 to 30 inches, very dark grayish-brown, loose fine sand.
30 to 34 inches, dark yellowish-brown, loose fine sand.
34 to 53 inches +, yellowish-brown to light yellowish-brown, loose fine sand.

These soils have low available moisture capacity and moderate to low natural fertility. Permeability is rapid. Surface runoff is slow, but internal drainage is rapid. Flooding occurs once or twice in 5 years. Normally, the surface layer is mildly calcareous, but the soil is medium acid to neutral below the plow layer.

Zumbro loamy fine sand (Zb).—This is the only Zumbro soil mapped in the county. It is mainly nearly level, but a few small areas are gently sloping. This soil is on bottom lands and on low stream terraces. The water table is high, and the hazard of drought is slight. Occasional floods occur early in spring and, less frequently, during the growing season. Flooding is more frequent where the soil is on narrow flood plains.

This soil is suited to all the crops normally grown in the county. Corn and soybeans are the crops that are generally grown. (Capability unit IIIw–4; woodland suitability group 14)

Zwingle Series

The Zwingle series consists of light-colored, deep soils that are poorly drained. These soils are nearly level or gently sloping and are on stream terraces along the minor tributaries of the Mississippi River. They developed under hardwood forest in slack-water deposits of silt and clay. In most places in the profile the materials are gray, but in places the lower layers contain bands that have a reddish color. The thickness of the silty material over clay is variable. The following describes a profile of a Zwingle silt loam:

0 to 6 inches, dark grayish-brown, distinctly mottled, friable silt loam.
6 to 8 inches, grayish-brown, distinctly mottled, friable silt loam.
8 to 12 inches, grayish-brown, distinctly mottled, friable to firm silty clay loam.
12 to 14 inches, dark grayish-brown, firm silty clay.
14 to 20 inches, dark grayish-brown and grayish-brown, firm silty clay that has a few, fine, distinct mottles.
20 to 32 inches, dark grayish-brown, very firm clay that has a few, fine, distinct mottles.

32 to 41 inches, brown to dark-brown, very firm clay that has a few, faint mottles.
41 to 48 inches, dark grayish-brown, very firm clay.
48 to 60 inches +, dark-gray to dark grayish-brown, very firm clay that has common, medium, prominent mottles.

These soils have moderately high available moisture capacity and moderate natural fertility. Permeability is moderately slow to slow, and surface runoff is slow. In many places artificial drainage is desirable, but the effectiveness of tiling has not yet been demonstrated. Normally, the surface layer of these soils is medium acid to slightly acid and the subsoil is strongly acid.

Zwingle silt loam, 0 to 2 percent slopes (ZgA).—This is a soil of high stream terraces. There is a moderate hazard of wetness, but drainage is difficult. This soil is suited to all of the crops commonly grown in the county, but it is only moderately productive. (Capability unit IIIw–1; woodland suitability group 17)

Zwingle silt loam, 2 to 6 percent slopes (ZgB).—The hazard of wetness is slight to moderate on this soil of high stream terraces. In places surface drainage is used to remove the excess water. If this soil is adequately drained, it is productive and is suited to all the crops normally grown in the county. (Capability unit IIIw–2; woodland suitability group 17)

Zwingle silt loam, 2 to 6 percent slopes, moderately eroded (ZgB2).—From 2 to 5 inches of the surface layer of this soil of high stream terraces has been removed by erosion. The hazard of further erosion is slight. There is a slight to moderate hazard of wetness, but surface drainage is effective. Mapped with this soil are a few areas of a better drained soil.

This moderately eroded Zwingle soil is suited to all the crops grown in the county. If it is adequately drained, yields are moderately high. (Capability unit IIIw–2; woodland suitability group 17)

Use and Management of the Soils

This section discusses the system of capability classification used by the Soil Conservation Service, gives the classification of the soils of the county according to that system, and describes the capability units in which the soils are placed. Then, it gives estimates of average yields of the principal crops. Finally, it describes the use and management of the soils for pasture, apple orchards, woodland, windbreaks, shelterbelts, and wildlife areas, and describes the suitability of the soils for engineering.

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products. There are no class V or VIII soils in Wabasha County.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes, there can be as many as four subclasses. The subclass is indicated 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* means that water in or on the soil will interfere 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 country, indicates that the chief limitation is a climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no susceptibility to erosion but have other limitations that restrict their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils 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 identified by numbers assigned locally, for example, IIe–1 or IIIe–2.

Soils are classified in capability classes, subclasses and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible but unlikely major reclamation projects.

The eight classes in the capability system, and the subclasses and units in this county, are described in the list that follows.

Class I. Soils that have few limitations that restrict their use.
(No subclasses.)
Unit I–1. Deep, well-drained, moderately dark colored and dark colored, nearly level soils on uplands.
Unit I–2. Deep, nearly level, well drained or moderately well drained, light-colored soils on flood plains and low terraces.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.
Subclass IIe. Soils subject to moderate erosion if they are not protected.
Unit IIe–1. Deep, well-drained, gently sloping soils that are moderately dark or dark colored and medium textured.

Unit IIe–2. Deep, well drained or moderately well drained, gently sloping soils that are light colored and medium textured.
Unit IIe–3. Moderately deep, well-drained, gently sloping, and medium-textured soils that are underlain by bedrock at a depth of 24 to 42 inches.
Unit IIe–4. Moderately deep, well-drained, gently sloping, dark-colored soils that are medium textured and are underlain by coarse-textured material at a depth of 24 to 42 inches.
Unit IIe-5. Moderately deep, well-drained, gently sloping, light-colored soils that are medium textured and are underlain by coarse-textured material at a depth of 24 to 42 inches.

Subclass IIw. Soils that have moderate limitations because of excess water.
Unit IIw–1. Deep, nearly level soil that is somewhat poorly drained; this soil is dark colored and medium textured.
Unit IIw–2. Deep, gently sloping, somewhat poorly drained soil that is dark colored and medium textured.
Unit IIw–3. Deep, nearly level, somewhat poorly drained to well-drained soils that are medium textured and are on bottom lands and waterways.
Unit IIw–4. Deep, gently sloping, well drained or moderately well drained soils of waterways; the soils are medium textured.

Subclass IIs. Soils that have moderate limitations of moisture capacity or tilth.
Unit IIs–1. Moderately deep, nearly level, well-drained, medium-textured soils that are underlain at a depth of 24 to 42 inches by coarse-textured material.

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

Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
Unit IIIe–1. Deep, dark-colored, moderately sloping, well-drained soils that are medium textured.
Unit IIIe–2. Deep, light-colored, moderately sloping, well-drained soils that are medium textured.
Unit IIIe–3. Moderately deep, moderately sloping, well-drained soils that are medium textured and are underlain by bedrock at a depth of 24 to 42 inches.
Unit IIIe–4. Moderately deep, moderately sloping, well-drained soils that are medium textured and are underlain by coarse-textured material at a depth of 24 to 42 inches.
Unit IIIe–5. Gently sloping, well-drained soils that are medium textured and are underlain by bedrock at a depth of 12 to 24 inches.
Unit IIIe–6. Light-colored, gently sloping, well-drained soils that are medium textured to moderately coarse textured and are underlain by sand, gravel, or sandstone at a depth of only 12 to 24 inches.

Subclass IIIw. Soils that have severe limitations because of excess water.
Unit IIIw–1. Deep, nearly level, somewhat poorly drained soil that is medium textured.
Unit IIIw–2. Deep, gently sloping, somewhat poorly drained soils that are medium textured.
Unit IIIw–3. Deep, nearly level, very poorly drained soil that is medium textured.
Unit IIIw–4. Sandy, well drained or moderately well drained soil of the bottom lands.

Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.
Unit IIIs–1. Nearly level, well-drained, moderately coarse textured and medium-textured soils that are underlain by sand and gravel at a depth of 12 to 24 inches.
Unit IIIs–2. Dark-colored, gently sloping, well-drained, moderately coarse textured and medium-textured soils that are underlain by sand and gravel at a depth of 12 to 24 inches.

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

Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
Unit IVe–1. Deep, dark-colored, strongly sloping, well-drained soils that are medium textured.
Unit IVe–2. Deep, light-colored, strongly sloping, well-drained soils that are medium textured.
Unit IVe–3. Moderately deep, strongly sloping, well-drained soils that are medium textured and are underlain by bedrock at a depth of 24 to 42 inches.
Unit IVe–4. Moderately deep, light-colored, strongly sloping, well-drained soils that are medium textured and are underlain by sand or gravel at a depth of 24 to 42 inches.
Unit IVe–5. Moderately sloping, well-drained medium-textured soils that are underlain by bedrock at a depth of 12 to 24 inches.
Unit IVe–6. Light-colored and dark-colored, moderately sloping, well-drained soils that are moderately coarse textured to medium textured and are underlain by sand, gravel, or sandstone at a depth of 12 to 24 inches.

Subclass IVs. Soils that have very severe limitations of stoniness, low moisture capacity, or other soil features.
Unit IVs–1. Deep, droughty, nearly level or gently sloping, sandy soils.
Unit IVs–2. Droughty, nearly level or gently sloping soils that are gravelly and are shallow over gravel.

Class V. Soils not likely to erode, but that have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife food and cover. (None in Wabasha County.)

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

Subclass VIe. Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.
Unit VIe–1. Moderately deep and deep, well-drained, medium-textured soils that are steep or moderately steep.
Unit VIe–2. Moderately steep to hilly, well-drained, medium-textured soils that are underlain by bedrock at a depth of 12 to 24 inches.
Unit VIe–3. Strongly sloping, well-drained soils that are medium textured to moderately coarse textured and are underlain by sand, sandstone, or gravel at a depth of 12 to 24 inches.
Subclass VIw. Soils severely limited by excess water and generally unsuitable for cultivation.
Unit VIw–1. Miscellaneous bottom-land and waterway soils that are frequently flooded and in places are moderately droughty.
Class VII. Soils that have very severe limitations that make them unsuited to cultivated crops and that restrict their use largely to grazing, woodland, or wildlife.
Subclass VIIe. Soils very severely limited, chiefly by risk of erosion if protective cover is not maintained.
Unit VIIe–1. Steep or very steep soils that are subject to severe erosion and that are very shallow over bedrock or coarse-textured material.
Subclass VIIw. Soils very severely limited by excess water.
Unit VIIw–1. Miscellaneous land types that are on bottom lands and have no agricultural value.
Subclass VIIs. Soils very severely limited by moisture capacity, stones, or other soil features.
Unit VIIs–1. Deep, droughty sands or gravelly soils that are shallow over gravel or sand and are gently sloping to steep.
Class VIII. Soils and landforms that have limitations that preclude their use for commercial production of plants and that restrict their use to recreation, wildlife, water supply, or esthetic purposes. (None in Wabasha County.)

Management by capability units

The soils in one capability unit have about the same limitations and similar risks of damage. The soils in one unit, therefore, need about the same kind of management, though they may have formed from different kinds of parent material and in different ways. The capability units are described in the following pages, and management is suggested for the soils of each unit.

CAPABILITY UNIT I-1

In this capability unit are deep, nearly level soils that are well drained. The soils are moderately dark or dark and are medium textured. The soils in this unit are—

Downs and Mt. Carroll silt loams, 0 to 2 percent slopes.
Downs and Mt. Carroll silt loams, benches, 0 to 2 percent slopes.
Port Byron silt loam, 0 to 2 percent slopes.
Port Byron silt loam, benches, 0 to 2 percent slopes.
Racine silt loam, 0 to 2 percent slopes.

These are the most desirable soils in the county for cultivation. There are no hazards in their use for crops, and all the crops adapted to the climate can be grown successfully.

If the right kinds and amounts of fertilizer are applied and all crop residues are returned to the soils, corn can be grown intensively, and other row crops can be grown as often as 4 years out of 6. A suitable rotation is row crops for 4 years, a small grain for 1 year, and meadow for 1 year. If enough livestock are raised that a larger acreage of hay and pasture is needed, the following rotations are suitable: Row crops for 3 years, a small grain for 1 year, and meadow for 1 year; row crops for 2 years, a small grain for 1 year, and meadow for 2 years; or a row crop, a small grain, and meadow for 1 year each.

These soils can be plowed either in fall or in spring. A few stones may need to be removed from the Racine soil. Wheel-track planting of corn causes less of the soil compaction that often develops when these soils are farmed intensively to row crops.

Unless they have been recently limed, all of these soils are likely to need lime. In addition, they generally need a moderate amount of phosphate and potash.

These soils are generally used for field crops, but good pasture crops can be grown on them. Rotation pasture may be included in the cropping system. If the soils are limed and fertilized, grasses and legumes, such as bromegrass, alfalfa, and orchardgrass, may provide suitable pasture in summer.

Generally, these soils are not considered desirable for new plantings of trees, but open areas in existing woodland may be planted to white pine. Basswood, black walnut, red elm, rock elm, or other hardwoods may be planted also. These soils are in woodland suitability group 16.

CAPABILITY UNIT I-2

Deep, nearly level, moderately well drained or well drained soils make up this capability unit. The soils are light colored and medium textured. The soils in this unit are—

Fayette silt loam, uplands, 0 to 2 percent slopes.
Fayette silt loam, benches, 0 to 2 percent slopes.
Medary silt loam, brown variant, 0 to 2 percent slopes.

These are very desirable soils for cultivation. There are no hazards in their use for crops, and all of the crops adapted to the climate can be grown successfully.

If the right kinds and amounts of fertilizer are applied and all crop residues are returned to the soils, corn can be grown intensively, and other row crops can be grown as often as 3 years out of 5. A suitable rotation is row crops for 3 years, oats for 1 year, and meadow for 1 year. If enough livestock are raised that a larger acreage of hay and pasture is needed, the following rotations are suitable: Row crops for 2 years, oats for 1 year, and meadow for 1 year; row crops for 2 years, oats for 1 year, and meadow for 2 years; or row crops, oats, and meadow for 1 year each.

All of these soils, except the Medary, can be plowed either in fall or in spring. The Medary soil may have to be fall plowed because it is slow to warm up in spring and is less permeable than the other soils. Wheel-track

planting of corn causes less of the soil compaction that often develops when these soils are farmed intensively to row crops.

Unless they have been recently limed, all of these soils are likely to need lime. Also, most of them need a moderate amount of phosphate and potash. Nitrogen should be applied according to the requirements of the crop to be grown. Unless a good crop rotation has been used on these soils, the content of organic matter should be increased by adding a large amount of manure or by using a rotation that includes legumes and grasses.

These soils are generally used for field crops, but they are also well suited to pasture. Rotation pasture may be included in the cropping system. If the soils are limed and fertilized, grasses and legumes, such as bromegrass, alfalfa, and orchardgrass, may provide suitable pasture in summer. Use of nitrogen fertilizer will promote the growth of the plants in early and late pastures.

Generally, these soils are not considered desirable for new plantings of trees, but open areas in existing woodland may be planted to white pine. Basswood, black walnut, red elm, rock elm, or other hardwoods may be planted also. These soils are in woodland suitability group 16.

CABABILITY UNIT IIe-1

Deep, gently sloping, well-drained soils make up this capability unit. The soils are moderately dark or dark, and are medium textured. The soils in this unit are—

Downs and Mt. Carroll silt loams, 2 to 6 percent slopes.
Downs and Mt. Carroll silt loams, 2 to 6 percent slopes, moderately eroded.
Downs and Mt. Carroll silt loams, benches, 2 to 6 percent slopes.
Lindstrom silt loam, 2 to 6 percent slopes.
Port Byron silt loam, 2 to 6 percent slopes.
Port Byron silt loam, 2 to 6 percent slopes, moderately eroded.
Port Byron silt loam, benches, 2 to 6 percent slopes.
Racine silt loam, 2 to 6 percent slopes.
Racine silt loam, 2 to 6 percent slopes, moderately eroded.

All crops adapted to the climate can be successfully grown on these soils. There is a slight hazard of erosion, however, and some of the soils have already lost from one-fourth to one-half of the original surface layer through erosion. On soils that have an average slope of 4 percent and an average slope length of 250 feet, losses from erosion can be kept to a minimum by using good management practices, such as the rotation of crops, contour stripcropping, terraces, proper fertilization, and the return of plant residues to the soils. The crop rotation should include 1 year of meadow every third year. If the soils are tilled on the contour, grow meadow crops at least 1 year out of 5. If the soils are terraced (fig. 6), a meadow crop is needed 1 year in every 6. Use graded, rather than level, terraces. Grassed waterways will remove runoff water safely and prevent gullying. They should be constructed a year before the terraces are built.

If a large amount of hay is needed, it is desirable to grow hay in contour strips. Leave alternate strips, about 100 feet wide, in meadow 2 years out of every 4. Wheel-track planting of corn reduces the number of trips needed to move equipment across the field, and thus

Figure 6.—**Recently constructed terraces on soils of capability classes II and III. A terraced outlet and turn row are in the center.**

causes less of the soil compaction that develops when these soils are farmed intensively to row crops. This practice also increases the probability that water will be absorbed before runoff occurs. These soils can be plowed either in fall or in spring. A few stones may need to be removed from the Racine soils.

Unless they have been recently limed, all of these soils are likely to need lime. Also, most areas need moderate amounts of phosphate and potash. Nitrogen should be applied according to the needs of the crop to be grown. Unless a good crop rotation has been used on these soils, the content of organic matter should be increased by adding a large amount of manure or by using a rotation that includes legumes and grasses.

These soils are generally used for field crops, but they are well suited to pasture. Rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, alfalfa, and orchardgrass, provide pasture in summer. Use of a nitrogen fertilizer will promote the growth of pasture plants early and late in the season.

Generally, these soils are not considered desirable for new plantings of trees, but open areas in existing woodland may be planted to white pine. Basswood, black walnut, red elm, rock elm, or other hardwoods may be planted also. These soils are in woodland suitability group 16.

CAPABILITY UNIT IIe-2

Deep, gently sloping, moderately well drained or well drained soils make up this capability unit. The soils are light colored and medium textured. The soils in this unit are—

Fayette silt loam, uplands, 2 to 6 percent slopes.
Fayette silt loam, uplands, 2 to 6 percent slopes, moderately eroded.

Fayette silt loam, benches, 2 to 6 percent slopes.
Fayette silt loam, benches, 2 to 6 percent slopes, moderately eroded.
Fayette silt loam, valleys, 2 to 6 percent slopes.
Fayette silt loam, valleys, 2 to 6 percent slopes, moderately eroded.
Fayette-Renova silt loams, 2 to 6 percent slopes, moderately eroded.
Medary silt loam, brown variant, 2 to 6 percent slopes.
Renova silt loam, 2 to 6 percent slopes.
Renova silt loam, 2 to 6 percent slopes, moderately eroded.

The moderately eroded soils have lost from 25 to 50 percent of their original surface layer through erosion, and the hazard of further erosion is slight to moderate. The Medary soil is moderately well drained and is somewhat slower to warm up in spring than the other soils. The light-colored soils are normally lower in content of organic matter than the dark-colored ones, and they are somewhat lower in natural fertility. All of the crops adapted to the climate can be grown.

Where the soils have slopes of about 4 percent and the slopes are about 200 feet long, losses from erosion can be kept to a minimum by using good management. Desirable practices include the rotation of crops, contour stripcropping, terraces, proper fertilization, and returning plant residues to the soils.

Where the soils are farmed on the contour, row crops may be grown 2 years out of 4. For such areas a suitable rotation is one in which row crops are grown 2 years, a small grain is grown 1 year, and grass and legume meadow crops are grown 1 year.

Farming the soils on the contour may not be practical in areas where the slopes are uneven and irregular. In those areas protection from erosion can be obtained by using a good rotation, wheel-track planting, applying a large amount of fertilizer, and returning crop residues to the soils. A suitable rotation for such areas is one in which a row crop is grown 1 year, a small grain is grown 1 year, and meadow crops are grown 2 years.

Where the soils are terraced, a suitable rotation is one in which row crops are grown 3 years, a small grain is grown 1 year, and meadow crops are grown 1 year. Grassed waterways will remove runoff safely and prevent gullying (fig. 7). They should be constructed a year before the terraces are built.

Figure 7.—**A grassed waterway suitable for use as a terrace outlet.**

Figure 8.—**Stripcropping, showing small grains and hay to the left and corn and hay to the right.**

Where the soils are stripcropped (fig. 8), a suitable rotation is row crops 1 year, a small grain 1 year, and meadow 2 years. In this rotation the strips are normally 100 feet wide and the alternate strips are in meadow, which provides effective control of erosion. A 5-year rotation of 2 years of row crops, 1 year of small grain, and 2 years of meadow can also be used. This rotation is less desirable, however, than the rotation in which row crops are grown only 1 year in 4.

Unless they have been recently limed, these soils need lime. They also need a moderate amount of phosphate and potash. The lime, phosphate, and potash should be applied according to the needs indicated by soil tests. Nitrogen ought to be applied according to the needs of the crop to be grown. The subsoil of the Fayette soils is high in available phosphorus. Therefore, the Fayette soils are potentially highly productive if they are properly managed. The content of organic matter may be low, however, unless a good rotation has been used and all crops residues returned to the soils. The supply of organic matter can be increased by adding a large amount of manure and using a rotation in which legumes and grasses are grown a larger part of the time than indicated in the suggested rotations.

If the wheel-track planting or wide-row method of planting corn is used, and if other new practices are followed, row crops can be grown a greater part of the time than indicated in the rotations suggested for contour farming and stripcropping.

Wheel-track planting of corn reduces the number of trips made by equipment across the field. It thus causes less of the soil compaction that develops when these soils are farmed intensively to row crops. This practice also increases the probability that water will be absorbed before runoff occurs. These soils can be plowed either in fall or in spring. A few stones may need to be removed from the Renova soils.

These soils are generally used for row crops, but good pasture crops can also be grown on them. Rotation

pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture. Nitrogen fertilizer, used on pastures of native grass, will provide grazing early and late in the season.

Generally, these soils are not considered desirable for new plantings of trees, but open areas in existing woodland may be planted to white pine. Basswood, red pine, black walnut, red elm, rock elm, or other hardwoods may be planted also. These soils are in woodland suitability group 16.

CAPABILITY UNIT IIe-3

Moderately deep, well-drained, gently sloping soils make up this capability unit. The soils are medium textured, and they are underlain by bedrock at a depth of 24 to 42 inches. The soils in this unit are—

Dubuque silt loam, 2 to 6 percent slopes.
Dubuque silt loam, 2 to 6 percent slopes, moderately eroded.
Whalan silt loam, 2 to 6 percent slopes, moderately eroded.

Because these soils are only moderately deep over bedrock, erosion must be carefully controlled. The hazard of further erosion is slight, however, if the soils are well managed. There is a slight hazard of drought. Crop rotations and measures to control erosion are similar to those needed for the soils of capability unit IIe–2. The soils have lower available moisture capacity, however, than the soils in capability unit IIe–2, and crops grown on them make lower yields.

Where the slopes are uneven and irregular, contour farming may not be practical. In such areas the soils can be protected from erosion by using a rotation consisting of a row crop for 1 year, a small grain for 1 year, and meadow crops for 4 years. By using wheel-track planting of row crops, high fertilization, and returning all crop residues to the soils, a rotation consisting of a row crop for 2 years, a small grain for 1 year, and meadow for 3 years may be used.

The following rotations and practices are suggested for areas where the soils have slopes of about 4 percent and the slopes are about 150 feet long.

If the soils are farmed on the contour, row crops may be grown 2 years out of 5. A suitable rotation is row crops for 2 years, a small grain for 1 year, and meadow for 2 years. Another suitable rotation is a row crop, a small grain, and meadow for 1 year each.

Where the soils are terraced, a suitable rotation is row crops for 3 years, a small grain for 1 year, and meadow for 2 years. A better rotation, however, is row crops for 2 years, a small grain for 1 year, and meadow for 1 year. Grassed waterways, used as outlets for the terraces, remove runoff safely and prevent gullying. They should be constructed a year before the terraces are built.

If the soils are stripcropped, row crops may be grown for 2 years, a small grain for 1 year, and meadow for 2 years. This rotation is less desirable for stripcropping, however, than a 4-year rotation consisting of a row crop for 1 year, a small grain for 1 year, and meadow for 2 years. In these rotations the strips are normally 100 feet wide, and the alternate strips are in meadow, which provides effective control of erosion.

Unless they have been recently limed, all of these soils need lime. In addition, they need a moderate amount of phosphate and potash. The lime, phosphate, and potash should be applied according to the needs indicated by soil tests. Nitrogen should be applied according to the needs of the crop to be grown. The content of organic matter may be low unless a good rotation has been used and all crop residues are returned to the soils. Large applications of manure and a rotation in which legumes and grasses are grown a larger part of the time than indicated in the suggested rotations will increase the content of organic matter.

If the wheel-track or wide-row method of planting of corn is used and if other new practices are followed, row crops can be grown a greater part of the time than indicated in the suggested rotations. Wheel-track planting of corn reduces the number of trips made by equipment across the field. It thus causes less of the soil compaction that results when these soils are farmed intensively to row crops. This practice also increases the probability that water will be absorbed before runoff occurs. These soils can be plowed either in fall or in spring. In places fragments of limestone, sandstone, or chert are on the surface and in the profile.

These soils are generally used for row crops, but good pasture crops can be grown on them. Rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer will promote the growth of the plants early and late in the season. These soils are in woodland suitability group 1.

CAPABILITY UNIT IIe-4

In this capability unit are dark-colored, gently sloping soils that are well drained and medium textured. The soils are moderately deep and are underlain at a depth of 24 to 42 inches by coarse-textured material. The soils in this unit are—

Waukegan silt loam, 2 to 6 percent slopes.
Waukegan silt loam, 2 to 6 percent slopes, moderately eroded.

All of the crops adapted to the climate can be grown on these soils. From 25 to 50 percent of the original surface layer, however, has been lost through erosion, and there is a slight to moderate hazard of further erosion. Erosion must, therefore, be carefully controlled. If average rather than the best management is practiced, the rotations given second for the alternative cropping systems that follow provide better control than the first ones given. These soils have lower available moisture capacity than the soils in capability units IIe–1 and IIe–2 because coarse-textured material is at only a moderate depth.

Where slopes are uneven and irregular, contour farming may not be practical. In those areas the soils can be protected from erosion by using a rotation consisting of a row crop for 1 year, a small grain for 1 year, and meadow for 2 years. By using wheel-track planting of row crops, high fertilization, and returning of all crop residues to the soils, a rotation consisting of a row crop for 2 years, a small grain for 1 year, and meadow for 2 years may be used.

The following rotations and practices are suggested for areas where the soils have slopes of about 4 percent and the slopes are about 150 feet long.

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Where the soils are farmed on the contour, row crops may be grown 2 years out of 4. A suitable rotation is row crops for 2 years, a small grain for 1 year, and meadow for 1 year. Another suitable rotation is a row crop, a small grain, and meadow for 1 year each.

Where the soils are terraced, a suitable rotation consists of row crops for 3 years, a small grain for 1 year, and meadow for 1 year. A better rotation, however, is row crops for 2 years, a small grain for 1 year, and meadow for 1 year. Grassed waterways, used as outlets for the terraces, will remove runoff safely and prevent gullying. They should be constructed a year before the terraces are built.

If the soils are stripcropped, row crops can be grown 2 years out of 5. A suitable rotation is row crops 2 years, a small grain 1 year, and meadow 2 years. This rotation is less desirable for stripcropping, however, than a 4-year rotation consisting of row crops 1 year, a small grain 1 year, and meadow 2 years. In these rotations the strips are normally 100 feet wide, and the alternate strips are in meadow, which provides effective control of erosion.

Unless they have been recently limed, all of these soils need lime. In addition, they need a moderate amount of phosphate and potash. The lime, phosphate, and potash should be applied according to the needs indicated by soil tests, and nitrogen should be applied according to the needs of the crop to be grown. The content of organic matter may be low unless a good rotation has been used and all crop residues have been returned to the soils. Large applications of manure and a rotation in which legumes and grasses are grown a larger part of the time than indicated in the suggested rotations will increase the content of organic matter.

If the wheel-track or wide-row method of planting corn is used and if other new practices are followed, row crops can be grown a greater part of the time in the rotation. Wheel-track planting of corn reduces the number of trips made by equipment across the field. It thus causes less of the soil compaction that results when these soils are farmed intensively to row crops. This practice also increases the probability that water will be absorbed before runoff occurs. The soils can be plowed either in fall or in spring.

These soils are generally used for row crops, but good pasture crops can be grown on them. Rotation pasture may be included in the cropping system. Use of nitrogen fertilizer will provide grazing early in spring and late in fall. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer.

Generally, these soils are not considered desirable for new plantings of trees, but open areas in existing woodland may be planted to white pine. Red pine or basswood may be planted also. These soils are in woodland suitability group 16.

CAPABILITY UNIT IIe-5

Light-colored soils that are moderately deep, gently sloping, and well drained make up this capability unit. The soils are medium textured and are underlain at a depth of 24 to 42 inches by coarse-textured material. The soils in this unit are—

Bixby loam, 2 to 6 percent slopes.
Bixby loam, 2 to 6 percent slopes, moderately eroded.
Gale silt loam, 2 to 6 percent slopes, moderately eroded.
Renova-Wykoff loams, 2 to 6 percent slopes, moderately eroded.
Tell silt loam, 2 to 6 percent slopes.
Tell silt loam, 2 to 6 percent slopes, moderately eroded.

Because these soils are only moderately deep over coarse-textured material, erosion must be carefully controlled. The hazard of further erosion is slight to moderate, however, if the soils are well managed. There is a slight hazard of drought. Crop rotations and measures to control erosion are similar to those suggested for the soils in capability unit IIe–2. The soils have lower available moisture capacity than the soils in capability unit IIe–2, however, and crops grown on them make lower yields. If less than the highest level of management is used, the rotations that are given second in the alternative cropping systems that follow provide better control of erosion than the ones given first.

Where the slopes are uneven and irregular, contour farming may not be practical. In such areas the soils can be protected from erosion by using a rotation consisting of a row crop for 1 year, a small grain for 1 year, and meadow crops for 3 years. By using wheel-track planting of row crops, high fertilization, and return of all crop residues to the soils, a rotation consisting of a row crop for 1 year, a small grain for 1 year, and meadow for 2 years may be used.

The following rotations and practices are suggested for areas where the soils have slopes of about 4 percent and the slopes are about 150 feet long.

Where the soils are farmed on the contour, row crops may be grown 2 years out of 5. A suitable rotation is row crops for 2 years, a small grain for 1 year, and meadow for 2 years. Another suitable rotation is a row crop, a small grain, and meadow for 1 year each.

If the soils are terraced, a suitable rotation is row crops for 2 years, a small grain for 1 year, and meadow for 1 year. Grassed waterways, used as outlets for the terraces, remove runoff safely and prevent gullying. They should be constructed a year before the terraces are built.

Where the soils are stripcropped, row crops may be grown for 2 years, a small grain for 1 year, and meadow for 2 years. This rotation is less desirable for stripcropping, however, than a 4-year rotation consisting of a row crop for 1 year, a small grain for 1 year, and meadow for 2 years. In these rotations the strips are normally 100 feet wide, and the alternate strips are in meadow, which provides effective control of erosion.

Unless they have been recently limed, all of these soils need lime. They also need a moderate amount of phosphate and potash. The lime, phosphate, and potash should be applied according to the needs indicated by soil tests, and nitrogen should be applied according to the needs of the crop to be grown. The content of organic matter may be low, however, unless a good rotation has been used and all crop residues returned to the soils. The supply of organic matter can be increased by

adding a large amount of manure and using a rotation in which legumes and grasses are grown a greater part of the time than is indicated in the suggested rotations.

If wheel-track or wide-row planting of corn is used, and if other new practices are followed, row crops can be grown a greater part of the time that is indicated in the suggested rotations. Wheel-track planting of corn reduces the number of trips made by equipment across the field. It thus causes less of the soil compaction that develops when these soils are farmed intensively to row crops. This practice also increases the probability that water will be absorbed before runoff occurs. These soils can be plowed either in fall or in spring. A few stones may need to be removed from the Renova-Wykoff soils.

These soils are generally used for row crops, but good pasture crops can be grown on them. Rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer used on native grass pastures will provide grazing early and late in the season. These soils are in woodland suitability groups 1 and 16.

CAPABILITY UNIT IIw-1

Only one soil, Muscatine silt loam, 0 to 2 percent slopes, is in this capability unit. This soil is deep, nearly level, and somewhat poorly drained. It is dark colored and medium textured.

Unless this soil is adequately drained, it is not suitable for alfalfa and for canning peas. Adequate drainage, however, increases substantially the yields of all the crops that are grown. Tile lines should be installed where needed. The lines ought to be 90 to 100 feet apart and at least 42 to 48 inches deep.

Corn may be grown intensively on this soil, and other row crops can be grown 4 years out of 6 if the soil is drained and fertilized properly, and if all crop residues are turned under. A suitable rotation is row crops for 4 years, a small grain for 1 year, and meadow for 1 year. Other good rotations are row crops for 3 years, a small grain for 1 year, and meadow for 2 years; or a row crop, a small grain, and meadow for 1 year each.

This soil tends to be somewhat wet and cold in spring. Therefore, a starter fertilizer that includes nitrogen, as well as phosphate and potash, should be added to promote the rapid initial growth of the crop. This soil generally needs a moderately large amount of phosphate and potash, but lime ought to be applied only if soil tests show a need for it. Nitrogen should be applied according to the needs of the crop to be grown.

This soil should not be plowed when wet, because the clods that form are difficult to break up. It needs to be plowed in fall to insure a good seedbed in spring.

This soil is generally used for row crops, but good pasture crops can be grown on it. Rotation pasture may be included in the cropping system. If the soil is limed and fertilized properly, and if it is adequately drained, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer will promote the growth of the plants early and late in the season. This soil is not suited to trees.

CAPABILITY UNIT IIw-2

Only one soil, Muscatine silt loam, 2 to 6 percent slopes, is in this capability unit. This soil is deep, gently sloping, and somewhat poorly drained. It is dark colored and medium textured.

Unless this soil is adequately drained, it is not suitable for alfalfa or for canning peas. Adequate drainage, however, increases substantially the yields of all the crops that are grown. Where needed, tile lines ought to be installed to catch seepage; the lines should be 90 to 100 feet apart and at least 4 feet deep. Grassed waterways will remove surface runoff and thus provide some drainage. The design of the waterway depends on the size and nature of the area to be drained, but the waterway should be at least 1 rod wide and 1 foot deep. Drop-box inlet structures may be needed where the outlet for the waterways or for tile is in a roadside ditch.

Terraces or occasional contour strips of meadow cross this soil in a few places. In areas where the slopes are 300 feet or longer, the terraces or strips are necessary to control erosion. On these long slopes the strips and the terraces ought to have a slight grade. In many places terraces are built around the upper rim of this soil to divert surface runoff from adjoining higher areas.

If this soil is not terraced, stripcropped, or farmed on the contour, a suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 2 years. If the soil receives a large amount of fertilizer and if all crop residues are returned to it, row crops may be grown 2 years out of 5.

If this soil is adequately drained, is fertilized, and is farmed on the contour, and if all crop residues are returned to it, a suitable rotation is row crops for 2 years, a small grain for 1 year, and meadow for 1 year.

Where this soil is stripcropped, it can be used for row crops 2 years out of 5. The same rotation as that used on the adjoining higher soils is suitable, or a rotation consisting of row crops for 2 years, a small grain for 1 year, and meadow for 2 years may be used.

If this soil is terraced, adequately drained, and highly fertilized, and if all crop residues are returned to it, it can be used for row crops 3 years out of 5. A suitable rotation is row crops for 3 years, a small grain for 1 year, and meadow for 1 year.

This soil tends to be somewhat wet and cold in spring. Therefore, a starter fertilizer that includes nitrogen, as well as phosphate and potash, should be added to promote the rapid initial growth of the crop. This soil generally needs a moderately large amount of phosphate and potash, but lime and fertilizer ought to be applied according to the needs indicated by soil tests. Nitrogen ought to be applied according to the needs of the crop to be grown.

This soil should not be plowed when wet, because the clods that form are difficult to break up. It needs to be plowed in fall to insure a good seedbed in spring.

This soil is generally used for row crops, but good pasture crops can be grown on it. Rotation pasture may be included in the cropping system. If the soil is limed, fertilized, and adequately drained, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer will

promote the growth of the plants early and late in the season. This soil is not suited to trees.

CAPABILITY UNIT IIw-3

Deep, nearly level, medium-textured, somewhat poorly drained to well-drained soils of bottom lands and waterways are in this capability unit. The soils in this unit are—

Arenzville silt loam.
Chaseburg silt loam, 0 to 2 percent slopes.
Colo silty clay loam.
Genesee sandy loam.
Genesee silt loam.
Huntsville silt loam.
Judson silt loam, 0 to 2 percent slopes.
Minneiska silt loam.

Occasionally, flooding decreases the yields of crops grown on these soils, but the hazard of flooding is slight to moderate. Lodging of oats is often a problem. Late-maturing crops may occasionally be damaged by frost.

If the right kinds and amounts of fertilizer are applied and if all crop residues are returned to the soils, corn may be grown intensively, but other row crops should not be grown more often than 4 years out of 6. A suitable rotation is row crops for 4 years, a small grain for 1 year, and meadow for 1 year. In many places the Judson and Chaseburg soils are farmed the same as surrounding soils, and the same rotations are used.

The Colo soil and some areas of the Minneiska soil are somewhat poorly drained. Most of the poor drainage results from the fluctuating water table caused by the dams in the Mississippi River. In most places drainage is not feasible, but the soils on tributary streams of the Mississippi can be protected from occasional flooding by dikes or by flood-control measures that are used farther up the watershed. The benefits from such measures must be considered in relation to the cost.

Normally, waterways are needed to carry water safely across these soils. Specifications vary according to the grade, size, and nature of the watershed. The minimum width suitable for the waterway is 1 rod, and the minimum depth is 1 foot. Streambanks need to be stabilized where a river or creek adjoins these soils or makes sharp turns into them.

These soils seldom need lime. Only a moderate or small amount of fertilizer is needed because the sediment left by the occasional floods is fertile. The Chaseburg soil may require more fertilizer than the other soils in this group. Lime, phosphate, and potash should be applied according to the needs indicated by soil tests. Nitrogen ought to be applied according to the needs of the crop to be grown.

These soils are generally used for row crops, but good pasture crops can be grown on them. The more frequently flooded areas and those that are somewhat poorly drained have been left in native pasture or wild hay. The pastures and areas where wild hay is grown can be improved by applying nitrogen fertilizer or by working the area, fertilizing, and reseeding to more productive grasses and legumes during dry seasons. These soils are in woodland suitability group 14.

CAPABILITY UNIT IIw-4

In this capability unit are deep, medium-textured, gently sloping, well drained or moderately well drained soils of waterways. The soils in this unit are—

Chaseburg fine sandy loam, 2 to 6 percent slopes.
Chasebury silt loam, 2 to 6 percent slopes.
Judson silt loam, 2 to 6 percent slopes.

Occasionally, flooding decreases yields of the crops grown on these soils, but the hazard of flooding is slight to moderate. Lodging of oats is often a problem. Late-maturing crops are occasionally damaged by frost.

Grassed waterways should be established and maintained across these sloping soils. Specifications vary according to the grade, size, and nature of the watershed. The minimum width suitable for the waterway is 1 rod, and the minimum depth is 1 foot. Measures to control erosion used on adjoining soils will channel excess water through these grassed waterways and considerably reduce the damage caused by flooding. Rotations identical to those used on surrounding soils should be used on those areas not in grassed waterways.

These soils seldom need lime. Only a moderate or small amount of fertilizer is needed because of the fertility of the sediment left by the occasional floods. The Chaseburg soil may require more fertilizer than the Judson soil. Lime, phosphate, and potash, however, should be applied according to the needs indicated by soil tests. Nitrogen ought to be applied according to the needs of the crop to be grown.

Generally, these soils are used for grassed waterways, but they may be used for pasture if care is taken to prevent the formation of gullies. Nitrogen fertilizer will keep the grass growing, increase the yield of forage crops, and make the soils more resistant to the formation of gullies. The soils should not be used for cattle lanes. They are in woodland suitability group 14.

CAPABILITY UNIT IIs-1

Moderately deep, nearly level, well-drained soils make up this capability unit. The soils are medium textured. They are underlain by coarse-textured material at a depth of 24 to 42 inches. The soils in this unit are—

Bixby loam, 0 to 2 percent slopes.
Tell silt loam, 0 to 2 percent slopes.
Waukegan silt loam, 0 to 2 percent slopes.

All of the crops adapted to the climate can be grown successfully on these soils, but there is a slight hazard of drought. If the right kinds and amounts of fertilizer are applied and if all crop residues are returned to the soils, corn may be grown intensively, but other row crops should not be grown more often than 3 years out of 5. A suitable rotation is row crops for 3 years, a small grain for 1 year, and meadow for 1 year. If enough livestock is raised that a larger acreage of hay and pasture is needed, the following rotations are suitable: Row crops for 2 years, a small grain for 1 year, and meadow for 2 years; or a row crop, a small grain, and meadow for 1 year each.

These soils may be plowed either in fall or in spring. Wheel-track planting of corn causes less of the soil com-

paction that often develops when the soils are farmed intensively to row crops.

Unless they have been recently limed, these soils need lime. In addition, a moderate amount of phosphate and potash is generally needed. The lime, phosphate, and potash should be applied according to the needs indicated by soil tests, and nitrogen should be applied according to the needs of the crop to be grown.

These soils are generally used for row crops, but good forage for pasture can be grown on them. Rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, may provide suitable pasture in summer.

Generally, these soils are not considered desirable for new plantings of trees, but open areas in existing woodland may be planted to white pines. Red pine can be planted also. These soils are in woodland suitability group 16.

CAPABILITY UNIT IIIe-1

In this capability unit are deep, dark-colored, and moderately sloping soils that are well drained and medium textured. The soils in this unit are—

Downs and Mt. Carroll silt loams, 6 to 12 percent slopes.
Downs and Mt. Carroll silt loams, 6 to 12 percent slopes, moderately eroded.
Lindstrom silt loam, 6 to 12 percent slopes.
Lindstrom silt loam, 6 to 12 percent slopes, moderately eroded.
Port Byron silt loam, 6 to 12 percent slopes.
Port Byron silt loan, 6 to 12 percent slopes, moderately eroded.
Racine silt loam, 6 to 12 percent slopes, moderately eroded.

All of the crops adapted to the climate can be grown successfully on these soils if proper measures are taken to control erosion. From 25 to 75 percent of the original surface layer of some of the soils, however, has been lost through erosion, and the hazard of further erosion is moderate. To give protection from erosion, it is necessary to farm these soils on the contour and to use other good management practices, such as contour stripcropping or terracing, rotation of crops, adequate fertilizer, and the return of crop residues to the soils.

Where the soils have slopes of about 8 percent and the slopes are about 200 feet long, losses from erosion can be kept to a minimum by the following rotations and practices:

If the soils are terraced, a suitable rotation is one in which row crops are grown for 2 years, a small grain is grown for 1 year, and a meadow crop is grown for 2 years. Graded, rather than level, terraces should be used. Grassed waterways remove runoff safely and prevent gullying. They should be constructed a year before the terraces are built.

If the soils are not suitable for terraces, or if a large amount of hay is needed, it is desirable to use contour strips and a rotation in which meadow crops are grown 2 years out of 4. In this rotation the strips are normally 100 feet wide, and the alternate strips are in meadow.

Where the soils are farmed on the contour, a row crop should be grown no more often than 1 year out of 4. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 2 years.

If these soils are not stripcropped, terraced, or farmed on the contour, a row crop may be grown 1 year out of 6. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 4 years. If the wheel-track method of planting is used, a rotation of 1 year of a row crop, 1 year of a small grain, and 2 years of meadow is suitable.

In areas where the slopes are steeper than 8 percent or longer than 200 feet, a rotation in which meadow crops are grown a greater part of the time than suggested is suitable.

Grassed waterways are needed in areas where water collects and as outlets for terraces. Specifications vary according to the grade of the waterway and the size and nature of the watershed. The minimum width suitable for the waterway is 1 rod, and the minimum depth is 1 foot. Gullies should be shaped and seeded for use as grassed waterways. Engineering structures may be required to stabilize some gullies enough to allow growth of grass.

Unless they have been recently limed, these soils need lime. They also need a moderate amount of phosphate and potash. The lime, phosphate, and potash should be applied according to the needs indicated by soil tests. Nitrogen should be applied according to the needs of the crop to be grown. Manure should be used first on eroded areas and on the channels of terraces. The content of organic matter may be low, however, unless a good rotation has been used and all crop residues have been returned to the soils. The supply of organic matter can be increased by adding a large amount of manure and using a rotation in which legumes and grasses are grown a larger part of the time than suggested in the rotations given.

These soils are generally used for row crops, but good pasture crops can be grown on them. Rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer, used on native grass pastures, will provide grazing early and late in the season. These soils are in woodland suitability groups 1 and 16.

CAPABILITY UNIT IIIe-2

Soils that are deep, moderately sloping, and well drained make up this capability unit. The soils are light colored and medium textured. The soils in this unit are—

Fayette silt loam, uplands, 6 to 12 percent slopes.
Fayette silt loam, uplands, 6 to 12 percent slopes, moderately eroded.
Fayette silt loam, benches, 6 to 12 percent slopes.
Fayette silt loam, benches, 6 to 12 percent slopes, moderately eroded.
Fayette silt loam, valleys, 6 to 12 percent slopes.
Fayette silt loam, valleys, 6 to 12 percent slopes, moderately eroded.
Fayette-Renova silt loams, 6 to 12 percent slopes, moderately eroded.
Renova silt loam, 6 to 12 percent slopes.
Renova silt loam, 6 to 12 percent slopes, moderately eroded.

The hazard of further erosion is moderately severe on these soils. If these soils are not farmed on the contour, stripcropped, or terraced, they should not be used for row crops. If the wheel-track method of planting is used, and if a large amount of fertilizer is added and all crop residues are returned to the soils, row crops can be grown 1 year out of 6. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 4 years.

Where the soils have slopes of about 8 percent and the slopes are about 200 feet long, losses from erosion can be kept to a minimum by the following rotations and practices:

Where the soils are contoured, a suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 3 years.

Where the soils are stripcropped (fig. 9), a suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 2 years. In this rotation the strips are normally 80 to 100 feet wide, and the alternate strips are in meadow.

Where the soils are terraced, row crops can be grown 1 year out of 3. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 1 year. Grassed waterways are needed in areas where water collects and as outlets for terraces. Specifications vary according to the grade of the waterway and the size and nature of the watershed. The minimum width suitable for the waterway is 1 rod, and the minimum depth is 1 foot. Gullies should be shaped and seeded for use as grassed waterways. Engineering structures may be required to stabilize some gullies enough to allow growth of grass.

Unless they have been recently limed, all of these soils need lime. They also need a moderate amount of phosphate and potash. The lime, phosphate, and potash should be applied according to the needs indicated by soil tests, and nitrogen should be applied according to the needs of the crop to be grown. Manure ought to be used first on eroded areas and on the channels of terraces. The soils are likely to have a low content of organic matter unless a good rotation has been used and all crop residues have been returned. The supply of organic matter can be increased by adding a large amount of manure and using a rotation in which legumes and grasses are grown a larger part of the time than suggested in the rotations given.

These soils are generally used for row crops, but good pasture crops can be grown on them. Rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer, used on native grass pastures, will provide grazing early and late in the season. These soils are in woodland suitability group 1.

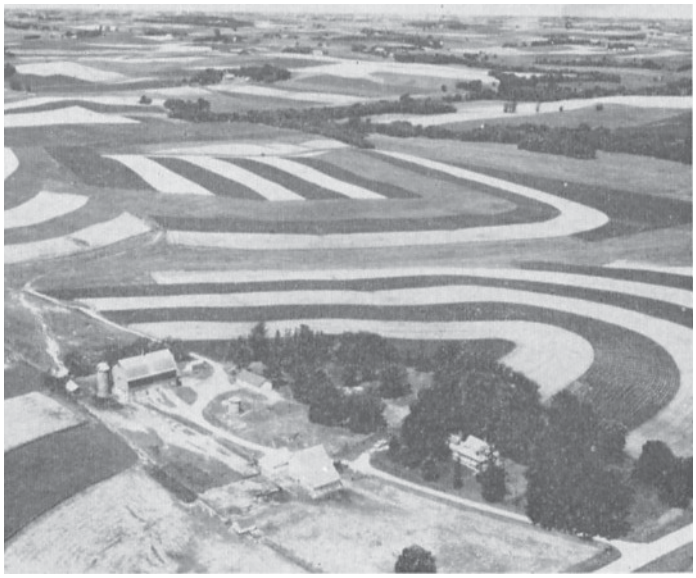

Figure 9.—**A large field where stripcropping has been practiced. A waterway has been constructed in the center of the field to safely carry away runoff.**

CAPABILITY UNIT IIIe-3

Soils that are moderately deep, moderately sloping, and well drained make up this capability unit. The soils are medium textured. They are underlain by bedrock at a depth of 24 to 42 inches. The soils in this unit are—

Dodgeville silt loam, 6 to 12 percent slopes, moderately eroded.
Dubuque silt loam, 6 to 12 percent slopes.
Dubuque silt loam, 6 to 12 percent slopes, moderately eroded.
Whalan silt loam, 6 to 12 percent slopes, moderately eroded.

On all of these soils, the hazard of further erosion is moderate, and the hazard of drought is slight to moderate. If the soils are used for row crops, they should be stripcropped, or terraced.

Where the soils have slopes of about 10 percent, about 200 feet long, losses from erosion can be kept to a minimum by the following rotations and practices:

Where these soils are stripcropped, a suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 2 years. In this rotation the strips are normally 80 to 100 feet wide, and the alternate strips are in meadow.

Where the soils are terraced, a row crop can be grown 1 year out of 4. A suitable rotation is 1 year of a row crop, 1 year of a small grain, and 2 years of meadow. Grassed waterways are needed in areas where water collects and as outlets for terraces. Specifications vary according to the grade of the waterway and the size and nature of the watershed. The minimum width suitable for the waterway is 1 rod, and the minimum depth is 1 foot. Gullies should be shaped and seeded for use as grassed waterways. In some gullies engineering structures are required before grass can be grown.

Unless they have been recently limed, all of these soils need lime. They also generally need a moderate amount of phosphate and potash. The lime, phosphate, and potash should be applied according to the results of soil tests. Nitrogen ought to be applied according to the needs of the crop to be grown. Manure should be used first on eroded areas and on the channels of terraces. The content of organic matter may be low, however, unless a good rotation has been used and all crop residues have been returned to the soils. The supply of organic matter can be increased by adding a large amount of manure and using a rotation in which legumes and grasses are

grown a greater part of the time than suggested in the rotations given.

Rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer, used on native grass pastures, will provide grazing early and late in the season. These soils are in woodland suitability group 1.

CAPABILITY UNIT IIIe-4

Soils that are moderately deep, moderately sloping, and well drained make up this capability unit. The soils are medium textured and are underlain by coarse-textured material at a depth of 24 to 42 inches. The soils in this unit are—

Gale silt loam, 6 to 12 percent slopes, moderately eroded.
Renova-Wykoff loams, 6 to 12 percent slopes, moderately eroded.
Waukegan silt loam, 6 to 12 percent slopes, moderately eroded.

In all of these soils, the hazard of further erosion is moderate and the hazard of drought is moderate. In areas where the slopes are uneven and irregular, management practices, such as contour stripcropping, terraces, or farming on the contour, may not be practical. Adequate rotations, fertilization, and the return of crop residues can help to protect the soils from erosion.

Row crops should not be grown, unless these soils are stripcropped, or terraced.

Where the slopes are about 8 percent and about 100 feet long, losses from erosion can be kept to a minimum by the following rotations and practices.

Where these soils are farmed on the contour, a row crop can be grown 1 year out of 6. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 4 years.

Where the soils are stripcropped, a suitable rotation is row crops for 1 year, a small grain for 1 year, and meadow for 2 years. In this rotation the strips are normally 80 to 100 feet wide, and the alternate strips are in meadow.

Where the slopes are longer than 100 feet and are suitable for terracing, row crops can be grown 1 year out of 6. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 4 years. Grassed waterways are needed as outlets for terraces and in areas where water collects. Specifications vary according to the grade of the waterway and the size and nature of the watershed. The minimum width suitable for the waterway is 1 rod, and the minimum depth is 1 foot. Gullies should be shaped and seeded for use as grassed waterways. Engineering structures are needed to stabilize some gullies enough to allow growing of grass.

Unless they have been recently limed, all of these soils generally need lime. In addition, most areas need a moderate amount of phosphate and potash. The lime, phosphate, and potash should be applied according to the needs indicated by soil tests. Nitrogen should be applied according to the needs of the crop to be grown. Manure ought to be used first on eroded areas and on the channels of terraces. The content of organic matter in the soils may be low, however, unless a good rotation has been used and all crop residues have been returned. The supply of organic matter can be increased by adding a large amount of manure and using a rotation in which legumes and grasses are grown a greater part of the time than suggested in the rotations given. However, these soils are not suited to soybeans.

Rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer, used on native grass pastures, will provide grazing early and late in the season. These soils are in woodland suitability groups 2 and 16.

CAPABILITY UNIT IIIe-5

Gently sloping, well-drained, medium-textured soils that are underlain by bedrock at a depth of 12 to 24 inches make up this capability unit. The soils in this unit are—

Dubuque silt loam, shallow, 2 to 6 percent slopes.
Dubuque silt loam, shallow, 2 to 6 percent slopes, moderately eroded.
Whalan silt loam, shallow, 2 to 6 percent slopes, moderately eroded.

The hazard of erosion is slight to moderate on these soils, and the hazard of drought is slight to moderate. Terracing is not practical, because the depth to bedrock is less than 24 inches in most places.

Where the slopes are about 4 percent and about 150 feet long, losses from erosion can be kept to a minimum by the following rotations and practices.

Where these soils are farmed on the contour, row crops can be grown 1 year out of 4. A suitable rotation is 1 year of a row crop, 1 year of a small grain, and 2 years of meadow.

If these soils are not farmed on the contour, row crops should not be grown. If wheel-track planting is used, a suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 3 years.

Where these soils are stripcropped, the usual rotation is row crops for 1 year, a small grain for 1 year, and meadow for 2 years. In this rotation the strips may be as wide as 100 feet, and alternate strips are in meadow.

Unless these soils have been recently limed, all of them need lime. In addition, they need a moderately large amount of phosphate and potash. The lime, phosphate, and potash should be applied according to the needs indicated by soil tests, and nitrogen should be applied according to the needs of the crop to be grown. The content of organic matter may be low, unless a good rotation has been used and all crop residues have been returned to the soils. The supply of organic matter can be increased by adding a large amount of manure and using a rotation in which legumes and grasses are grown a larger part of the time than suggested in the rotations given.

Rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer, used on native grass pastures, will provide

grazing early and late in the season. These soils are in woodland suitability group 7.

CAPABILITY UNIT IIIe-6

Soils that are gently sloping and well drained make up this capability unit. The soils are light colored and medium textured to moderately coarse textured, and they are underlain at a depth of 12 to 24 inches by sandstone or by sand and gravel. The soils in this unit are—

Hixton fine sandy loam, 2 to 6 percent slopes.
Meridian sandy loam, 2 to 6 percent slopes.
Meridian sandy loam, 2 to 6 percent slopes, moderately eroded.
Wykoff gravelly loam, 2 to 6 percent slopes.

The hazard of erosion is slight to moderate, and the hazard of drought is moderate. Because of the uneven, irregular slopes, contouring or stripcropping may be difficult to lay out. Terracing is not practical, because sand and gravel are at a depth of less than 24 inches in most places.

Unless these soils are farmed on the contour, row crops should be grown no more often than 1 year out of 4. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 2 years.

The following suggested rotations and practices are for areas where the slopes are about 4 percent and about 150 feet long.

Where the soils are farmed on the contour, a row crop can be grown 2 years out of 4. A suitable rotation is a row crop for 2 years, a small grain for 1 year, and meadow for 1 year. If the wheel-track method of planting is practiced and if a large amount of fertilizer is added and all crop residues are returned to the soils, the rotation may consist of row crops for 3 years, a small grain for 1 year, and meadow for 1 year.

Where the soils are stripcropped, a row crop may be grown for 1 year, a small grain for 1 year, and meadow for 2 years. The strips may be as much as 100 feet wide. Alternate strips should be in meadow.

These soils are droughty. Therefore, pasturing meadow the second year is better than maintaining permanent pasture. Unless the soils have been recently limed, all of them generally need lime. In addition, they need a moderately large amount of phosphate and potash. The lime, phosphate, and potash should be applied according to the needs indicated by soil tests. Nitrogen ought to be applied according to the needs of the crop to be grown. The content of organic matter may be low unless a good rotation has been used and all crop residues have been returned to the soils. The supply of organic matter can be increased by adding a large amount of manure and using a rotation in which legumes and grasses are grown a larger part of the time than suggested in the rotations given. These soils are in woodland suitability group 6.

CAPABILITY UNIT IIIw-1

Only one soil, Zwingle silt loam, 0 to 2 percent slopes, is in this capability unit. This nearly level soil is deep, somewhat poorly drained, and medium textured.

Yields are increased only slightly by improving the drainage. Waterways or shallow, open ditches will remove excess surface water. The substratum is dense and firm; therefore, if tile are used, they should be placed at a depth of 42 to 48 inches, and the lines should be spaced 60 to 80 feet apart. This close spacing is expensive and is not successful in all places.

If this soil is adequately limed and fertilized, and if all crop residues are returned to it, row crops can be grown as often as 2 years out of 4. A suitable rotation is row crops for 2 years, a small grain for 1 year, and meadow for 1 year; or a row crop, a small grain, and meadow crops may be grown for 1 year each.

This soil should be plowed in fall to insure a good seedbed in spring and to avoid plowing when the soil is too wet. Unless the soil has been recently limed, it generally needs lime. In addition, a moderately large amount of phosphate and potash is needed. The phosphate and potash, however, should be applied in accordance with the results of soil tests. Because the surface layer is thin, manure or commercial nitrogen should be added frequently. This soil is not suited to trees.

CAPABILITY UNIT IIIw-2

Deep, gently sloping soils that are somewhat poorly drained and medium textured make up this capability unit. The soils in this unit are—

Zwingle silt loam, 2 to 6 percent slopes.
Zwingle silt loam, 2 to 6 percent slopes, moderately eroded.

Yields are increased only slightly by improving drainage. Grassed waterways or shallow, open ditches will remove excess surface water. The substratum is dense and firm. If tile are installed, they should be placed 42 to 48 inches deep and spaced 60 to 80 feet apart. This close spacing is expensive and is not successful in all places.

If adequate lime and fertilizer are added and all crop residues are returned to the soils, row crops can be grown 2 years out of 5. A suitable rotation is row crops for 2 years, a small grain for 1 year, and meadow for 2 years; or a row crop, a small grain, and meadow crops can be grown for 1 year each.

These soils should be plowed in fall to insure a good seedbed in spring and to avoid plowing when the soil is too wet. Unless they have been recently limed, these soils need lime. In addition, a moderately large amount of phosphate and potash is needed. The lime, phosphate, and potash should be applied in accordance with the results of soil tests. Because the surface layer is thin, manure or commercial nitrogen ought to be applied frequently. These soils are not suited to trees.

CAPABILITY UNIT IIIw-3

Only one soil, Garwin silt loam, is in this capability unit. This soil is nearly level and is deep, very poorly drained, and medium textured.

This soil is in depressions. Because of the hazard of frost, only the early maturing varieties of corn and soybeans are suited. Unless it is drained, it can be farmed only in dry years. Most of the undrained areas are kept in permanent pasture. Adequate drainage is profitable, however, and tile lines should be installed where they are needed. The lines should be 90 to 100 feet apart and 42 to 48 inches deep.

Some money may be saved in tiling costs by using grassed waterways to remove excess surface water. The design of the waterway depends on the size and nature of the area to be drained, but the waterway should be at least 1 rod wide and 1 foot deep. Drop-box inlet structures may be needed where the waterway or tile empty into an open ditch.

If this soil is adequately drained and fertilized and if all crop residues are returned to it, corn can be grown intensively, and other row crops can be grown 4 years out of 6. A suitable rotation is row crops for 4 years, a small grain for 1 year, and meadow for 1 year. Other good rotations are row crops for 2 years, a small grain for 1 year, and meadow for 1 year; or row crops for 2 years, a small grain for 1 year, and meadow for 2 years.

If this soil is not adequately fertilized, or if crop residues are not returned to it, meadow crops should be grown for a longer period than in the suggested rotations. If the soil is not adequately drained it is difficult to establish a rotation. Undrained areas probably should be used for permanent pasture.

This soil should be plowed in fall to insure a good seedbed in spring and to avoid plowing when the soil is too wet. Lime is seldom needed, but phosphate and potash should be applied in accordance with the results of soil tests. This soil tends to be wet and cold in spring, and a starter fertilizer that includes nitrogen ought to be used to encourage the rapid initial growth of crops. Fertilizing this soil before it is adequately drained is not economical. This soil is not suited to trees.

CAPABILITY UNIT IIIw-4

Only one soil, Zumbro loamy fine sand, is in this capability unit. It is a sandy, well drained or moderately well drained soil of the bottom lands.

The hazard of drought is slight, and the hazard of flood is moderate. Dikes would protect this soil from occasional flooding, but the benefits from dikes must be considered in relation to the cost.

This soil is suited to corn, soybeans, small grain, and hay. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and a catch crop of sweetclover or alfalfa to be plowed down in spring before the row crop is planted. If the right kinds and amounts of fertilizer are applied and all crop residues are returned, corn may be grown intensively.

This soil seldom needs lime, and the need for fertilizer is moderate. Lime, phosphate, and potash, however, should be applied according to the results of soil tests. The soil is in woodland suitability group 14.

CAPABILITY UNIT IIIs-1

Nearly level, well-drained, moderately coarse textured and medium-textured soils that are underlain by sand or gravel at a depth of 12 to 24 inches make up this capability unit. The soils in this unit are—

Burkhardt sandy loam, 0 to 2 percent slopes.
Burkhardt loam, 0 to 2 percent slopes.
Meridian sandy loam, 0 to 2 percent slopes.

The hazard of drought is moderate to moderately severe. If an adequate amount of fertilizer is applied to these soils and all crop residues are returned, corn can be grown intensively and other row crops can be grown 2 years out of 4. A suitable rotation is row crops for 2 years, a small grain for 1 year, and meadow for 1 year. Other rotations are row crops for 2 years, a small grain for 1 year, and meadow for 2 years; or a row crop, a small grain, and meadow can be grown for 1 year each.

These soils can be plowed either in fall or in spring. If they are plowed in spring, the wheel-track method of planting causes less of the soil compaction that often develops after equipment has been driven frequently across a field.

Unless these soils have been limed recently, all of them generally need lime. In addition, a moderate to large amount of phosphate and potash is needed. Lime, phosphate, and potash should be applied in accordance with the results of soil tests, and nitrogen should be applied according to the needs of the crop to be grown. The content of organic matter may be low, however, unless a good rotation has been used and all crop residues returned to the soils. The supply of organic matter can be increased by adding a large amount of manure and using a rotation in which legumes and grasses are grown a greater part of the time than suggested in the rotations given.

The present woodland on these soils is unproductive. The area now in trees should be converted to red pine. These soils are in woodland suitability group 6.

CAPABILITY UNIT IIIs-2

Dark-colored, gently sloping, well-drained soils that are moderately coarse textured and medium textured make up this capability unit. These soils are underlain by sand and gravel at a depth of 12 to 24 inches. The soils in this unit are—

Burkhardt sandy loam, 2 to 6 percent slopes.
Burkhardt sandy loam, 2 to 6 percent slopes, moderately eroded.
Burkhardt loam, 2 to 6 percent slopes.

The hazard of erosion is slight to moderate, and the hazard of drought is moderate to moderately severe. Erosion can be controlled by using a suitable crop rotation, adding a large amount of fertilizer, and returning all crop residues to the soils. Because the soils are droughty, it is better to pasture meadow the second year in the rotation than to maintain permanent pasture. Because the soils are shallow over sand or gravel, terracing is not practical.

The following rotations are suggested for areas where the slopes are about 4 percent and about 150 feet long.

If the soils are farmed on the contour, a row crop can be grown 2 years out of 5. A suitable rotation is 2 years of a row crop, 1 year of a small grain, and 2 years of meadow.

If the soils are not farmed on the contour, row crops should be grown no more often than 1 year out of 5. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 3 years.

Where the soils are stripcropped, a suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 2 years. The strips may be as much as 100 feet wide, and alternate strips should be in meadow.

Unless they have been recently limed, all of these soils generally need lime. In addition, a moderately large amount of phosphate and potash is needed. Lime, phosphate, and potash should be applied in accordance with the results of soil tests. Nitrogen should be applied according to the needs of the crop to be grown. The content of organic matter may be low, however, unless a good rotation has been used and all crop residues have been returned to the soils. The supply of organic matter can be increased by adding a large amount of manure and using a rotation in which legumes and grasses are grown a greater part of the time than suggested in the rotations given. These soils are in woodland suitability group 6.

CAPABILITY UNIT IVe-1

Soils that are deep, dark colored, and well drained make up this capability unit. The soils are strongly sloping and are medium textured. The soils in this unit are—

Downs and Mt. Carroll silt loams, 12 to 18 percent slopes.
Downs and Mt. Carroll silt loams, 12 to 18 percent slopes, moderately eroded.
Lindstrom silt loam, 12 to 18 percent slopes.
Lindstrom silt loam, 12 to 18 percent slopes, moderately eroded.
Racine silt loam, 12 to 18 percent slopes, moderately eroded.

Many of these soils are moderately eroded, and the hazard of further erosion is moderately severe. The soils are fairly well suited, however, to occasional use for cultivated crops if erosion is controlled. The major crops are corn, oats, and hay, but the soils are also used extensively for pasture and trees.

The following crops and practices are suggested for areas where the soils have slopes of about 14 percent and the slopes are about 200 feet long.

Unless erosion is controlled, these sloping areas should not be used for row crops. A small grain can be grown at intervals, however, to help reestablish a stand of hay or pasture. The small grain should generally be followed by 3 years of meadow. The soils are too steep to be terraced or farmed on the contour. Stripcropping or a system of field diversions may be used to control erosion. Then row crops can be grown 1 year out of 4. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 2 years. Wheel-track planting should be used for the row crop. If corn is grown, the field ought to be disked and the stalks left on the field while the small grain is seeded. The soils should be plowed only in spring. If this work must be done in fall, the fields ought to be left rough. A few stones may need to be removed from the Racine soil.

Waterways must be maintained, and it may be necessary to establish new ones. Gullies should be shaped and seeded for use as grassed waterways. Some gullies may require engineering structures to stabilize them enough to grow grass.

Unless they have been recently limed, all of the soils in this unit need lime. They also need a moderate amount of phosphate and potash. The content of organic matter can be increased by adding a large amount of manure and using a rotation in which legumes are grown a greater part of the time than suggested in the rotations given. Lime and fertilizer should be applied according to the results of soil tests.

These soils are well suited to either rotation pasture or permanent pasture. The rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer will promote the growth of the plants early and late in the season. These soils are in woodland suitability group 3.

CAPABILITY UNIT IVe-2

Soils that are deep, light colored, and well drained make up this capability unit. They are medium textured and strongly sloping. The soils in this unit are—

Fayette silt loam, uplands, 6 to 12 percent slopes, severely eroded.
Fayette silt loam, uplands, 12 to 18 percent slopes.
Fayette silt loam, uplands, 12 to 18 percent slopes, moderately eroded.
Fayette silt loam, valleys, 12 to 18 percent slopes.
Fayette silt loam, valleys, 12 to 18 percent slopes, moderately eroded.
Fayette-Renova silt loams, 12 to 18 percent slopes, moderately eroded.
Renova silt loam, 12 to 18 percent slopes.
Renova silt loam, 12 to 18 percent slopes, moderately eroded.
Seaton-Bold soils, 12 to 18 percent slopes, moderately eroded.

Most of these soils are moderately eroded, and the hazard of further erosion is moderately severe to severe. The soils are fairly well suited, however, to occasional use for cultivated crops if erosion is controlled. The major crops are corn, oats, and hay, but the soils are also used extensively for pasture and trees. Because of the strong slopes, soybeans should not be grown.

The following crops and practices are suggested for areas where the soils have slopes of about 14 percent and the slopes are about 200 feet long.

Unless erosion is controlled, the soils should not be used for row crops. A small grain can be grown at intervals, however, to help reestablish a stand of hay or pasture. The small grain should generally be followed by 3 years of meadow.

Most of the soils are too steep to be terraced or farmed on the contour. Stripcropping or a system of field diversions should be used to control erosion. Row crops can be grown 1 year out of 6, if the soils are plowed in spring. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 4 years. Row crops can be grown 1 year out of 5 if, in addition to stripcropping and field diversions, a large amount of fertilizer is added, wheel-track planting is practiced, and all crop residues are returned to the soils. If these practices are used, a suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 3 years. A few stones may need to be removed from the Renova soils.

Waterways must be maintained, and it may be necessary to establish new ones. Gullies should be shaped and seeded for use as grassed waterways (fig. 10). Some gullies may require engineering structures to stabilize them enough to grow grass.

Limy soil material underlies the Seaton and Bold soils, and this helps make these excellent soils for grow-

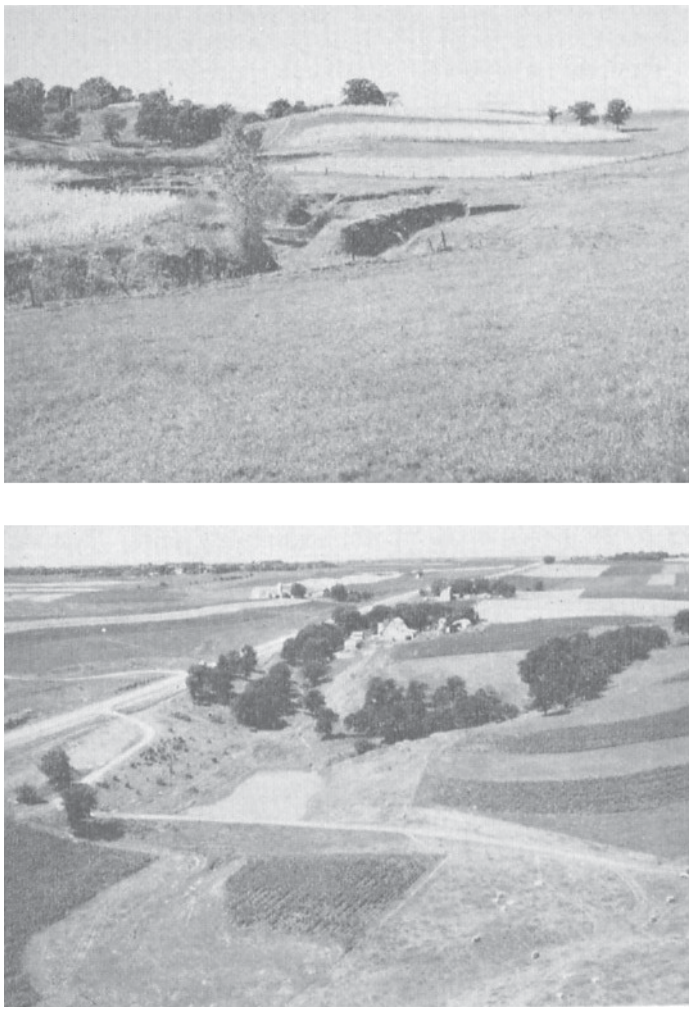

Figure 10.—**A gullied area of soils in capability unit IVe–2 is shown in the upper picture. The same area is shown in the lower picture, after a detention dam was built and the gullies were shaped and seeded to serve as waterways. The surrounding slopes are protected from erosion by keeping them in pasture or planting the crops in strips.**

ing legumes. All of the other soils in this capability unit, however, need lime unless they have been limed recently. A moderate amount of phosphate and potash is also needed on all of the soils.

The content of organic matter should be increased by adding a large amount of manure and using a rotation in which legumes and grasses are grown a greater part of the time than suggested in the rotations given. Lime and fertilizer ought to be added according to the results of soil tests.

The soils of this unit are well suited to either rotation or permanent pasture, and the rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer, used on native grass pasture, will provide grazing early and late in the season. These soils are in woodland suitability groups 1 and 3.

CAPABILITY UNIT IVe-3

Soils that are moderately deep, well drained, and strongly sloping make up this capability unit. The soils are medium textured and are underlain by bedrock at a depth of 24 to 42 inches. The soils in this unit are—

Dodgeville silt loam, 12 to 18 percent slopes, moderately eroded.
Dubuque silt loam, 12 to 18 percent slopes.
Dubuque silt loam, 12 to 18 percent slopes, moderately eroded.
Whalan silt loam, 12 to 18 percent slopes, moderately eroded.

Most of these soils are already moderately eroded, and the hazard of further erosion is moderately severe. In places the soils are slightly droughty, and they are slightly low in natural fertility. They are fairly well suited, however, to occasional use for cultivated crops if erosion is controlled. The major crops grown are corn, oats, and hay, but the soils are also used extensively for pasture and trees. Because of the strong slopes, these soils are not suited to soybeans.

The following rotations and practices are suggested for areas where the soils have slopes of about 14 percent and the slopes are about 150 feet long.

Unless erosion is controlled, the soils should not be used for row crops. A small grain can be grown at intervals, however, to establish a stand of hay or pasture. The hay or pasture should remain as long as it is productive.

The soils are too steep to be terraced or farmed on the contour. Stripcropping is the only practice that is suitable for controlling erosion, and the soils should be used for row crops no more often than 1 year out of 6. A suitable rotation where stripcropping is used is a row crop for 1 year, a small grain for 1 year, and meadow for 4 years. Wheel-track planting of row crops should be practiced. If corn is grown, the field should be disked and the stalks left on the field while the small grain is seeded. The soils ought to be plowed only in spring.

Waterways must be maintained, and it may be necessary to establish new ones. Gullies should be shaped and seeded for use as grassed waterways. Engineering structures may be required to stabilize a few of the gullies enough to grow grass (fig. 11).

Unless they have been limed recently, all of the soils of this unit generally need lime. Also, a moderate amount of phosphate and potash is needed. The soils should be tested, however, to determine the need for lime and fertilizer.

These soils are well suited to either rotation pasture or permanent pasture, and rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer, used on native grass pastures, will provide grazing early and late in the season. These soils are in woodland suitability group 2.

CAPABILITY UNIT IVe-4

In this capability unit are moderately deep, light-colored soils that are strongly sloping and well drained.

Figure 11.—**A diversion terrace built in an area that formerly contained several gullies. The soils have slopes of about 13 percent.**

The soils are medium textured and are underlain by sand or gravel at a depth of 24 to 42 inches. The soils in this unit are—

Gale silt loam, 12 to 18 percent slopes, moderately eroded.
Renova-Wykoff loams, 12 to 18 percent slopes, moderately eroded.

Most areas of these soils are already moderately eroded, and the hazard of further erosion is moderately severe. The soils are slightly to moderately droughty and are slightly low in natural fertility. They are fairly well suited to occasional use for cultivated crops, but erosion must be controlled if cultivated crops are grown. The major crops are corn, oats, hay, pasture, and trees. Soybeans are not suitable.

The following rotations and practices are suggested for areas where the soils have slopes of about 14 percent and the slopes are approximately 150 feet long.

Unless erosion is controlled, the soils should not be used for row crops. A small grain can be grown at intervals, however, to help reestablish a stand of hay or pasture. The hay or pasture should remain as long as it is productive.

The soils are too steep to be terraced or farmed on the contour, and stripcropping is the only practice that is suitable for controlling erosion. Where it is used, the soils should be used for row crops only 1 year out of 6. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 4 years. Wheel-track planting should be used. If corn is grown, the field should be disked and the stalks left on the field while the small grain is seeded. The soils should be plowed only in spring.

Waterways must be maintained, and it may be necessary to establish new ones. Gullies ought to be shaped and seeded for use as grassed waterways. In a few gullies engineering structures are needed to stabilize the soils enough to grow grass. Unless they have been limed recently, the soils of this unit generally need lime. Also, a moderate amount of phosphate and potash is needed. The stand of hay may be maintained by adding manure or commercial fertilizer after the second crop of hay has been harvested. These soils should be tested, however, to determine the need for lime and fertilizer.

These soils are well suited to either rotation pasture or permanent pasture, and the rotation pasture may be included in the cropping system. If the soils are limed and fertilized properly, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer, used on native grass pastures, will provide grazing early and late in the season. These soils are in woodland suitability group 2.

CAPABILITY UNIT IVe-5

Moderately sloping, well-drained, medium-textured soils that are underlain by bedrock at a depth of only 12 to 24 inches make up this capability unit. The soils in this unit are—

Dodgeville silt loam, shallow, 6 to 12 percent slopes, moderately eroded.
Dubuque silt loam, shallow, 6 to 12 percent slopes, moderately eroded.
Whalan silt loam, shallow, 6 to 12 percent slopes.
Whalan silt loam, shallow, 6 to 12 percent slopes, moderately eroded.

The hazards of further erosion and of drought are moderate. The soils are fairly well suited to occasional use for cultivated crops, however, if erosion is controlled. The major crops grown are corn, oats, hay, and pasture. Soybeans are not suited to these soils. It is important to select varieties of suitable crops that mature early. Yields vary widely, depending on the weather; the yields are largest in wet years.

The following rotations and practices are suggested for areas where the soils have slopes of about 8 percent and the slopes are 150 feet long.

If the soils are farmed on the contour, row crops can be grown 1 year out of 6. If wheel-track planting is used, a suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 4 years. If the soils are stripcropped, row crops can be grown 1 year out of 5. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 3 years. A rotation in which a row crop is grown 1 year out of 4 may be used if the soils are adequately fertilized and if wheel-track planting is practiced. A suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 2 years. The soils should be plowed only in spring.

Bedrock is too near the surface for terraces to be used on these soils. In a few places there are rock outcrops, and these areas should be kept in permanent vegetation.

Waterways must be maintained, and a few of them need to be reestablished. Gullies ought to be shaped and seeded for use as grassed waterways. In a few gullies engineering structures may be required to stabilize the soils enough to get grass started.

The soils of this unit should be tested to determine the needs for lime and fertilizer. Unless the soils have been recently limed, all of them need lime. Also, a moderate amount of phosphate and potash is necessary.

Rotation pasture may be included in the cropping system. If the soils are limed and fertilized, grasses and legumes, such as bromegrass, orchardgrass, and alfalfa, provide suitable pasture in summer. Nitrogen fertilizer, used on native grass pastures, will provide grazing early and late in the season. These soils are in woodland suitability group 11.

CAPABILITY UNIT IVe-6

Light-colored and dark-colored soils that are moderately sloping and well drained make up this capability unit. They are medium textured to moderately coarse textured and are underlain by sand, gravel, or sandstone at a depth of only 12 to 24 inches. The soils in this unit are—

Burkhardt sandy loam, 6 to 12 percent slopes, moderately eroded.
Gale-Hixton complex, shallow, 6 to 12 percent slopes, moderately eroded.
Hixton fine sandy loam, 6 to 12 percent slopes.
Meridian sandy loam, 6 to 12 percent slopes.
Meridian sandy loam, 6 to 12 percent slopes, moderately eroded.
Wykoff gravelly loam, 6 to 12 percent slopes, moderately eroded.

The hazard of erosion is moderate to moderately severe. There is also a moderate to moderately severe hazard of drought.

The following practices are suggested for areas where the soils have slopes of about 8 percent and the slopes are about 150 feet long.

Unless the soils are farmed on the contour, row crops should not be grown. A suitable rotation is a small grain for 1 year, followed by 3 years of meadow. Terracing is not practical, because the soils are too shallow over bedrock or coarse-textured material.

If the soils are stripcropped, they can be used for row crops 1 year out of 6. If the soils are contoured or stripcropped, and if all crop residues are returned, a suitable rotation is a row crop for 1 year, a small grain for 1 year, and meadow for 2 years. If the wheel-track method of planting is used, a suitable rotation is a row crop for 2 years, a small grain for 1 year, and meadow for 3 years. The strips are normally 80 to 90 feet wide, and alternate strips are in meadow.

Unless they have been recently limed, all of the soils in this unit generally need lime. Also, a moderately large amount of phosphate and potash is needed. Lime, phosphate, and potash should be applied in accordance with the needs indicated by soil tests. Nitrogen ought to be applied according to the needs of the crop to be grown.

Because these soils are droughty, it is better to pasture the meadow the second year in the rotation than to attempt to maintain permanent pasture. These soils are in woodland suitability group 10.

CAPABILITY UNIT IVs-1

Deep, droughty, nearly level or gently sloping, sandy soils make up this capability unit. The soils in this unit are—

Boone and Chelsea loamy fine sands, 2 to 6 percent slopes.
Sparta loamy fine sand, 0 to 2 percent slopes.
Sparta loamy fine sand, 2 to 6 percent slopes.

The hazard of drought is moderate to severe on these soils, and the hazard of erosion is slight to moderate. At present, no systematic rotation of crops is followed, but soybeans and melons are grown, and the soils are used occasionally for corn. Much of the acreage is idle or lies fallow.

These soils need a cropping system that provides year-round ground cover. Practices such as contour stripcropping, stubble-mulch tillage, and spring plowing help to control erosion. To protect the soils from erosion by wind, plant shelterbelts of pine at intervals of 40 rods. All available manure and crop residues need to be returned to the soils. They help to control wind erosion and improve the moisture-holding capacity of the soils. It is also advisable to plow down a good growth of legumes at regular intervals.

If wind stripcropping is practiced, a suitable rotation is a row crop for 1 year, and a small grain for 1 year. The strips of row crops should alternate with strips of small grain. This rotation may be used also if the soils are contour stripcropped or are farmed on the contour. The strips may be as wide as 100 feet. Alternate strips should be in small grain.

All crops grown on these soils, and especially legumes, benefit from lime and fertilizer, particularly in years when moisture is normal or better. They generally need a moderately large amount of phosphate and potash. Nitrogen should be applied according to the needs of the crops to be grown.

Truck crops can be grown if the soils are irrigated. They need larger applications of nitrogen, phosphate, and potash, however, than other crops. As is desirable with other crops, a large amount of green manure needs to be turned under, and all crop residues should be returned to the soils.

These soils are not suitable for permanent pasture, because it is too difficult to maintain a good sod. They are in woodland suitability group 8.

CAPABILITY UNIT IVs-2

Droughty, nearly level or gently sloping soils that are gravelly and shallow over gravel make up this capability unit. The soils in this unit are—

Burkhardt gravelly sandy loam, 0 to 2 percent slopes.
Burkhardt gravelly sandy loam, 2 to 6 percent slopes, moderately eroded.

The hazard of drought is very severe on these soils. At present, no systematic rotation is followed, because satisfactory stands of legumes are difficult to establish. Corn, soybeans, and winter small grains are grown.

The following rotations and practices are suggested for areas where the soils have slopes of about 4 percent and the slopes are about 150 feet long.

If field stripcropping is practiced, a suitable rotation is a row crop for 1 year and a small grain, seeded to a catch crop, the next year. The catch crop should remain until the following spring and then ought to be plowed under for green manure.

If the soils are farmed on the contour or if contour stripcropping is practiced, a suitable rotation is a row crop for 2 years, a small grain for 1 year, and meadow

for 1 year. The strips may be as wide as 100 feet, and alternate strips should be in meadow. Unless the meadow consists of a good cover of grasses and legumes, it will be difficult to establish and maintain the strips.

Terracing these soils is not practical, because gravel is too near the surface. Generally, the soils are not suitable for permanent pasture, because it is too difficult to maintain a good sod.

Unless they have been recently limed, all of the soils in this unit need lime. Also, a moderate amount of phosphate and potash is needed. Lime, phosphate, and potash should be applied according to the results of soil tests. Nitrogen ought to be applied according to the needs of the crop to be grown. These soils are in woodland suitability group 9.

CAPABILITY UNIT VIe-1

Moderately deep and deep, steep or moderately steep soils that are well drained and medium textured make up this unit. The soils in this unit are—

Dubuque silt loam, 18 to 25 percent slopes.
Dubuque silt loam, 25 to 35 percent slopes.
Dubuque soils, 12 to 18 percent slopes, severely eroded.
Fayette silt loam, uplands, 12 to 18 percent slopes, severely eroded.
Fayette silt loam, uplands, 18 to 25 percent slopes, moderately eroded.
Fayette silt loam, uplands, 18 to 25 percent slopes, severely eroded.
Fayette silt loam, uplands, 25 to 35 percent slopes, moderately eroded.
Fayette silt loam, valleys, 18 to 25 percent slopes, moderately eroded.
Fayette silt loam, valleys, 25 to 35 percent slopes.
Lindstrom silt loam, 18 to 25 percent slopes, moderately eroded.
Renova silt loam, 18 to 25 percent slopes, moderately eroded.
Renova silt loam, 25 to 35 percent slopes, moderately eroded.

Most of these soils are already eroded, and the hazard of further erosion is severe to very severe. Natural fertility is low to moderate. The soils are used mostly for hay and pasture, but they can also be used for trees or other permanent vegetation that will provide food and shelter for wildlife. Oats may be grown occasionally when the pastures need to be renovated, or to help reestablish permanent hay or pasture. The oats should be clipped, pastured, or harvested for grain.

Cleared areas of these soils need to be protected by a good cover of plants. If the pastures are to be renovated, the soils should be plowed in spring. A few stones may need to be removed from the Renova soils to make renovation of pastures easier. Lime will improve the growth of forage crops on these soils. Manure and phosphate should also be added, or a commercial fertilizer that contains nitrogen, phosphate, and potash should be applied.

Gullies ought to be shaped and seeded so that they will serve as grassed waterways. A few gullies may require engineering structures to stabilize them enough to grow grass.

Areas that are now in trees should not be cleared. Trees can be planted to improve the existing woodland, or areas now used for crops or pasture may be retired to trees.

To develop these soils so that they will provide shelter and food for wildlife, plant a combination of white pine, red pine, white spruce, redcedar, honeysuckle, lilac, Caragana, legumes, and grasses. Sweetclover is especially well suited. These soils are in woodland suitability groups 2, 3, and 4.

CAPABILITY UNIT VIe-2

Soils that are well drained and moderately steep to hilly make up this capability unit. They are medium textured and are underlain by bedrock at a depth of only 12 to 24 inches. The soils in this unit are—

Dodgeville silt loam, shallow, 12 to 18 percent slopes.
Dodgeville silt loam, shallow, 12 to 18 percent slopes, moderately eroded.
Dubuque silt loam, shallow, 12 to 18 percent slopes.
Dubuque silt loam, shallow, 12 to 18 percent slopes, moderately eroded.
Whalan silt loam, shallow, 12 to 18 percent slopes.
Whalan silt loam, shallow, 12 to 18 percent slopes, moderately eroded.

The hazards of further erosion and drought are moderately severe. Natural fertility is low to moderate. The soils are suitable for pasture, and they can also be used for trees or other permanent vegetation that will provide shelter and food for wildlife. Oats may be grown occasionally when the pastures need to be renovated or to reestablish permanent hay or pasture. The soils are used mainly for hay, pasture, and trees.

Gullies should be shaped and seeded for use as grassed waterways. A few gullies may require engineering structures that will stabilize them enough to allow grass to get a start.

Areas that are in permanent vegetation should remain so. Trees can be planted to improve the existing woodland or to retire areas now used for crops or pasture to trees. To develop these soils so that they will provide food and shelter for wildlife, use a combination of white pine, red pine, white spruce, redcedar, honeysuckle, lilac, Caragana, legumes, and grasses. Sweetclover is especially well suited.

Areas of these soils that have been cleared need to be protected by a good cover of vegetation. In such areas manure and phosphate should be added, or a commercial fertilizer that contains nitrogen, phosphate, and potash should be applied. Lime may also be needed. In some places rock outcrops make plowing difficult. Where plowing is feasible, the pastures can be renovated when necessary by seeding to oats. The plowing should be done in spring. Where plowing is not feasible, other means need to be used for renovating the pasture. These soils are in woodland suitability group 11.

CAPABILITY UNIT VIe-3

Soils that are well drained and strongly sloping make up this capability unit. They are medium textured to moderately coarse textured and are underlain by sand, sandstone, or gravel at a depth of only 12 to 24 inches. The soils in this unit are—

Gale-Hixton complex, shallow, 12 to 18 percent slopes, moderately eroded.
Hixton fine sandy loam, 12 to 18 percent slopes.
Wykoff gravelly loam, 12 to 18 percent slopes, moderately eroded.

The hazards of drought and of further erosion are severe. The soils are suited to pasture and trees, or they can be used to provide food and shelter for wildlife. They are used mainly for hay, pasture, and trees. Oats or rye are grown only to reestablish permanent hay or pasture. In many places it is desirable to establish permanent vegetation to provide food and shelter for wildlife.

Gullies should be shaped and seeded for use as grassed waterways. Engineering structures may be required to stabilize some gullies enough to allow grass to grow.

Areas that are now in permanent vegetation should remain so. Trees can be planted to improve the existing woodland or to retire areas now used for crops or pasture to trees. Where these soils are to be developed so that they will provide food and shelter for wildlife, a combination of white pine, red pine, redcedar, honeysuckle, lilac, Caragana, legumes, and grasses may be used. Sweetclover is especially well suited.

Areas of these soils that have been cleared need to be protected by a good cover of vegetation. Liming is necessary to encourage the growth of legumes. Manure and phosphate should be added, or a commercial fertilizer applied, to maintain the cover of vegetation. Lime, phosphate, and potash ought to be applied, however, in accordance with the results of soil tests. Nitrogen should be applied if the grass shows a need for it, but if too much nitrogen is added, or if nitrogen is applied too frequently, it causes the grass to crowd out the legumes.

When it is necessary to renovate pastures, lime ought to be applied in summer or fall, and after that, fertilizer should be added. Then seed to oats, appropriate grasses, and legumes. The oats need to be clipped or pastured when the crop is ready to head. The soils ought to be plowed in spring, but if plowing is not feasible, other methods of killing the sod should be used. These soils are in woodland suitability group 12.

CAPABILITY UNIT VIw-1

Soils of bottom lands and waterways that are frequently flooded make up this capability unit. In places the soils are moderately droughty. The soils in this unit are—

Alluvial land.
Osseo silt loam.

These soils are suited to pasture and trees, and they can be used to provide food and shelter for wildlife. Poor drainage is a moderately severe problem in the imperfectly drained areas, but in some places draining the area is not practical. The sandy areas are moderately droughty.

These soils are flooded often enough to restrict their use to permanent hay, pasture, and trees, or to use as a habitat for wildlife. The frequency of the floods, however, varies considerably. Occasionally, a row crop can be grown successfully. Areas that are now in trees should be left in trees. New plantings will improve the stand. Shrubs, conifers, and grasses that tolerate wetness ought to be used in those areas developed as shelter for wildlife.

The areas that have been cleared should be used for permanent hay and pasture. A good cover of vegetation ought to be maintained. If the stand becomes weedy or if infertile sediment buries the established sod, renovation is necessary. These soils can be plowed, but they should be reseeded as quickly as feasible after they are plowed. If oats are used as a companion crop when pasture grasses are seeded, they ought to be clipped or pastured because they are likely to lodge and kill the seedlings. Reed canarygrass or other grasses that tolerate both flooding and wetness should be grown.

In places where streams make sharp turns, the streambanks need to be stabilized so that the stream will not overflow onto areas used for crops. Lime is not needed on these soils. Alluvial land is in woodland suitability group 14, and Osseo silt loam is in group 15.

CAPABILITY UNIT VIIe-1

Steep or very steep soils that are subject to severe erosion and are very shallow over bedrock or coarse-textured material make up this capability unit. The soils are well drained to excessively drained and are medium textured. The soils in this unit are—

Dodgeville silt loam, shallow, 18 to 35 percent slopes, moderately eroded.
Dubuque silt loam, shallow, 18 to 25 percent slopes.
Dubuque silt loam, shallow, 25 to 35 percent slopes.
Dubuque soils, shallow, 12 to 18 percent slopes, severely eroded.
Dubuque soils, shallow, 18 to 25 percent slopes, severely eroded.
Gale-Hixton complex, shallow, 18 to 25 percent slopes, moderately eroded.
Hixton fine sandy loam, 18 to 35 percent slopes.
Terrace escarpments, loamy.
Whalan silt loam, shallow, 18 to 25 percent slopes, moderately eroded.
Whalan silt loam, shallow, 25 to 35 percent slopes, moderately eroded.
Wykoff gravelly loam, 18 to 35 percent slopes, moderately eroded.

Many areas of these soils are moderately eroded or severely eroded. The hazard of further erosion is severe or very severe, and the hazard of drought is moderately severe or severe. Natural fertility is moderate. These soils are suited to permanent pasture and trees. They can be used also to provide food and shelter for wildlife.

Gullies should be shaped and seeded for use as grassed waterways. Engineering structures are needed to stabilize some gullies enough to allow grass to get a start.

A good cover of vegetation needs to be maintained on pastured areas. Manure and phosphate should be added, or a commercial fertilizer should be applied. Lime may be needed on all of these soils.

Areas that have not been cleared ought to be left in trees. New plantings will improve the stand in wooded areas, and pastured areas can be planted to trees. Shrubs, conifers, grasses, and legumes that are suited to droughty and shallow soils can be planted to provide food and shelter for wildlife. These soils are in woodland suitability groups 5 and 12.

CAPABILITY UNIT VIIw-1

Miscellaneous land types that are on bottom lands and that are not suitable for agriculture make up this capability unit. The land types in this unit are—

Alluvial land, wet.
Riverwash.
Stony colluvial land.

These land types have very limited suitability for permanent pasture and trees, but they can be used to provide food and shelter for wildlife. The hazard of flooding is very severe.

Most areas of Alluvial land, wet, are on the flood plains along the Mississippi River, and in these areas the dams in the river cause the water table to fluctuate. As a result, these areas are generally suited only to trees or to provide food and shelter for wildlife.

Riverwash consists mainly of sand, which shifts each time the areas are flooded. It has little or no value for agriculture. In places it supports a thin cover of grass or a few willows, although it is generally unsuitable for trees.

Stony colluvial land supports a fair stand of pasture grasses and trees. In places, however, flash floods occasionally leave silt and chunks or fragments of rock.

The land types in this capability unit ought to be allowed to reseed naturally to trees that will provide cover for wildlife. If planting appears to be desirable in open areas, cottonwood and hybrid poplar may be planted. Hybrid poplar should be planted on the better sites. Alluvial land, wet, is in woodland suitability group 15, and Stony colluvial land is in woodland suitability group 14. Riverwash is not suited to trees.

CAPABILITY UNIT VIIs-1

Deep, gently sloping to steep, droughty sands, or gravelly soils that are shallow over gravel or sand, make up this capability unit. The soils in this unit are—

Boone and Chelsea loamy fine sands, 6 to 12 percent slopes.
Boone and Chelsea loamy fine sands, 12 to 18 percent slopes.
Boone loamy fine sand, 18 to 35 percent slopes.
Dune land.
Plainfield fine sand, 0 to 2 percent slopes.
Plainfield fine sand, 2 to 6 percent slopes.
Plainfield fine sand, 6 to 12 percent slopes.
Sogn soils.
Steep, stony, and rocky land.
Terrace escarpments, sandy.

The hazard of erosion is moderate to very severe, and the hazard of drought is severe or very severe. The soils can be used for pasture if a good cover of vegetation is maintained at all times. That is difficult to do, however, because these soils are droughty and do not support a good sod. These areas are suited to trees and can be used to provide food and shelter for wildlife.

If the cover of vegetation is destroyed or weakened, gullies form rapidly. They are difficult to control or to heal, and in some areas controlling them is not feasible. Adding manure, phosphate, and potash will improve the sod in pastures. In addition, lime is needed in most places. Lime, phosphate, and potash should be applied according to the results of soil tests.

These areas are probably best suited to trees, and areas that are wooded should remain so. Trees can be planted to improve the present woodland or to reforest idle areas and areas not used for crops or pasture. Shrubs, conifers, grasses, and legumes that are suited to droughty soils will provide food and shelter for wildlife. These soils are in woodland suitability groups 5, 8, and 13.

Estimated Yields

Table 2 shows the estimated average acre yields of the principal crops on the soils of Wabasha County, over a period of years, under average management and under the improved management described in the section on capability units. These estimates are based on records and observations of representatives of the Soil Conservation Service, the Extension Service, and the University of Minnesota, Institute of Agriculture; they are also based on interviews with farmers in the county.

TABLE 2.—*Estimated average yields per acre of principal crops under two levels of management*

[Yield in columns A are to be expected under average management practices; those in columns B are to be expected under improved management practices, as described in the individual capability units. Absence of a figure indicates that the crop is not generally grown or the soil is not suited to it]

Map symbol	Mapping unit	Corn		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]
Ad	Alluvial land	65	80	15	30	35	40	2.5	3.0	100	135		
Aw	Alluvial land, wet											60	80
Az	Arenzville silt loam	65	90	20	30	45	55	2.8	3.5	110	145		
BbA	Bixby loam, 0 to 2 percent slopes	45	55	17	22	35	45	2.4	3.2	75	105		
BbB	Bixby loam, 2 to 6 percent slopes	40	50	16	20	30	40	2.2	3.0	65	100		
BbB2	Bixby loam, 2 to 6 percent slopes, moderately eroded	30	45	14	18	25	35	2.0	2.7	60	85		
BfE	Boone loamy fine sand, 18 to 35 percent slopes											20	40
BhB	Boone and Chelsea loamy fine sands, 2 to 6 percent slopes	15	30	8	10	15	25	1.7	2.0	80	110		
BhC	Boone and Chelsea loamy fine sands, 6 to 12 percent slopes					10	20	1.2	1.5	65	85		
BhD	Boone and Chelsea loamy fine sands, 12 to 18 percent slopes							.7	1.0	55	75		
BkA	Burkhardt gravelly sandy loam, 0 to 2 percent slopes					20	25						
BkB2	Burkhardt gravelly sandy loam, 2 to 6 percent slopes, moderately eroded					18	23						

See footnotes at end of table.

TABLE 2.—*Estimated average yields per acre of principal crops under two levels of management*—Continued

Map symbol	Mapping unit	Corn		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]
BrA	Burkhardt loam, 0 to 2 percent slopes	30	35	10	15	25	35	1. 5	2. 0	75	90	------	------
BrB	Burkhardt loam, 2 to 6 percent slopes	30	35	10	15	25	35	1. 5	2. 0	75	90	------	------
BtA	Burkhardt sandy loam, 0 to 2 percent slopes	25	35	6	7	25	30	1. 5	1. 7	75	90	------	------
BtB	Burkhardt sandy loam, 2 to 6 percent slopes	19	30	4	5	22	27	1. 6	1. 8	81	97	------	------
BtB2	Burkhardt sandy loam, 2 to 6 percent slopes, moderately eroded	18	28	4	5	20	25	1. 5	1. 7	75	90	------	------
BtC2	Burkhardt sandy loam, 6 to 12 percent slopes, moderately eroded	12	23	3	4	18	23	1. 0	1. 2	50	65	------	------
CaB	Chaseburg fine sandy loam, 2 to 6 percent slopes	50	65	15	20	35	40	2. 0	2. 5	85	110	------	------
ChA	Chaseburg silt loam, 0 to 2 percent slopes	60	75	20	25	40	45	2. 3	2. 7	90	120	------	------
ChB	Chaseburg silt loam, 2 to 6 percent slopes	60	75	20	25	40	45	2. 3	2. 7	90	120	------	------
Co	Colo silty clay loam:												
	Inadequately drained	45	55	14	17	30	35	1. 8	2. 2	80	100	------	------
	Adequately drained	65	75	22	27	40	45	2. 4	2. 7	110	130	------	------
DdC2	Dodgeville silt loam, 6 to 12 percent slopes, moderately eroded	35	50	12	17	35	45	2. 0	3. 0	80	120	------	------
DdD2	Dodgeville silt loam, 12 to 18 percent slopes, moderately eroded	----	----	----	----	30	40	1. 5	2. 5	60	100	------	------
DgC2	Dodgeville silt loam, shallow, 6 to 12 percent slopes, moderately eroded	25	35	----	----	20	30	1. 5	2. 0	70	90	------	------
DgD	Dodgeville silt loam, shallow, 12 to 18 percent slopes	----	----	----	----	20	30	1. 5	2. 0	55	80	45	70
DgD2	Dodgeville silt loam, shallow, 12 to 18 percent slopes, moderately eroded	----	----	----	----	15	30	1. 3	2. 0	50	75	40	65
DgE2	Dodgeville silt loam, shallow, 18 to 35 percent slopes, moderately eroded	----	----	----	----	----	----	------	------	------	------	40	65
DhA	Downs and Mt. Carroll silt loams, 0 to 2 percent slopes	65	100	25	32	50	65	3. 0	4. 0	120	160	------	------
DhB	Downs and Mt. Carroll silt loams, 2 to 6 percent slopes	65	100	23	30	45	65	3. 0	4. 0	120	160	------	------
DhB2	Downs and Mt. Carroll silt loams, 2 to 6 percent slopes, moderately eroded	60	90	21	28	40	60	2. 8	3. 8	110	150	------	------
DhC	Downs and Mt. Carroll silt loams, 6 to 12 percent slopes	60	80	20	27	40	55	2. 8	3. 8	110	150	------	------
DhC2	Downs and Mt. Carroll silt loams, 6 to 12 percent slopes, moderately eroded	50	70	17	24	35	50	2. 6	3. 6	100	145	------	------
DhD	Downs and Mt. Carroll silt loams, 12 to 18 percent slopes	40	60	----	----	30	45	2. 4	3. 5	90	140	60	115
DhD2	Downs and Mt. Carroll silt loams, 12 to 18 percent slopes, moderately eroded	35	55	----	----	25	40	2. 2	3. 3	85	135	60	110
DmA	Downs and Mt. Carroll silt loams, benches, 0 to 2 percent slopes	65	95	25	34	55	70	3. 0	4. 0	115	155	------	------
DmB	Downs and Mt. Carroll silt loams, benches, 2 to 6 percent slopes	65	95	22	30	50	65	3. 0	4. 0	115	155	------	------
DnB	Dubuque silt loam, 2 to 6 percent slopes	45	60	19	26	30	50	2. 2	3. 4	90	135	------	------
DnB2	Dubuque silt loam, 2 to 6 percent slopes, moderately eroded	35	55	15	22	25	45	2. 0	3. 2	80	130	------	------
DnC	Dubuque silt loam, 6 to 12 percent slopes	40	55	----	----	30	50	2. 0	3. 2	80	130	------	------
DnC2	Dubuque silt loam, 6 to 12 percent slopes, moderately eroded	30	45	----	----	20	40	1. 8	3. 0	70	120	------	------
DnD	Dubuque silt loam, 12 to 18 percent slopes	35	50	----	----	25	40	1. 8	3. 0	70	120	50	80
DnD2	Dubuque silt loam, 12 to 18 percent slopes, moderately eroded	25	35	----	----	15	25	1. 6	2. 6	65	110	35	70
DnE	Dubuque silt loam, 18 to 25 percent slopes	----	----	----	----	(3)	(3)	1. 4	2. 6	------	------	40	65
DnF	Dubuque silt loam, 25 to 35 percent slopes	----	----	----	----	----	----	------	------	------	------	35	55
DrB	Dubuque silt loam, shallow, 2 to 6 percent slopes	35	50	12	18	25	35	1. 8	2. 5	70	100	------	------
DrB2	Dubuque silt loam, shallow, 2 to 6 percent slopes, moderately eroded	30	40	10	15	20	30	1. 5	2. 3	60	90	------	------
DrC2	Dubuque silt loam, shallow, 6 to 12 percent slopes, moderately eroded	25	35	----	----	10	20	1. 2	1. 8	50	75	35	60
DrD	Dubuque silt loam, shallow, 12 to 18 percent slopes	----	----	----	----	(3)	(3)	1. 0	1. 8	50	75	35	60
DrD2	Dubuque silt loam, shallow, 12 to 18 percent slopes, moderately eroded	----	----	----	----	(3)	(3)	0. 8	1. 6	30	65	25	50
DrE	Dubuque silt loam, shallow, 18 to 25 percent slopes	----	----	----	----	----	----	------	------	------	------	25	45
DrF	Dubuque silt loam, shallow, 25 to 35 percent slopes	----	----	----	----	----	----	------	------	------	------	20	40
DsD3	Dubuque soils, 12 to 18 percent slopes, severely eroded	20	30	----	----	10	20	1. 0	1. 8	40	65	30	50

See footnotes at end of table.

TABLE 2.—*Estimated average yields per acre of principal crops under two levels of management*—Continued

Map symbol	Mapping unit	Corn		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]
DtD3	Dubuque soils, shallow, 12 to 18 percent slopes, severely eroded	----	----	----	----	(3)	(3)	0. 7	1. 5	30	60	25	45
DtE3	Dubuque soils, shallow, 18 to 25 percent slopes, severely eroded	----	----	----	----	----	----	----	----	----	----	20	40
Du	Dune land	----	----	----	----	----	----	----	----	----	----	----	----
FaA	Fayette silt loam, uplands, 0 to 2 percent slopes	60	100	21	30	45	65	3. 0	4. 0	120	160	----	----
FaB	Fayette silt loam, uplands, 2 to 6 percent slopes	60	100	18	27	45	55	3. 0	4. 0	120	160	----	----
FaB2	Fayette silt loam, uplands, 2 to 6 percent slopes, moderately eroded	55	95	16	24	40	55	2. 8	3. 8	110	150	----	----
FaC	Fayette silt loam, uplands, 6 to 12 percent slopes	55	90	16	24	35	55	2. 8	3. 8	110	150	----	----
FaC2	Fayette silt loam, uplands, 6 to 12 percent slopes, moderately eroded	55	85	13	22	35	50	2. 8	3. 8	110	145	----	----
FaC3	Fayette silt loam, uplands, 6 to 12 percent slopes, severely eroded	35	60	----	----	20	45	2. 5	3. 4	85	135	----	----
FaD	Fayette silt loam, uplands, 12 to 18 percent slopes	45	75	----	----	30	45	2. 5	3. 5	95	140	55	110
FaD2	Fayette silt loam, uplands, 12 to 18 percent slopes, moderately eroded	40	70	----	----	25	45	2. 5	3. 5	90	140	50	105
FaD3	Fayette silt loam, uplands, 12 to 18 percent slopes, severely eroded	----	----	----	----	15	30	2. 4	3. 4	75	135	45	100
FaE2	Fayette silt loam, uplands, 18 to 25 percent slopes, moderately eroded	----	----	----	----	(3)	(3)	----	----	----	----	45	100
FaE3	Fayette silt loam, uplands, 18 to 25 percent slopes, severely eroded	----	----	----	----	(3)	(3)	----	----	----	----	40	90
FaF2	Fayette silt loam, uplands, 25 to 35 percent slopes, moderately eroded	----	----	----	----	----	----	----	----	----	----	30	60
FbA	Fayette silt loam, benches, 0 to 2 percent slopes	65	95	21	30	55	70	3. 0	4. 0	115	155	----	----
FbB	Fayette silt loam, benches, 2 to 6 percent slopes	65	95	18	27	55	68	3. 0	4. 0	110	150	----	----
FbB2	Fayette silt loam, benches, 2 to 6 percent slopes, moderately eroded	60	90	17	24	50	68	2. 8	3. 8	105	150	----	----
FbC	Fayette silt loam, benches, 6 to 12 percent slopes	55	80	15	24	40	60	2. 6	3. 2	100	145	----	----
FbC2	Fayette silt loam, benches, 6 to 12 percent slopes, moderately eroded	50	75	12	21	35	55	2. 6	3. 2	95	145	----	----
FcB	Fayette silt loam, valleys, 2 to 6 percent slopes	60	100	18	27	45	55	3. 0	4. 0	120	160	----	----
FcB2	Fayette silt loam, valleys, 2 to 6 percent slopes, moderately eroded	55	95	16	24	40	55	2. 8	3. 8	110	150	----	----
FcC	Fayette silt loam, valleys, 6 to 12 percent slopes	55	90	16	24	35	55	2. 8	3. 8	105	150	----	----
FcC2	Fayette silt loam, valleys, 6 to 12 percent slopes, moderately eroded	55	85	13	18	35	50	2. 8	3. 8	100	145	----	----
FcD	Fayette silt loam, valleys, 12 to 18 percent slopes	45	75	----	----	30	45	2. 5	3. 5	95	140	60	110
FcD2	Fayette silt loam, valleys, 12 to 18 percent slopes, moderately eroded	40	70	----	----	25	45	2. 5	3. 5	90	140	55	105
FcE2	Fayette silt loam, valleys, 18 to 25 percent slopes, moderately eroded	----	----	----	----	(3)	(3)	----	----	----	----	45	100
FcF	Fayette silt loam, valleys, 25 to 35 percent slopes	----	----	----	----	----	----	----	----	----	----	30	60
FrB2	Fayette-Renova silt loams, 2 to 6 percent slopes, moderately eroded	55	90	15	24	40	50	2. 8	3. 8	110	150	----	----
FrC2	Fayette-Renova silt loams, 6 to 12 percent slopes, moderately eroded	50	80	12	18	30	50	2. 8	3. 8	95	145	----	----
FrD2	Fayette-Renova silt loams, 12 to 18 percent slopes, moderately eroded	45	70	----	----	25	40	2. 5	3. 5	90	140	55	105
GaB2	Gale silt loam, 2 to 6 percent slopes, moderately eroded	45	60	15	24	30	50	2. 2	3. 4	90	135	----	----
GaC2	Gale silt loam, 6 to 12 percent slopes, moderately eroded	30	40	----	----	20	40	1. 8	2. 8	75	120	----	----
GaD2	Gale silt loam, 12 to 18 percent slopes, moderately eroded	25	35	----	----	15	25	1. 6	2. 6	65	110	40	70
GhC2	Gale-Hixton complex, shallow, 6 to 12 percent slopes, moderately eroded	25	35	----	----	10	20	1. 2	1. 8	50	75	35	60
GhD2	Gale-Hixton complex, shallow, 12 to 18 percent slopes, moderately eroded	----	----	----	----	(3)	(3)	0. 8	1. 6	35	65	30	50
GhE2	Gale-Hixton complex, shallow, 18 to 25 percent slopes, moderately eroded	----	----	----	----	----	----	----	----	----	----	25	45
Gm	Garwin silt loam:												
	Inadequately drained	30	35	15	19	20	25	----	----	70	110	40	85
	Adequately drained	60	80	27	32	45	55	2. 3	2. 8	120	140	----	----
Gn	Genesee sandy loam	50	65	15	20	35	40	2. 0	2. 5	85	110	----	----
Gs	Genesee silt loam	60	75	20	25	40	45	2. 3	2. 7	90	120	----	----
HfB	Hixton fine sandy loam, 2 to 6 percent slopes	30	45	14	18	25	35	2. 0	2. 7	60	85	----	----
HfC	Hixton fine sandy loam, 6 to 12 percent slopes	25	40	12	16	20	30	2. 0	2. 5	60	80	----	----

See footnotes at end of table.

TABLE 2.—*Estimated average yields per acre of principal crops under two levels of management*—Continued

Map symbol	Mapping unit	Corn		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]
HfD	Hixton fine sandy loam, 12 to 18 percent slopes	----	----	----	----	(3)	(3)	1. 2	2. 0	45	70	------	------
HfE	Hixton fine sandy loam, 18 to 35 percent slopes	----	----	----	----	----	----	------	------	------	------	------	------
Hu	Huntsville silt loam	70	90	20	30	45	50	2. 5	3. 0	100	135	------	------
JuA	Judson silt loam, 0 to 2 percent slopes	70	80	20	25	45	50	2. 5	2. 8	110	140	------	------
JuB	Judson silt loam, 2 to 6 percent slopes	70	80	20	25	45	50	2. 5	2. 8	110	140	------	------
LnB	Lindstrom silt loam, 2 to 6 percent slopes	60	100	18	27	45	60	3. 0	4. 0	120	160	------	------
LnC	Lindstrom silt loam, 6 to 12 percent slopes	55	80	16	24	35	55	2. 8	3. 8	110	150	------	------
LnC2	Lindstrom silt loam, 6 to 12 percent slopes, moderately eroded	50	80	12	21	35	50	2. 6	3. 6	100	145	------	------
LnD	Lindstrom silt loam, 12 to 18 percent slopes	45	75	----	----	30	45	2. 4	3. 5	90	140	60	115
LnD2	Lindstrom silt loam, 12 to 18 percent slopes, moderately eroded	40	70	----	----	25	40	2. 2	3. 3	85	140	60	110
LnE2	Lindstrom silt loam, 18 to 25 percent slopes, moderately eroded	----	----	----	----	(3)	(3)	1. 2	2. 0	75	115	50	100
MbA	Medary silt loam, brown variant, 0 to 2 percent slopes	60	85	20	30	45	50	2. 5	3. 5	110	150	------	------
MbB	Medary silt loam, brown variant, 2 to 6 percent slopes	55	80	17	24	40	50	2. 5	3. 5	110	150	------	------
MdA	Meridian sandy loam, 0 to 2 percent slopes	40	50	16	20	30	40	2. 2	3. 0	65	100	------	------
MdB	Meridian sandy loam, 2 to 6 percent slopes	30	45	14	18	25	35	2. 0	2. 7	60	85	------	------
MdB2	Meridian sandy loam, 2 to 6 percent slopes, moderately eroded	25	40	12	16	20	30	1. 8	2. 4	55	80	------	------
MdC	Meridian sandy loam, 6 to 12 percent slopes	25	40	12	16	20	30	2. 0	2. 5	60	80	------	------
MdC2	Meridian sandy loam, 6 to 12 percent slopes, moderately eroded	20	35	10	14	15	25	1. 6	2. 2	50	75	35	60
Mn	Minneiska silt loam	60	80	17	24	40	50	2. 3	2. 8	100	135	------	------
MuA	Muscatine silt loam, 0 to 2 percent slopes:												
	Inadequately drained	45	55	22	25	40	45	1. 8	2. 2	95	110	70	100
	Adequately drained	65	85	27	33	50	60	2. 4	3. 0	125	180	------	------
MuB	Muscatine silt loam, 2 to 6 percent slopes:												
	Inadequately drained	50	60	24	27	45	50	2. 0	2. 2	100	110	70	100
	Adequately drained	65	85	27	33	50	60	2. 4	3. 0	125	145	------	------
Os	Osseo silt loam:												
	Inadequately drained	----	----	----	----	----	----	------	------	------	------	30	80
	Adequately drained	60	75	20	25	40	45	2. 3	2. 7	90	120	------	------
PaA	Plainfield fine sand, 0 to 2 percent slopes	----	----	----	----	----	----	------	------	------	------	------	------
PaB	Plainfield fine sand, 2 to 6 percent slopes	----	----	----	----	----	----	------	------	------	------	------	------
PaC	Plainfield fine sand, 6 to 12 percent slopes	----	----	----	----	----	----	------	------	------	------	------	------
PbA	Port Byron silt loam, 0 to 2 percent slopes	70	100	27	35	50	65	3. 0	4. 0	120	160	------	------
PbB	Port Byron silt loam, 2 to 6 percent slopes	65	100	25	32	50	65	3. 0	4. 0	120	160	------	------
PbB2	Port Byron silt loam, 2 to 6 percent slopes, moderately eroded	60	95	21	28	45	60	2. 8	3. 8	110	150	------	------
PbC	Port Byron silt loam, 6 to 12 percent slopes	55	85	20	27	40	55	2. 8	3. 8	110	150	------	------
PbC2	Port Byron silt loam, 6 to 12 percent slopes, moderately eroded	50	80	18	24	35	50	2. 6	3. 6	100	145	------	------
PoA	Port Byron silt loam, benches, 0 to 2 percent slopes	65	100	27	35	55	65	3. 5	4. 0	125	160	------	------
PoB	Port Byron silt loam, benches, 2 to 6 percent slopes	65	95	25	33	55	65	3. 5	4. 0	125	160	------	------
RaA	Racine silt loam, 0 to 2 percent slopes	60	75	23	30	45	60	2. 5	3. 5	100	140	------	------
RaB	Racine silt loam, 2 to 6 percent slopes	55	75	21	28	40	55	2. 5	3. 5	100	140	------	------
RaB2	Racine silt loam, 2 to 6 percent slopes, moderately eroded	50	70	18	25	35	50	2. 4	3. 4	95	135	------	------
RaC2	Racine silt loam, 6 to 12 percent slopes, moderately eroded	45	65	15	22	30	45	2. 3	3. 3	90	130	------	------
RaD2	Racine silt loam, 12 to 18 percent slopes, moderately eroded	35	55	----	----	25	40	2. 0	3. 0	65	100	------	------
ReB	Renova silt loam, 2 to 6 percent slopes	45	70	16	25	30	50	2. 3	3. 5	90	140	------	------
ReB2	Renova silt loam, 2 to 6 percent slopes, moderately eroded	40	65	13	22	25	50	2. 3	3. 5	85	135	------	------
ReC	Renova silt loam, 6 to 12 percent slopes	40	65	----	22	30	50	2. 1	3. 3	80	130	------	------
ReC2	Renova silt loam, 6 to 12 percent slopes, moderately eroded	35	60	----	19	25	45	2. 1	3. 3	75	130	------	------
ReD	Renova silt loam, 12 to 18 percent slopes	30	55	----	----	25	40	1. 9	3. 1	70	125	50	105
ReD2	Renova silt loam, 12 to 18 percent slopes, moderately eroded	25	50	----	----	20	35	1. 9	3. 1	70	125	45	100
ReE2	Renova silt loam, 18 to 25 percent slopes, moderately eroded	----	----	----	----	(3)	(3)	------	------	------	------	40	90
ReF2	Renova silt loam, 25 to 35 percent slopes, moderately eroded	----	----	----	----	----	----	------	------	------	------	25	55

See footnotes at end of table.

TABLE 2.—*Estimated average yields per acre of principal crops under two levels of management*—Continued

Map symbol	Mapping unit	Corn		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]
RkB2	Renova-Wykoff loams, 2 to 6 percent slopes, moderately eroded	35	45	15	22	25	45	2.0	3.0	80	125	----	----
RkC2	Renova-Wykoff loams, 6 to 12 percent slopes, moderately eroded	30	40	----	----	20	40	1.8	2.8	70	120	----	----
RkD2	Renova-Wykoff loams, 12 to 18 percent slopes, moderately eroded	25	35	----	----	15	25	1.6	2.6	65	110	40	70
Rv	Riverwash	----	----	----	----	----	----	----	----	----	----	----	----
SbD2	Seaton-Bold soils, 12 to 18 percent slopes, moderately eroded	25	50	----	----	25	40	2.2	3.1	80	130	45	100
So	Sogn soils	----	----	----	----	----	----	0.8	1.3	25	50	20	40
SpA	Sparta loamy fine sand, 0 to 2 percent slopes	25	40	6	8	25	30	1.0	1.5	25	50	----	----
SpB	Sparta loamy fine sand, 2 to 6 percent slopes	20	35	5	5	25	30	0.8	1.4	25	50	----	----
Sr	Steep, stony, and rocky land	----	----	----	----	----	----	----	----	----	----	----	----
St	Stony colluvial land	----	----	----	----	----	----	----	----	----	----	----	----
ThA	Tell silt loam, 0 to 2 percent slopes	50	65	21	28	35	55	2.4	3.6	100	145	----	----
ThB	Tell silt loam, 2 to 6 percent slopes	45	60	19	25	30	50	2.2	3.4	90	135	----	----
ThB2	Tell silt loam, 2 to 6 percent slopes, moderately eroded	35	45	15	22	25	45	2.0	3.0	80	130	----	----
Tm	Terrace escarpments, loamy	----	----	----	----	----	----	----	----	----	----	25	45
Ts	Terrace escarpments, sandy	----	----	----	----	----	----	----	----	----	----	----	----
WaA	Waukegan silt loam, 0 to 2 percent slopes	60	80	25	30	55	60	2.7	3.2	110	130	----	----
WaB	Waukegan silt loam, 2 to 6 percent slopes	55	75	23	28	50	60	2.7	3.2	110	130	----	----
WaB2	Waukegan silt loam, 2 to 6 percent slopes, moderately eroded	50	60	20	25	45	50	2.6	3.1	105	125	----	----
WaC2	Waukegan silt loam, 6 to 12 percent slopes, moderately eroded	45	55	----	----	40	50	2.4	2.8	100	120	----	----
WhB2	Whalan silt loam, 2 to 6 percent slopes, moderately eroded	35	45	15	22	25	45	2.0	3.0	80	130	----	----
WhC2	Whalan silt loam, 6 to 12 percent slopes, moderately eroded	30	40	----	----	20	40	1.8	2.8	70	120	----	----
WhD2	Whalan silt loam, 12 to 18 percent slopes, moderately eroded	25	35	----	----	15	25	1.6	2.6	65	110	40	70
WsB2	Whalan silt loam, shallow, 2 to 6 percent slopes, moderately eroded	30	40	10	15	20	30	1.5	2.3	60	95	----	----
WsC	Whalan silt loam, shallow, 6 to 12 percent slopes	30	40	----	----	20	30	1.5	2.3	60	95	40	70
WsC2	Whalan silt loam, shallow, 6 to 12 percent slopes, moderately eroded	25	35	----	----	10	20	1.2	1.8	50	70	35	60
WsD	Whalan silt loam, shallow, 12 to 18 percent slopes	----	----	----	----	(3)	(3)	1.0	1.8	45	70	35	60
WsD2	Whalan silt loam, shallow, 12 to 18 percent slopes, moderately eroded	----	----	----	----	(3)	(3)	0.8	1.6	35	65	30	50
WsE2	Whalan silt loam, shallow, 18 to 25 percent slopes, moderately eroded	----	----	----	----	----	----	----	----	----	----	25	45
WsF2	Whalan silt loam, shallow, 25 to 35 percent slopes, moderately eroded	----	----	----	----	----	----	----	----	----	----	20	40
WvB	Wykoff gravelly loam, 2 to 6 percent slopes	25	30	10	15	25	35	1.2	2.0	50	80	----	----
WvC2	Wykoff gravelly loam, 6 to 12 percent slopes, moderately eroded	20	25	----	----	20	30	0.9	1.9	40	75	30	55
WvD2	Wykoff gravelly loam, 12 to 18 percent slopes, moderately eroded	----	----	----	----	(3)	(3)	----	----	----	----	25	50
WvE2	Wykoff gravelly loam, 18 to 35 percent slopes, moderately eroded	----	----	----	----	----	----	----	----	----	----	20	45
Zb	Zumbro loamy fine sand	30	35	12	15	20	30	1.5	2.0	60	80	----	----
ZgA	Zwingle silt loam, 0 to 2 percent slopes:												
	Inadequately drained	35	45	10	15	20	30	1.5	2.0	80	100	----	----
	Adequately drained	55	80	17	24	40	45	2.2	3.0	100	130	----	----
ZgB	Zwingle silt loam, 2 to 6 percent slopes:												
	Inadequately drained	35	45	10	15	25	35	1.5	2.0	80	100	----	----
	Adequately drained	50	75	16	20	35	45	2.0	3.0	100	130	----	----
ZgB2	Zwingle silt loam, 2 to 6 percent slopes, moderately eroded:												
	Inadequately drained	30	40	10	15	25	35	1.5	2.0	80	100	----	----
	Adequately drained	45	70	14	18	30	40	2.0	3.0	100	130	----	----

[1] These yields are to be expected if a mixture of alfalfa and bromegrass is grown. If a mixture of red clover and timothy is grown, average yields will be about 10 to 25 percent less than those given here.

[2] Cow-acre-days is the number of days in a year that 1 acre will furnish grazing for one mature cow or horse without injury to the pasture.

[3] Oats are grown on this soil when it is necessary to renovate permanent pasture. Yields were not estimated, because oats may be pastured off, clipped, or harvested.

Yields were not estimated for crops that were not considered suited to a particular soil. The major crops can be grown on such soils, but because the soil is shallow, steep, severely eroded, very droughty, poorly drained, or susceptible to flooding, the crops are not likely to be successful. For soils on which adequate drainage makes a considerable difference in suitability for crops, yields are given both with and without adequate drainage.

It is assumed that rotation pasture consists of a mixture of suitable legumes and grasses. Permanent pasture, under average management, consists principally of native grass. Under improved management, in which permanent pasture is renovated at intervals, a mixture of suitable grasses and legumes is the principal cover.

Actual yields may vary considerably from the figures given in this table. Variations in soil characteristics, slight differences in management, damage by diseases and insects, and especially variations in weather will affect the yields.

These yield figures represent an average to be expected over a period of 10 years. They are useful chiefly in judging the increases in yields that can be expected from improved management and from draining the soils.

For yields given in columns A, the rotation consists mainly of cultivated crops; meadow crops are grown only 1 year in 5 or 6. Under this level of management, lime is added and a starter fertilizer is applied for corn. All the available manure is spread before the corn is planted. Measures to control erosion are not used. Two cuttings of alfalfa are harvested. The number of corn plants ranges from 12,000 to 14,000 per acre.

Yields given in columns B can be expected if improved management is practiced, according to suggestions given in the individual capability units. Under this level of management, three cuttings of alfalfa are harvested. The number of corn plants ranges from 16,000 to 20,000 per acre.

Management of Pastures

Pastures can be improved by reseeding to a suitable combination of grasses and legumes or by properly managing the existing forage. Before reseeding a pasture, test the soils to determine the need for lime and fertilizer. Apply lime at least 6 months before seeding, and phosphorus and potassium at the time of seeding. The fertilizer can be broadcast and then worked into the soils before the seed is planted. Drilling fertilizer in a band 1 inch below the seed will help the plants to establish themselves early.

If the soil is level to moderately sloping, a good seedbed should be prepared by plowing on the contour. If the cost is not too great, stones, stumps, and other obstructions should be removed so that farm equipment can be used more easily. On the steeper slopes it is best not to plow, but to work the soil so as to leave a mulch on the surface. Weeds should be removed by treating them with chemicals or by cultivating the soils several weeks or months before the seed is planted.

Legumes and grasses that will grow on the kind of soil available and that will be productive at the season of the year when pasture is needed should be chosen for seeding (fig. 12). Inoculate the legumes. A companion crop ought to be used only to control erosion. One bushel of oats per acre is enough for seeding.

Figure 12.—**Productive permanent pasture, mainly of birdsfoot trefoil and timothy.**

Prepare a firm seedbed and cover the seed lightly. When the oats, or other companion crop, is about 8 inches high, pasture or clip it to reduce competition with the young forage plants.

After the pasture has been established, it can be maintained and improved by adding fertilizer, controlling grazing, and controlling the growth of weeds and brush. If the soils are acid, they ought to be limed to encourage legumes, such as white clover. The legumes will provide nitrogen for the grasses in the mixture. Apply a top-dressing of phosphorus and potassium, as needed, to increase the yield.

Nitrogen applied on grass early in spring helps to provide grazing earlier in the season. If there is enough moisture to support the increased growth, the extra nitrogen will increase the total yield and the protein content of the grass. Repeated applications of nitrogen will encourage the supremacy of grass over legumes.

Grazing should be controlled by dividing the pasture into three or more sections and rotating the grazing. This practice prolongs the life of the legumes and grasses by allowing the roots to store up reserves of plant nutrients. Delay grazing in spring until growth is well started and the ground is firm enough to prevent damage to the roots by trampling. Legume pastures need protection from grazing for 1 month in fall before frost, preferably during September. Do not allow overgrazing of the pasture during any part of the season.

Weeds and brush should be controlled by mowing them before they have a chance to set seed. Mow the weeds before the livestock are moved to another pasture, because cattle will eat wilted weeds or other vegetation from urine spots after the areas have been mowed. In some pastures it is more economical or more effective to destroy the weeds and brush by spraying.

Management of Apple Orchards

The soils in the eastern part of Wabasha County are especially well suited to apple orchards because of the moderating influence of Lake Pepin and the Mississippi River on the climate in that area. As a result, several orchards from 50 to 80 acres in size have been established in that part of the county.

The soils best suited to apple orchards are the Lindstrom and Fayette soils. The valleys are preferred over the ridges for the location of apple orchards. The valley slopes below the bluffs that face north or east and the nearly level or gently sloping bench phases of the Fayette soils are the most desirable locations. These sites are slower to warm up in spring, which holds back the bloom and thus avoids damage from late, killing frosts. In many places orchards on Fayette soils on the upland ridges are successful, but wind may interfere frequently with spraying or it may cause severe dropping of the fruit. The slopes that face south and west ought to be avoided because they warm up too rapidly in spring. Also, occasional warm spells in winter cause winter injury to the trees.

When locating a new orchard, select a site that has good air drainage, so that cold air moving down the slopes will move on out of the orchard site and not cause frost pockets. Orchards can be located on slopes ranging from nearly level to moderately steep. If the slope is more than 18 percent, operation of spraying machinery and other equipment is difficult and may be hazardous.

On the sites that are nearly level, orchards can be laid out in straight rows in a square spacing system. The spacing of trees of conventional height should be at least 30 feet between the rows and 30 feet in the row. For trees of the so-called dwarf type, the spacing can be 20 feet between the rows and 20 to 25 feet in the row, depending on the expected size of the tree.

If the slope is between 5 and 12 percent, the site can be terraced before planting. The rows of trees can then be placed on the terrace ridges and on other rows, according to the spacing interval between the terraces. Sod-mulch culture is better than clean cultivation. Under sod mulch, the orchard is seeded soon after planting, and the grass is mowed once or twice each season. The grass cuttings are left where they fall, which builds up a mulch of decaying grass. This method helps to control erosion and conserves moisture.

Where the site is sloping, planting the rows on the contour saves fuel and makes operation of the equipment easier. Careful consideration should be given to the layout of such a system to avoid numerous short rows and to allow a turning space for large spraying equipment. A person who plans to operate an orchard should seek help from persons trained in laying out orchards.

Apple trees do not feed heavily on most plant nutrients. Normally, only applications of nitrogen are needed, which must be applied according to the needs of the individual tree. Occasionally, some potash, phosphate, or possibly other elements may be beneficial. The needs should be determined by soil or leaf tests. Too much nitrogen prevents the fruit from coloring, and the rapid growth that results from too much nitrogen encourages fire blight, a bacterial disease of apples and pears.

If sod culture is practiced, tree losses will be severe unless mice, pocket gophers, and rabbits are controlled. Deer cause much damage to young orchards. Help in controlling the deer can be obtained from the local game warden.

Redcedar is a host for the fungus that causes cedar apple rust; therefore, redcedar trees within a radius of a quarter of a mile from an apple orchard should be removed.

Woodland, Windbreaks, and Shelterbelts [2]

This section gives general facts about the woodland in the county. It describes the principal forest cover type, the uses of the timber, the soil properties that affect the production of trees, and the pests and diseases that affect woodland. It also gives facts about windbreaks and shelterbelts and discusses the woodland suitability groups. The woodland groupings differ markedly from the capability groupings because trees have different requirements than crops.

Wabasha County is near the center of the new Minnesota Memorial Hardwood State Forest, which will extend from St. Paul and Minneapolis to Houston County in the southeastern corner of the State. This forest takes in all of the bluffs along the Mississippi River, and it extends back from the Mississippi River along the Zumbro and Whitewater Rivers and other major tributaries of the Mississippi. Because the county is within this forest, the woodland will have better management and better protection from fire.

When the area was first settled, around 1853, hardwoods, mainly aspen, birch, and northern red oak, covered a large part of the county. The early settlers cleared many of the wooded areas so that they could plant crops, and they harvested many of the trees for sawtimber.

In 1959, only 18.5 percent of the county, or about 61,600 acres, was in timber. Many of the soils that were formerly in timber are now used for crops and pasture, and it is not likely that they will be returned to forest. Most of the woodland area consists of soils that are too shallow, rocky, droughty, or steep to be favorable for crops. The stands are now generally understocked because the great demand for white oak, bur oak, basswood, and maple caused those species to be cut heavily. Livestock have been allowed to graze in most of the woodland, and many of the areas used for grazing have been burned over to improve them for pasture.

Some of the soils in capability classes VI and VII, now used for crops and pasture, are likely to be converted to woodland in the future. Also, some of the present woodlands, consisting of soils in capability classes I, II, and III, are likely to be cleared for crops and pasture. It is estimated that the future increase in woodland in Wabasha County will be about 15,000 acres.

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[2] ROBERT STORY, farm forester, Minnesota Department of Conservation, Division of Forestry, and THOR K. BERGH, woodland conservationist, Soil Conservation Service, helped prepare this section.

Few farmers now burn over their woodland, because they realize that burning is a practice that does little to improve the pasture or the woodland. Periodic burning and grazing destroy the surface mat of organic material. These practices keep desirable trees from reproducing, and they encourage brush and weeds. Grazing also compacts the soils. After the soils are compacted and the mat of organic material has been destroyed, runoff increases and erosion takes place. Serious flooding results in areas where the woodland formerly acted as a gigantic sponge that soaked up and held water.

Most of the red oak cut in the county is used primarily for railroad crossties and lumber for constructing and maintaining farm buildings. To some extent, black walnut and butternut are sold as veneer logs, and considerable white oak is used by the cooperage industry. In addition, nearly all the hardwoods can be used for pulpwood; material now wasted can be completely utilized as pulpwood when properly processed. A few trees are cut for fence posts, Christmas trees, and firewood.

Forest cover types.—Hardwoods make up a large part of the present forest cover in this county, but there are some brushy species. Most of the harvestable timber is red oak, but there are other valuable hardwoods of high quality that should be conserved and expanded, such as hard maple and basswood. The following six forest cover types are represented in this county (*8*) :

	Acres
Northern hardwoods	5,800
Oak	42,300
Bottom-land hardwoods	6,300
Aspen-birch	3,700
Grass-upland brush	1,800
Lowland brush	1,700
Total	61,600

The northern hardwoods cover type consists mainly of a mixture of red oak, white oak, basswood, hard maple, and American elm. There are a few black walnut, butternut, and black cherry trees.

Where the oak type is dominant, the stand is made up mainly of red oak. Secondary species are white oak and bur oak.

The bottom-land hardwoods cover type consists mainly of eastern cottonwood, soft maple, and American elm. White willow, basswood, and black ash are minor species.

The aspen-birch cover type is made up of trembling aspen and paper birch. It is often called the aspen type.

The grass-upland brush cover type is made up of partly cleared uplands. The areas were formerly occupied by oak or by northern hardwood types.

The lowland brush cover type is made up mainly of willows that grow on bottom lands along rivers. The areas were formerly cropland or pasture.

Soil properties that affect the production of trees.—The combinations of species or forest types that grow on a particular area are determined largely by the kinds of soils and by the position of the soils on the landscape. The soils of this county differ greatly from one another in their suitability for trees.

Among the most important factors that affect the productive capacity of soils for growing trees is ability to maintain optimum moisture and to permit the development of an adequate root system. Other significant characteristics are the thickness of the surface layer of the soil, the natural supply of plant nutrients, the texture and consistence of the soil material, the aeration, the drainage, and the depth to the water table.

In this county drainage is an important factor that affects the suitability of a site for trees. The soils have been classified, according to drainage, as excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. On excessively drained sites, pines are more suitable than hardwoods. On the somewhat poorly drained, poorly drained, and very poorly drained soils, most trees do not thrive.

In the steeper areas trees grow better on the slopes that face north and east than on the slopes that face south and west because the north- and east-facing slopes are cooler and more moist. The coves where the slopes face north or east are even more desirable for trees.

Woodland pests and diseases.—All wooded areas are subject to insects, animal pests, and diseases. The insects are defoliators, leaf miners, sucking insects, and twig and stem borers. Wild animal pests include mice, moles, gophers, rabbits, and deer. The most serious disease is oak wilt. White pine blister rust is not serious enough to require control measures.

Many insects, pests, and diseases are more prevalent in plantations, in pure stands, in even-aged stands, and in stands that are making poor growth than they are in other stands. The plantations that consist of a pure or even-aged stand require closer supervision than does a natural wooded area.

Little relationship can be established between the kind of soil and the prevalence of woodland pests and diseases. It is known, however, that damage caused by pocket gophers is more severe on sandy soils, such as the Plainfield and Sparta, and on silty soils, such as the Fayette, Downs, Mt. Carroll, and Port Byron, than on other soils. The relationship between the topography and the severity of white pine blister rust is less evident. Trees at the high elevations, such as the trees on upland ridges, appear to be less susceptible to that disease than the soils on valley slopes.

Windbreaks and shelterbelts

Most farmsteads need protection from wind, especially in winter. Windbreaks catch much of the snow before it reaches the farmstead, and it thus prevents damage. They also provide shelter for livestock. One of the direct benefits of a windbreak is a substantial saving in fuel costs. All of the soils in the county, except those in woodland group 17, are suitable for windbreaks.

Field windbreaks or shelterbelts are needed on some of the soils in the county to control soil blowing and the drifting of snow. They also conserve moisture and protect crops, livestock, and wildlife. Some of the soils in groups 8 and 13 need this kind of protection.

Windbreaks or shelterbelts should be designed to fit the site. Assistance in planning and in selecting the plants can be obtained from the local farm forester of the Minnesota Department of Conservation, Division of Forestry, or from the U.S. Soil Conservation Service. Information on preparation and maintenance of the site may also be obtained from those sources.

TABLE 3.—*Woodland*

[Comparison between species and relation of terms to site index are shown in

Group	Potential productivity			
	North and east slopes	South and west slopes	North and east coves	South and west coves
Group 1. Deep and moderately deep, well-drained, medium-textured soils; 2 to 12 percent slopes.	Excellent	Good	Excellent	Good to excellent.
Group 2. Moderately deep, well-drained, medium-textured soils; 6 to 18 percent slopes.	Good	Fair	Excellent	Good
Group 3. Deep, well-drained, medium-textured soils; 12 to 18 percent slopes.	Excellent	Fair to good	Excellent	Good
Group 4. Deep and moderately deep, well-drained, medium-textured soils; 18 to 35 percent slopes.	Excellent	Fair	Excellent	Fair
Group 5. Shallow, well-drained to excessively drained, medium-textured, eroded soils; moderately steep to very steep.	Fair to good	Poor	Good	Poor
Group 6. Shallow, somewhat droughty, moderately coarse textured and medium-textured soils over gravel, sand, or sandstone; 0 to 6 percent slopes.	Fair if converted to pine.	Fair if converted to pine.	Fair if converted to pine.	Fair if converted to pine.
Group 7. Shallow, well-drained, medium-textured soils over limestone bedrock; 2 to 6 percent slopes.	Fair to good	Fair	Good	Fair
Group 8. Deep, droughty, and sandy soils; 0 to 6 percent slopes.	Fair to poor	Fair to poor	Fair to poor	Fair to poor
Group 9. Shallow, droughty, and gravelly soils; 0 to 6 percent slopes.	Poor	Poor	Poor	Poor
Group 10. Shallow, somewhat droughty, moderately coarse textured and medium-textured soils over gravel, sand, or sandstone; 6 to 12 percent slopes.	Fair	Fair to poor	Fair	Fair
Group 11. Shallow, well-drained, medium-textured soils over limestone bedrock; 6 to 18 percent slopes.	Fair to good	Fair to poor	Good	Fair
Group 12. Shallow, droughty, moderately coarse textured and medium-textured soils over gravel, sand, or sandstone; moderately steep or steep.	Fair	Fair to poor	Fair	Fair
Group 13. Deep, droughty sands and shallow, droughty, gravelly soils; gently sloping to very steep.	Fair	Fair to poor	Fair	Fair to poor
Group 14. Deep, well-drained to somewhat poorly drained, medium-textured to coarse-textured soils on bottom lands and in upland waterways; nearly level to gently sloping.	Good to excellent.	Good to excellent.	Good to excellent.	Good to excellent.
Group 15. Deep, poorly drained or very poorly drained, medium-textured to moderately fine textured soils of bottom lands.	Good to poor	Good to poor	Good to poor	Good to poor
Group 16. Deep, well-drained, medium-textured soils; 0 to 12 percent slopes.	Excellent	Excellent	Excellent	Excellent
Group 17. Deep, somewhat poorly drained to very poorly drained, medium-textured soils; 0 to 6 percent slopes; these soils are not suited to trees.				

suitability grouping of soils

table 4. Dashed lines indicate soils are better used for field crops than trees]

Suitable species		Seedling mortality	Plant competition	Equipment limitation	Erosion hazard
Existing species to favor	Preferred species for new plantings				
White oak, red oak, rock elm, red elm, basswood, hard maple, black walnut, black cherry, butternut.	White pine, red elm, basswood, rock elm, black walnut.	Slight	Severe	Slight	Slight.
Red oak, white oak, bur oak, basswood.	White pine	Slight	Moderate to severe.	Slight	Moderate.
Red oak, white oak, basswood, butternut.	Black walnut, basswood, white pine.	Slight	Severe	Slight	Moderate.
Red oak, basswood, white oak, butternut.	White pine, basswood	Slight to moderate.	Severe	Moderate	Severe.
Red oak, white oak	White pine on north- and east-facing slopes; red pine on south- and west-facing slopes.	Slight to moderate.	Slight	Severe	Severe.
None	Red pine	Slight	Moderate	Slight	Slight.
Red oak	White pine	Slight to moderate.	Moderate	Slight	Slight.
None	Red pine	Slight to severe.	Slight	Moderate	Moderate.
None	Red pine, jack pine	Moderate to severe.	Slight	Slight	Slight.
None	Red pine	Slight to moderate.	Slight	Slight	Moderate.
Red oak, basswood	White pine	Slight to moderate.	Slight to moderate.	Slight to moderate.	Moderate to severe.
None	Red pine, jack pine	Slight to moderate.	Slight	Moderate to to severe.	Severe.
None	Red pine, jack pine	Slight to severe.	Slight	Moderate to severe.	Moderate to severe.
Soft maple, cottonwood, ash	Hybrid poplar, cottonwood	Slight	Severe	Slight to moderate.	Slight.
Soft maple, cottonwood, willow	Hybrid poplar, cottonwood	Slight to severe.	Severe	Moderate to severe.	Slight.
	Shelterbelt plantings only				

Woodland suitability groups

The management of woodland can be planned more easily if the soils are grouped according to those characteristics that affect the growth of trees and the management of the stand. For that reason, the soils of the county have been placed in woodland suitability groups. Each group is made up of soils that have about the same suitability for wood crops, require about the same management, and have about the same potential productivity.

The woodland suitability groups in the county are shown in table 3, which provides ratings of productivity for each group, lists kinds of trees to favor in existing stands or new plantings, and points out limitations of the soils that affect suitability for wood crops.

In table 4, the relative terms for productivity that are given in table 3 are converted to site indexes for oak and several other kinds of trees. Site index indicates productivity of trees more specifically than the verbal rating. This index is the average height attained by dominant and codominant trees in a relatively pure, even-aged stand at 50 years of age. The index reflects the combined effect of different factors of the environment on growth of trees. For example, soil areas in woodland group 1 that are on north and east slopes are rated in table 3 as having "excellent" productivity. By referring to table 4, one can see that oak, with a rating of excellent, has a site index of 70, or averages about 70 feet in height at 50 years of age.

The ratings in table 3 were based largely on the experience and judgment of local soil scientists, woodland conservationists, and foresters. They represent the best information now available about the way soils influence the growth and management of trees. The ratings are tentative and may be revised as more information becomes available.

The major limitations of the woodland suitability groups listed in table 3 are defined as follows.

Seedling mortality refers to the expected degree of mortality of seedlings as influenced by the kind of soil. Mortality is *slight* if ordinarily adequate natural regeneration will take place. It is *moderate* if natural regeneration cannot always be relied upon for adequate and immediate restocking. It is *severe* if much replanting, special preparation of the seedbed, and superior planting techniques are needed to assure adequate restocking.

The expected hazard from competition by other plants is also given a rating of slight, moderate, or severe. A rating of *slight* means that competition from other plants is no special problem; of *moderate*, that plant competition develops but generally does not prevent an adequate stand from becoming established; and of *severe*, that plant competition prevents trees from restocking naturally.

Ratings for equipment limitations.—The soil characteristics that restrict or prohibit the use of equipment commonly needed in tending and harvesting the trees are also given in table 3. By *slight* is meant there is no restriction in the kind of equipment or in the time of year it is used; by *moderate* is meant that there is a seasonal restriction of less than 3 months in the use of equipment and that the equipment can be expected to damage the roots of the trees to some extent; and by *severe* is meant that there is a seasonal restriction of more than 3 months in the use of equipment and that the equipment can be expected to cause severe damage to the roots of trees.

Erosion hazard refers to the potential hazard of erosion when the soil is managed according to currently acceptable standards. The ratings are based on the increasing risk of erosion.

WOODLAND SUITABILITY GROUP 1

The soils in this group are moderately deep or deep, well drained, and medium textured. They are on uplands, valley slopes, and stream terraces. The natural supply of plant nutrients is moderate to high, and the content of organic matter is moderate. Permeability is moderate, and the available moisture capacity is moderate to high. The soils in this group are—

Bixby loam, 2 to 6 percent slopes.
Bixby loam, 2 to 6 percent slopes, moderately eroded.
Dodgeville silt loam, 6 to 12 percent slopes, moderately eroded.
Downs and Mt. Carroll silt loams, 6 to 12 percent slopes.
Downs and Mt. Carroll silt loams, 6 to 12 percent slopes, moderately eroded.
Dubuque silt loam, 2 to 6 percent slopes.
Dubuque silt loam, 2 to 6 percent slopes, moderately eroded.
Dubuque silt loam, 6 to 12 percent slopes.

TABLE 4.—*Site index and species of trees*

Species	Site index [1]					
	30	40	50	60	70	80
Oak		Poor	Fair	Good	Excellent	
Aspen		Poor	Fair	Good	Excellent	
Black ash		Poor	Fair	Good	Excellent	
Green ash	Poor	Fair	Good	Excellent		
Cottonwood			Poor	Fair	Good	Excellent.
Basswood			Poor	Fair	Good	Excellent.
Birch		Poor	Fair	Good	Excellent	
Soft maple			Poor	Fair	Good	Excellent.
Hard maple	Poor	Fair	Good	Excellent		

[1] Height attained by dominant and codominant trees in 50 years.

Dubuque silt loam, 6 to 12 percent slopes, moderately eroded.
Fayette silt loam, uplands, 6 to 12 percent slopes.
Fayette silt loam, uplands, 6 to 12 percent slopes, moderately eroded.
Fayette silt loam, uplands, 6 to 12 percent slopes, severely eroded.
Fayette silt loam, benches, 6 to 12 percent slopes.
Fayette silt loam, benches, 6 to 12 percent slopes, moderately eroded.
Fayette silt loam, valleys, 6 to 12 percent slopes.
Fayette silt loam, valleys, 6 to 12 percent slopes, moderately eroded.
Fayette-Renova silt loams, 6 to 12 percent slopes, moderately eroded.
Gale silt loam, 2 to 6 percent slopes, moderately eroded.
Lindstrom silt loam, 6 to 12 percent slopes.
Lindstrom silt loam, 6 to 12 percent slopes, moderately eroded.
Racine silt loam, 6 to 12 percent slopes, moderately eroded.
Renova silt loam, 6 to 12 percent slopes.
Renova silt loam, 6 to 12 percent slopes, moderately eroded.
Renova-Wykoff loams, 2 to 6 percent slopes, moderately eroded.
Whalan silt loam, 2 to 6 percent slopes, moderately eroded.
Whalan silt loam, 6 to 12 percent slopes, moderately eroded.

The principal forest cover types on these soils are oak, aspen-birch, and northern hardwoods. Oak is the dominant cover type.

Generally, because of their greater value for crops, these soils are not considered desirable for new plantings of trees. Open areas in existing woodland, however, may be planted to white pine, black walnut, or basswood. White pine should be favored on south- and west-facing slopes.

Generally, seedling mortality is slight. Less than 25 percent of the planted stock is lost.

Plant competition, especially from grass and weeds, is severe in the plantations. Furrowing, spraying, or preparation of the seedbed is necessary to prevent smothering of the seedlings. In areas where trees regenerate naturally, disking or some other preparation of the seedbed is necessary to assure a stand of desirable trees.

Equipment limitation is slight. Work can be done at any time during the year, except just after a heavy rain and for a short period in spring, during and following snowmelt.

WOODLAND SUITABILITY GROUP 2

In this group are well-drained, medium-textured soils that are moderately deep over sand, gravel, sandstone, or limestone. The soils are on uplands, valley slopes, and stream terraces. The natural supply of plant nutrients, the content of organic matter, and the permeability and available moisture capacity are all moderate. By following crevices in the rocks, tree roots penetrate deeper into the soils that are underlain by limestone than they do in the other soils. The soils in this group are—

Dodgeville silt loam, 12 to 18 percent slopes, moderately eroded.
Dubuque silt loam, 12 to 18 percent slopes.
Dubuque silt loam, 12 to 18 percent slopes, moderately eroded.
Dubuque soils, 12 to 18 percent slopes, severely eroded.
Gale silt loam, 6 to 12 percent slopes, moderately eroded.
Gale silt loam, 12 to 18 percent slopes, moderately eroded.
Renova-Wykoff loams, 6 to 12 percent slopes, moderately eroded.
Renova-Wykoff loams, 12 to 18 percent slopes, moderately eroded.
Whalan silt loam, 12 to 18 percent slopes, moderately eroded.

The principal forest cover types on these soils are oak and aspen-birch. Oak is the dominant cover type.

White pine is suitable for planting. Basswood or red pine may be planted also. Black walnut may be planted on the north- and east-facing slopes, which are more moist than the slopes that face south or west.

Generally, seedling mortality is slight. Less than 25 percent of the planted stock is lost.

Plant competition does not prevent desirable species from becoming established on these soils, but it delays the natural regeneration of trees and slows the initial growth. Competition from grass and weeds is severe in the plantations. Slight preparation of the seedbed helps to assure an adequate stand through natural regeneration. Furrowing, spraying, or preparation of the seedbed is necessary to prevent smothering of the seedlings.

Equipment limitation is slight. Work can be done at any time during the year, except just after a heavy rain and for a short period in spring, during and following snowmelt.

WOODLAND SUITABILITY GROUP 3

The soils in this group are deep, well drained, and medium textured, and they are on uplands and valley slopes. The natural supply of plant nutrients is moderately high or high, and the content of organic matter is moderate. Permeability is moderate, and the available moisture capacity is moderately high to high. The soils in this group are—

Downs and Mt. Carroll silt loams, 12 to 18 percent slopes.
Downs and Mt. Carroll silt loams, 12 to 18 percent slopes, moderately eroded.
Fayette silt loam, uplands, 12 to 18 percent slopes.
Fayette silt loam, uplands, 12 to 18 percent slopes, moderately eroded.
Fayette silt loam, uplands, 12 to 18 percent slopes, severely eroded.
Fayette silt loam, valleys, 12 to 18 percent slopes.
Fayette silt loam, valleys, 12 to 18 percent slopes, moderately eroded.
Fayette-Renova silt loams, 12 to 18 percent slopes, moderately eroded.
Lindstrom silt loam, 12 to 18 percent slopes.
Lindstrom silt loam, 12 to 18 percent slopes, moderately eroded.
Racine silt loam, 12 to 18 percent slopes, moderately eroded.
Renova silt loam, 12 to 18 percent slopes.
Renova silt loam, 12 to 18 percent slopes, moderately eroded.
Seaton-Bold soils, 12 to 18 percent slopes, moderately eroded.

The principal forest cover types on the soils of this group are oak, aspen-birch, and northern hardwoods. Oak is by far the dominant cover type.

White pine, black walnut, and basswood are suitable for planting on these soils. White pine should be favored for south- and west-facing slopes.

Generally, seedling mortality is slight. Less than 25 percent of the planted stock is lost.

Plant competition, especially from grass and weeds, is severe in the plantations. Furrowing, spraying, or preparation of the seedbed is necessary to prevent smothering of the seedlings. In areas where trees regenerate naturally, disking or some other preparation of the seedbed is necessary to assure a stand of desirable trees.

Equipment limitation is slight. Work can be done at any time during the year, except just after a heavy rain

and for a short period in spring, during and following snowmelt.

Erosion is a greater hazard on these soils than on the soils in group 1 because the soils are steeper.

WOODLAND SUITABILITY GROUP 4

The soils in this group are moderately deep and deep and are well drained and medium textured. They are on uplands and valley slopes. The soils are moderately steep or steep. Their natural supply of plant nutrients is moderate to high, and the content of organic matter is moderate. Permeability is also moderate, and the available moisture capacity is moderate to moderately high. The soils in this group are—

Dubuque silt loam, 18 to 25 percent slopes.
Dubuque silt loam, 25 to 35 percent slopes.
Fayette silt loam, uplands, 18 to 25 percent slopes, moderately eroded.
Fayette silt loam, uplands, 18 to 25 percent slopes, severely eroded.
Fayette silt loam, uplands, 25 to 35 percent slopes, moderately eroded.
Fayette silt loam, valleys, 18 to 25 percent slopes, moderately eroded.
Fayette silt loam, valleys, 25 to 35 percent slopes.
Lindstrom silt loam, 18 to 25 percent slopes, moderately eroded.
Renova silt loam, 18 to 25 percent slopes, moderately eroded.
Renova silt loam, 25 to 35 percent slopes, moderately eroded.

Oak is the dominant forest cover type. Trees of the aspen-birch forest type, however, grow in some areas.

White pine and basswood are suitable for planting on these soils. White pine should be favored for south- and west-facing slopes. Black walnut will grow well on the north- and east-facing lower slopes, which are more moist than the slopes that face south or west.

Generally, seedling mortality is slight, and less than 25 percent of the planted stock is lost. Trees must be planted by hand on these soils, however, and losses may be more than 25 percent unless the soils are furrowed or scalped.

Plant competition, especially from grass and weeds, is severe in the plantations. Furrowing, scalping, or spraying is necessary to prevent smothering of the seedlings. In areas where trees regenerate naturally, some preparation of the seedbed is desirable, but the strong slope makes it difficult to operate equipment to prepare the seedbed.

Equipment limitation is moderate, but tree-planting machines that are currently used in Wabasha County cannot be operated successfully on these steep soils. Logging operations are hazardous. There is constant danger from rolling logs or runaway tractors when trees are felled or logs are bucked or skidded. Fender logs should be installed to prevent the logs from rolling off the skidroad and damaging standing timber. Work can be done at any time during the year, except just after a heavy rain and for a short period in spring, during and after snowmelt. Logging in summer, however, will damage tree roots extensively. Logging in winter will cause less damage, but it is more hazardous to the logger and to the operator of the equipment.

The hazard of further erosion is severe. Sheet and gully erosion may be serious after an area has been logged unless care is taken when the timber is harvested. Skidroads ought to be slanted so that the grade will be as slight as possible. Water turnouts should be constructed at intervals close enough so that excessive build-up of runoff water will be avoided. After logging has been completed, the skidroads should be protected by water bars or cross logs and by mulching with logging debris. Bare areas ought to be seeded to provide an early cover of vegetation.

WOODLAND SUITABILITY GROUP 5

In this group are well-drained to excessively drained, medium-textured soils that are shallow over clay or limestone bedrock. These soils are on uplands and stream terraces. Their natural supply of plant nutrients and their content of organic matter are low. Permeability is moderate, and the available moisture capacity is low. In the Sogn soils, Steep, stony, and rocky land, and Terrace escarpments, loamy, however, the available moisture capacity is very low. The soils in this group are—

Dodgeville silt loam, shallow, 18 to 35 percent slopes, moderately eroded.
Dubuque silt loam, shallow, 18 to 25 percent slopes.
Dubuque silt loam, shallow, 25 to 35 percent slopes.
Dubuque soils, shallow, 12 to 18 percent slopes, severely eroded.
Dubuque soils, shallow, 18 to 25 percent slopes, severely eroded.
Sogn soils.
Steep, stony, and rocky land.
Terrace escarpments, loamy.
Whalan silt loam, shallow, 18 to 25 percent slopes, moderately eroded.
Whalan silt loam, shallow, 25 to 35 percent slopes, moderately eroded.

The soils in this group support the largest acreage of timber in the county. Oak is the dominant cover type, but there are some trees of the aspen-birch type.

White pine is suitable for planting on the north- and east-facing slopes. Red pine ought to be planted on the south- and west-facing slopes.

Generally, seedling mortality is slight to moderate; less than 25 percent of the planted stock is lost. Trees must be planted by hand on these soils, however, and considerable loss can be expected unless the soils are furrowed, scalped, or sprayed before the planting is done.

Plant competition is slight; less than 25 percent of the planted stock is lost. Furrowing, scalping, or spraying is necessary, however, to obtain a satisfactory stand.

Equipment limitation is severe. Tree-planting machines, normally used in this county, cannot be operated successfully, because the soils are too steep, and rock outcrops are likely to damage the equipment. Only hand tools and backpack sprayers can be used for fighting fires. Logging operations are hazardous. There is constant danger from rolling logs or from runaway tractors when trees are felled or logs are bucked or skidded. Fender logs should be installed to prevent the logs from rolling off the skidroad and damaging standing timber. Work can be done at any time during the year, except just after a heavy rain and for a short period in spring, during and after snowmelt. Logging in summer, however, will damage tree roots extensively. Logging in winter causes less damage, but it is more hazardous to the logger and to the operator of the equipment.

The hazard of further erosion is severe. Sheet and gully erosion may be serious after an area is logged

unless care is taken when the timber is harvested. Skidroads ought to be slanted so that there will be only a slight grade. Water turnouts ought to be constructed at intervals close enough to avoid excessive buildup of runoff water. After logging has been completed, the skidroads should be protected by water bars or cross logs and by mulching with logging debris. Bare areas should be seeded to provide an early cover of vegetation.

WOODLAND SUITABILITY GROUP 6

The soils in this group are somewhat droughty, moderately coarse textured or medium textured, and shallow over gravel, sand, or sandstone. These soils are on uplands and stream terraces. Their natural supply of plant nutrients and the content of organic matter are low. Permeability is moderately rapid. The available moisture capacity is low. The soils in this group are—

Burkhardt sandy loam, 0 to 2 percent slopes.
Burkhardt sandy loam, 2 to 6 percent slopes.
Burkhardt sandy loam, 2 to 6 percent slopes, moderately eroded.
Burkhardt loam, 0 to 2 percent slopes.
Burkhardt loam, 2 to 6 percent slopes.
Hixton fine sandy loam, 2 to 6 percent slopes.
Meridian sandy loam, 0 to 2 percent slopes.
Meridian sandy loam, 2 to 6 percent slopes.
Meridian sandy loam, 2 to 6 percent slopes, moderately eroded.
Wykoff gravelly loam, 2 to 6 percent slopes.

The cover type on the soils of this group is normally "off-site" oak, that is, oak growing in areas better suited to other kinds of trees or to other kinds of vegetation. The soils are too droughty and low in fertility to be suited to hardwoods. Red pine is suitable, however, and the wooded areas should be converted to red pine.

Seedling mortality is slight. Less than 25 percent of the planted stock is lost.

Plant competition is moderate. The "off-site" oaks should be removed by girdling, clearing, or spraying, and pines ought to be planted in the areas that are cleared.

Equipment limitation is slight. Work can be done at any time during the year, except just after a heavy rain and for a short period during and after snowmelt in spring.

WOODLAND SUITABILITY GROUP 7

The soils in this group are well drained and medium textured, and they are shallow over limestone. The soils are gently sloping and are in the uplands. Their natural supply of plant nutrients and content of organic matter are low. Permeability is moderate. The available moisture capacity is low, but tree roots are able to find additional moisture because the underlying limestone is fragmentary. The soils in this group are—

Dubuque silt loam, shallow, 2 to 6 percent slopes.
Dubuque silt loam, shallow, 2 to 6 percent slopes, moderately eroded.
Whalan silt loam, shallow, 2 to 6 percent slopes, moderately eroded.

The cover type on the soils of this group is normally oak, but there are some trees of the aspen-birch type. White pine and red pine may be planted also.

Seedling mortality is slight to moderate. Frequently, more than 25 percent of the planted stock is lost. It may be necessary to plant trees by hand in areas where bedrock outcrops or where the soil is shallow over bedrock.

Plant competition is moderate, but it does not prevent desirable species from becoming established. It delays natural regeneration of the trees, however, and slows their initial growth. In plantations, competition from grass and weeds is moderate to severe. Some preparation of the seedbed will probably help to assure an adequate stand in areas where trees regenerate naturally. In plantations, furrowing, scalping, or spraying should precede planting when the trees are set out by hand. Spraying to kill grass and weeds will help to increase the rate of survival when the trees are planted by machine.

Equipment limitation is slight; shallow spots and outcrops of bedrock limit the use of a mechanical planter, however, in some places. Work can be done at any time during the year, except just after a heavy rain and for a short period in spring, during and after snowmelt.

WOODLAND SUITABILITY GROUP 8

In this group are deep, droughty, gently sloping, sandy soils of uplands and terraces. The natural supply of plant nutrients and content of organic matter are low or very low. Permeability is rapid. The available moisture capacity is low to very low. The soils in this group are—

Boone and Chelsea loamy fine sands, 2 to 6 percent slopes.
Plainfield fine sand, 0 to 2 percent slopes.
Plainfield fine sand, 2 to 6 percent slopes.
Sparta loamy fine sand, 0 to 2 percent slopes.
Sparta loamy fine sand, 2 to 6 percent slopes.

The cover type on the soils of this group is "off-site" oak. Because the supply of plant nutrients is low and the soils are droughty, hardwoods are not suited, and the wooded areas should be converted to pines. Red pine is suitable for planting.

Seedling mortality is slight to severe, depending on the amount of moisture. A prolonged dry spell after the trees are planted may cause a loss of 90 to 100 percent of the planted stock. A few good rains after the trees are planted, however, may result in nearly 100 percent survival of the pines.

Plant competition is slight on these soils, both in areas where trees regenerate naturally and in plantations of pine. The cover of grass and weeds is sparse, and those plants offer little competition to the planted stock. Girdling, clearing, or spraying the trees and brush is necessary to convert the areas of "off-site" oak to pines.

The sandy texture of these soils limits the use of some kinds of equipment, even though the equipment is light.

These soils are likely to be eroded by wind if the protective cover of plants is removed. Wherever feasible, building of roads, clearing for firebreaks, and other operations that disturb the protective cover should follow the contour of the land. Shelterbelts or field windbreaks are needed to prevent wind erosion on the Sparta and Plainfield soils. Two types of shelterbelts are suitable. The first type consists of one row of trees, either jack pine or red pine, or the trees can be red pine alternating with redcedar. The second type of shelterbelt is two or three rows of jack pine, red pine, and redcedar, used either alone or in combination.

WOODLAND SUITABILITY GROUP 9

The soils of this group are droughty and gravelly, and they are shallow over gravel. The soils are gently sloping and are on stream terraces. Their natural supply of plant nutrients and the content of organic matter are low. Permeability is rapid, and the available moisture capacity is very low. The soils in this group are—

Burkhardt gravelly sandy loam, 0 to 2 percent slopes.
Burkhardt gravelly sandy loam, 2 to 6 percent slopes, moderately eroded.

The cover type on the soils of this group is "off-site" oak. The soils are too droughty and too low in plant nutrients to be suited to hardwoods. The wooded areas should be converted to pines. Jack pine and red pine are suitable for planting.

In places seedling mortality is severe, but it is moderate in some places if the supply of moisture is favorable. A dry spell after the trees are planted may cause a loss of from 90 to 100 percent of the planted stock, but if rainfall is adequate, more than 75 percent of the planted stock may survive.

Plant competition is slight on these soils, both in areas where trees regenerate naturally and in plantations of pine. Girdling, clearing, or spraying of the existing trees and brush is necessary to convert the stands of "off-site" oak to pine.

These soils have no limitations that hinder the use of equipment.

WOODLAND SUITABILITY GROUP 10

The soils of this group are somewhat droughty, moderately coarse textured or medium textured, and shallow over gravel, sand, or sandstone. They are moderately sloping and are on uplands and stream terraces. The natural supply of plant nutrients and the content of organic matter are low. Permeability is moderately rapid, and the available moisture capacity is low. The soils in this group are—

Burkhardt sandy loam, 6 to 12 percent slopes, moderately eroded.
Gale-Hixton complex, shallow, 6 to 12 percent slopes, moderately eroded.
Hixton fine sandy loam, 6 to 12 percent slopes.
Meridian sandy loam, 6 to 12 percent slopes.
Meridian sandy loam, 6 to 12 percent slopes, moderately eroded.
Wykoff gravelly loam, 6 to 12 percent slopes, moderately eroded.

The cover type on the soils of this group is normally "off-site" oak. Because the soils are droughty and the supply of plant nutrients is low, however, the soils are not suited to hardwoods. The wooded areas should be converted to pines; red pine is suitable for planting.

Seedling mortality is slight to moderate. Normally, less than 25 percent of the planted stock is lost. A prolonged dry spell after trees are planted may cause a loss greater than 25 percent, however, and replanting may be necessary. The rate of survival is higher when pines are used as planting stock rather than hardwoods.

Plant competition on these soils is slight. Girdling, clearing, or spraying of the trees and brush is necessary to convert the stands of "off-site" oak to pine.

Equipment limitation is slight. Work can be done at any time during the year, except just after a heavy rain and for a short period in spring, during and after snowmelt.

WOODLAND SUITAB ILITY GROUP 11

The soils in this group are well drained and medium textured, and they are shallow over limestone. They are moderately or strongly sloping and are in the uplands. Their natural supply of plant nutrients and the content of organic matter are low. Permeability is moderate. The available moisture capacity is low, but the roots of trees are able to find additional moisture because the underlying limestone is fragmentary. The soils in this group are—

Dodgeville silt loam, shallow, 6 to 12 percent slopes, moderately eroded.
Dodgeville silt loam, shallow, 12 to 18 percent slopes.
Dodgeville silt loam, shallow, 12 to 18 percent slopes, moderately eroded.
Dubuque silt loam, shallow, 6 to 12 percent slopes, moderately eroded.
Dubuque silt loam, shallow, 12 to 18 percent slopes.
Dubuque silt loam, shallow, 12 to 18 percent slopes, moderately eroded.
Whalan silt loam, shallow, 6 to 12 percent slopes.
Whalan silt loam, shallow, 6 to 12 percent slopes, moderately eroded.
Whalan silt loam, shallow, 12 to 18 percent slopes.
Whalan silt loam, shallow, 12 to 18 percent slopes, moderately eroded.

Normally, the cover type on the soils of this group is oak, but white pine is suitable for planting. Red pine may be planted in those places also.

Seedling mortality is slight to moderate on these soils; the loss of planting stock frequently exceeds 25 percent. It may be necessary to plant trees by hand in areas where bedrock outcrops or the soil is shallow over bedrock. Machine planting will probably be unsatisfactory in areas where the slope is greater than 12 percent.

Plant competition is slight to moderate, but it does not prevent desirable species from becoming established. It does delay the natural regeneration of trees and slows their initial growth. Competition from grass and weeds is moderate in the plantations. Some preparation of the seedbed will probably help to assure an adequate stand in areas where trees regenerate naturally. Furrowing, scalping, or spraying should precede hand planting in the plantations. Spraying to kill grass and weeds helps to increase the rate of survival where seedlings are planted by machine.

Equipment limitation is slight to moderate on these soils. Areas that are shallow over bedrock, or where bedrock outcrops, are not suitable for machine planting. Also, areas that have slopes of more than 12 percent are unsuitable. Work can be done at any time during the year, except just after a heavy rain and for a short period in spring, during and after snowmelt. If logging is done in summer, however, equipment may cause damage to tree roots. Also, outcrops of bedrock may damage equipment, and logging should be planned so that those areas are avoided.

The hazard of further erosion is moderate to severe. Sheet and gully erosion may be serious after an area has been logged, unless care is taken when the timber is harvested. Skidroads ought to be slanted so that there will be only a slight grade. Water turnouts ought to be constructed at intervals close enough so that excessive buildup of runoff water will be avoided. After logging has been completed, the skidroads ought to be protected

by water bars or cross logs and by mulching with logging debris. Bare areas should be seeded to provide an early cover of vegetation.

WOODLAND SUITABILITY GROUP 12

The soils of this group are droughty, moderately coarse textured or medium textured, and shallow over gravel, sand, or sandstone. They are strongly sloping to steep and are on stream terraces and in the uplands. Their natural supply of plant nutrients and the content of organic matter are low. Permeability is moderately rapid, and the available moisture capacity is low. The soils in this group are—

Gale-Hixton complex, shallow, 12 to 18 percent slopes, moderately eroded.
Gale-Hixton complex, shallow, 18 to 25 percent slopes, moderately eroded.
Hixton fine sandy loam, 12 to 18 percent slopes.
Hixton fine sandy loam, 18 to 35 percent slopes.
Wykoff gravelly loam, 12 to 18 percent slopes, moderately eroded.
Wykoff gravelly loam, 18 to 35 percent slopes, moderately eroded.

The cover type on these soils is normally "off-site" oak. Because the soils are droughty and the supply of plant nutrients is low, however, the soils are not suited to hardwoods, and the wooded areas should be converted to pines. Red pine is suitable, but jack pine may be planted on the slopes that face south and west.

Seedling mortality is slight to moderate. Normally, less than 25 percent of the planted stock is lost. A dry spell after the trees are planted, however, may cause a loss of more than 25 percent and may necessitate replanting. The rate of survival is higher when pines are used as planting stock, rather than hardwoods.

Plant competition is slight on these soils. Girdling, clearing, or spraying of the trees and brush is necessary to convert the stands of "off-site" oak to pine.

Equipment limitation is moderate to severe, and the machines that are normally used for planting trees cannot be operated successfully on these steep soils. Furrowing, scalping, or other preparation of the site is necessary when seedlings are planted by hand. Logging on the steeper slopes is hazardous. There is constant danger from rolling logs or runaway tractors when trees are felled or logs are bucked or skidded. Fender logs should be installed to prevent the logs from rolling off the skidroad and damaging standing timber. Work can be done at any time during the year, except just after a heavy rain and for a short period in spring, during and after snowmelt. Logging in summer, however, will damage the roots of trees extensively. Logging in winter causes less damage, but it is more hazardous to the logger and to the operator of the equipment.

The hazard of further erosion is severe. Sheet and gully erosion may be serious after an area has been logged, unless care is taken when the timber is harvested. Skidroads ought to be slanted so that there will be only a slight grade. Water turnouts should be constructed at intervals close enough so that excessive buildup of runoff water will be avoided. After logging has been completed, the skidroads should be protected by water bars or cross logs and by mulching with logging debris. Bare areas ought to be seeded to provide an early cover of vegetation.

WOODLAND SUITABILITY GROUP 13

In this group are deep, droughty sands and droughty, gravelly soils that are shallow over coarse-textured material. The soils are on stream terraces and uplands and are gently sloping to very steep. Their natural supply of plant nutrients and the content of organic matter are very low. Permeability is rapid to very rapid, and the available moisture capacity is very low. The hazard of drought is severe. The soils in this group are—

Boone and Chelsea loamy fine sands, 6 to 12 percent slopes.
Boone and Chelsea loamy fine sands, 12 to 18 percent slopes.
Boone loamy fine sand, 18 to 35 percent slopes.
Dune land.
Plainfield fine sand, 6 to 12 percent slopes.
Terrace escarpments, sandy.

The cover type on the soils of this group is "off-site" oak. Because the soils are droughty and the supply of plant nutrients is very low, hardwoods are not suited, and the wooded areas should be converted to pines. Red pine is suitable for the better sites, and jack pine can be planted on the poorer sites.

Seedling mortality is slight to severe, depending on the supply of moisture. Natural regeneration of pines is slow. A dry spell after the trees are planted may cause a loss of 90 to 100 percent of the planted stock. A few good rains after the trees are planted may result in nearly 100 percent survival of the planted pines.

Plant competition is slight, both in areas where trees regenerate naturally and in plantations of pines. The cover of grass and weeds is sparse and offers little competition to the planted stock. Girdling, clearing, or spraying of the trees and brush will be needed to convert the stands of "off-site" oak to pine.

In most areas where the slope is more than 12 percent, mechanical tree planters are not satisfactory. Logging on the steep slopes is hazardous to loggers and operators of equipment. Even though the equipment is light, the sandy texture of these soils limits the use of some kinds of equipment. In summer, loose, sandy soils are just as dangerous for the logger as other soils are in winter when they are covered by snow and ice. There is constant danger from rolling logs or runaway tractors when trees are felled and the logs are bucked or skidded. Fender logs should be installed to prevent logs from rolling off the skidroad and damaging standing timber. Work can be done at any time during the year, but logging in summer damages tree roots extensively.

The hazard of erosion is moderate to severe. In areas that have been opened by logging, wind erosion may be severe. Sheet and gully erosion may be very severe if care is not taken during and after harvesting of the timber. Wind erosion may make planting difficult on Dune land and on the Boone, Chelsea, and Plainfield soils. These soils should be mulched with straw or hay and lightly disked before trees are planted, so that they will be protected from erosion by wind. Gullies form rapidly on the steep slopes of Terrace escarpments, sandy, if the cover of plants is removed.

These gullies damage the soils above and below the escarpments. Skidroads should be slanted uphill so that

there will be only a slight grade. Water turnouts should be constructed at intervals close enough so that excessive buildup of runoff water will be avoided. After logging has been completed, the skidroads ought to be protected by water bars or cross logs and by mulching with logging debris. Bare areas ought to be seeded to provide an early cover of vegetation.

Shelterbelts or field windbreaks are needed on Dune land and on the Plainfield soils to prevent wind erosion. Two types of shelterbelts are suitable. The first type consists of one row of trees, which can be either jack pine or red pine, or the trees can be red pine alternating with redcedar. The second type of shelterbelt consists of two or three rows of jack pine, red pine, and redcedar, used either alone or in combination.

WOODLAND SUITABILITY GROUP 14

In this group are deep, well-drained to somewhat poorly drained, medium-textured to coarse-textured soils. The soils are nearly level to gently sloping and are on bottom lands and in upland waterways. Their natural supply of plant nutrients and the content of organic matter are moderately high. The soils are moderately permeable, and the available moisture capacity is moderate to moderately high. These soils are subject to occasional to frequent flooding, but the floodwaters usually recede before trees are damaged. The soils in this group are—

Alluvial land.
Arenzville silt loam.
Chaseburg fine sandy loam, 2 to 6 percent slopes.
Chaseburg silt loam, 0 to 2 percent slopes.
Chaseburg silt loam, 2 to 6 percent slopes.
Colo silty clay loam.
Genesee sandy loam.
Genesee silt loam.
Huntsville silt loam.
Judson silt loam, 0 to 2 percent slopes.
Judson silt loam, 2 to 6 percent slopes.
Minneiska silt loam.
Stony colluvial land.
Zumbro loamy fine sand.

The cover type on these soils is bottom-land hardwoods. Native cottonwood or hybrid poplar is suggested for planting, but black walnut grows well on the better drained sites and in areas that are flooded less frequently.

Seedling mortality is slight on these soils. Normally, less than 25 percent of the planted stock is lost. Natural regeneration restocks the areas rapidly.

Plant competition, especially from grass and weeds, is severe. Seeds are brought in each time the area is flooded. It is difficult to prepare a seedbed that is free of weeds.

Equipment limitation is slight to moderate. Floods, especially in spring, hamper logging operations. Winter is the best time to work in the bottom lands.

WOODLAND SUITABILITY GROUP 15

The soils in this group are deep, poorly drained to very poorly drained, and medium textured or moderately fine textured. They are nearly level and are on bottom lands. Their natural supply of plant nutrients and the content of organic matter are moderately high. Permeability is slow to moderately slow, and the available moisture capacity is moderately high. Flooding is a hazard during any season of the year. Usually the floodwaters remain only a short time, but water stands in the lower spots for long periods. The soils in this group are—

Alluvial land, wet.
Osseo silt loam.

The cover types on these soils are bottom-land hardwoods and lowland brush. Native cottonwood or hybrid poplar is suggested for planting on the better sites.

Seedling mortality ranges from slight to severe. Natural regeneration is rapid on the higher sites that are better drained. Regeneration is negligible on the lower sites that are very poorly drained. Planting should be done only on the higher sites, because of the better drainage.

Plant competition, especially from grass and weeds, is severe. Weed seeds are deposited each time the areas are flooded, and it is difficult to prepare a seedbed that is free of weeds.

Equipment limitation is moderate to severe because of flooding and because the floodwaters remain in depressions for a long time. Winter is the best time to work in the bottom lands.

WOODLAND SUITABILITY GROUP 16

In this group are deep, well-drained, medium-textured soils of uplands and stream terraces. The soils in this group are—

Bixby loam, 0 to 2 percent slopes.
Downs and Mt. Carroll silt loams, 0 to 2 percent slopes.
Downs and Mt. Carroll silt loams, 2 to 6 percent slopes.
Downs and Mt. Carroll silt loams, 2 to 6 percent slopes, moderately eroded.
Downs and Mt. Carroll silt loams, benches, 0 to 2 percent slopes.
Downs and Mt. Carroll silt loams, benches, 2 to 6 percent slopes.
Fayette silt loam, uplands, 0 to 2 percent slopes.
Fayette silt loam, uplands, 2 to 6 percent slopes.
Fayette silt loam, uplands, 2 to 6 percent slopes, moderately eroded.
Fayette silt loam, benches, 0 to 2 percent slopes.
Fayette silt loam, benches, 2 to 6 percent slopes.
Fayette silt loam, benches, 2 to 6 percent slopes, moderately eroded.
Fayette silt loam, valleys, 2 to 6 percent slopes.
Fayette silt loam, valleys, 2 to 6 percent slopes, moderately eroded.
Fayette-Renova silt loams, 2 to 6 percent slopes, moderately eroded.
Lindstrom silt loam, 2 to 6 percent slopes.
Medary silt loam, brown variant, 0 to 2 percent slopes.
Medary silt loam, brown variant, 2 to 6 percent slopes.
Port Byron silt loam, 0 to 2 percent slopes.
Port Byron silt loam, 2 to 6 percent slopes.
Port Byron silt loam, 2 to 6 percent slopes, moderately eroded.
Port Byron silt loam, 6 to 12 percent slopes.
Port Byron silt loam, 6 to 12 percent slopes, moderately eroded.
Port Byron silt loam, benches, 0 to 2 percent slopes.
Port Byron silt loam, benches, 2 to 6 percent slopes.
Racine silt loam, 0 to 2 percent slopes.
Racine silt loam, 2 to 6 percent slopes.
Racine silt loam, 2 to 6 percent slopes, moderately eroded.
Renova silt loam, 2 to 6 percent slopes.
Renova silt loam, 2 to 6 percent slopes, moderately eroded.
Tell silt loam, 0 to 2 percent slopes.
Tell silt loam, 2 to 6 percent slopes.
Tell silt loam, 2 to 6 percent slopes, moderately eroded.
Waukegan silt loam, 0 to 2 percent slopes.
Waukegan silt loam, 2 to 6 percent slopes.

Waukegan silt loam, 2 to 6 percent slopes, moderately eroded.
Waukegan silt loam, 6 to 12 percent slopes, moderately eroded.

These soils are especially well suited to crops. Many of them were originally covered by prairie grasses, and trees did not grow on them. Practically all areas of these soils are now used for crops, but some isolated areas are in trees. It would probably be best to convert those areas to field crops because, although the timber produced is of excellent quality, the return is much higher if the soils are used for field crops.

WOODLAND SUITABILITY GROUP 17

The soils in this group are not suited to trees, because most trees do not thrive on soils that have poor drainage or that are highly susceptible to overflow. The soils are—

Garwin silt loam.
Muscatine silt loam, 0 to 2 percent slopes.
Muscatine silt loam, 2 to 6 percent slopes.
Riverwash.
Zwingle silt loam, 0 to 2 percent slopes.
Zwingle silt loam, 2 to 6 percent slopes.
Zwingle silt loam, 2 to 6 percent slopes, moderately eroded.

Management of Wildlife

Plants and animals live in definite communities or mixtures. Among the factors that determine the kinds of plants and animals that live in a given community are the soils, climate, and physiography.

The importance of soils in determining the kinds and numbers of wildlife species in a specific area is illustrated by the fact that 70 percent of the best habitats for pheasants in Minnesota are in the south-central part of the State where the Clarion, Nicollet, and Webster soils are dominant. The soils alone, of course, do not make a suitable habitat, but they do influence the kind of vegetation and the type of farming, which, in turn, affect the kind of wildlife.

Figure 13.—**Densities of pheasants in Wabasha County.**

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Figure 14.—**Densities of quail, waterfowl, and furbearers in Wabasha County.**

In this county the population of game species and the natural habitat suitable for each species correspond roughly to the soil associations shown on the general soil map in the back of this report. The maps shown in figures 13, 14, and 15 also correspond to the map of soil associations, with some modifications, mainly in the map showing pheasant densities. Deer, squirrel, and quail are in soil associations other than the ones indicated, but in much fewer numbers.

Compared to the population of ring-necked pheasants in the western part of the State, the population of ring-necked pheasants in Wabasha County is small. Even in good years, there are seldom more than seven cocks per square mile. The pheasants are mostly in Elgin, Plainview, and Chester Townships (fig. 13), but they are fairly numerous in Mount Pleasant, Gillford, Mazeppa, and Zumbro Townships. The areas correspond roughly to the Port Byron-Downs-Mt. Carroll soil association and the Fayette-Renova-Chaseburg soil association.

Wabasha County is on the extreme northern fringe of the range for bobwhite quail, and therefore quail are not numerous in this county. The quail are generally within the boundaries of the Waukegan-Sparta-Plainfield association. An area of that association, called Sand Prairie, next to the Mississippi River provides the best combination of food, cover, nesting sites, and watering places for quail in this county. Figure 14 shows the densities of quail, waterfowl, and furbearers in the county.

Ruffed grouse provide fair to moderate hunting in this county, and white-tailed deer are becoming more numerous (fig. 15). The grouse and deer generally inhabit the wooded north- and east-facing slopes in the moderately steep ridges and valleys and the very steep bluffs in the Fayette-Dubuque-Steep, stony, and rocky land soil association. Protection from fire and grazing, however, is improving other areas in that association as a habitat for these species. Some deer are also in the Arenzville-Genesee-Minneiska-Alluvial land association where the

cover and supply of water are suitable. Fox squirrel and gray squirrel inhabit the areas in the Fayette-Dubuque-Steep, stony, and rocky land soil association where the timber is mature.

The following are some general management practices suitable for wildlife in this county. These are basic practices that can be used wherever the landowner is interested in improving the habitat for wildlife.

The habitat can be substantially improved for pheasant by providing winter cover and protected cover for nesting. Winter cover can be provided by improving the windbreaks around farmsteads and by planting odd areas on the farm to shrubs and trees, preferably conifers. Odd areas seeded to grass and legumes and protected from fire and grazing provide cover for nesting (fig. 16).

Field windbreaks and hedgerows provide cover for bobwhite quail, and existing wild thickets should be preserved. Planting food patches one-fourth of an acre in size within an eighth of a mile of winter cover will provide food. Suggested foods are corn, grain sorghum, winter grains, and soybeans.

Protecting the ridges and bluffs from grazing and burning is the most important practice in protecting deer, grouse, and squirrel. Interplanting conifers in open areas within the woodland provides better cover for ruffed grouse. White pine and red pine are suitable for planting in well-drained and open sites. Norway spruce and white spruce are suitable for shaded areas.

Leaving two or three good den trees per acre provides the necessary cover for squirrel. Wild cherry, dogwood, and blackberry bushes should be encouraged to provide food for squirrel in summer. Corn is a preferred food for fox squirrel.

In recent years ponds for watering livestock have been constructed in increasing numbers in this county. A recent survey of 33 such ponds showed that 31 were used by waterfowl, 23 by pheasants, and 24 by deer. If the areas adjacent to ponds are fenced and planted, they provide

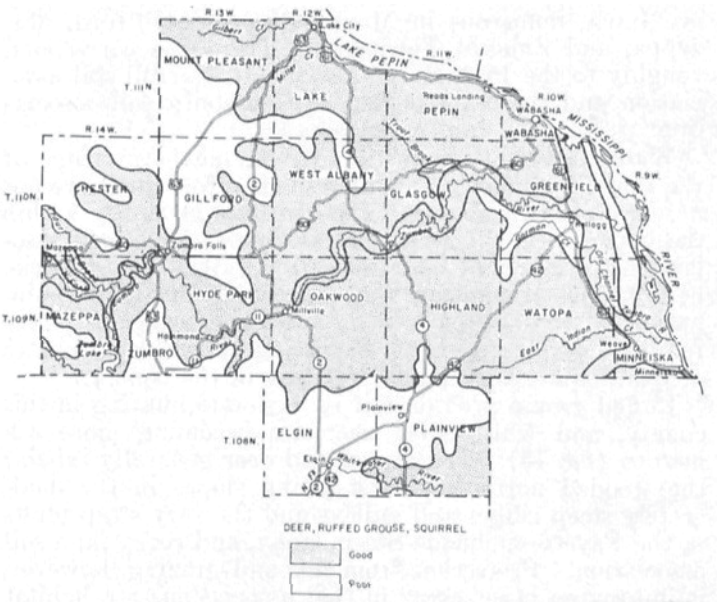

Figure 15.—**Densities of ruffed grouse, deer, and squirrel in Wabasha County.**

Figure 16.—**A corner of a field, not suited to crops, where trees and shrubs have been planted for a wildlife area. Grass and legumes have been planted to provide a nesting area, and corn and sunflowers to provide food.**

nesting sites, escape areas, and food and water for many different kinds of birds and animals. Well-planted and protected areas around ponds encourage songbirds. White pine, red pine, white spruce, and redcedar are suitable for planting around the ponds. Crabapple, American plum, mountain-ash, honeysuckle, Caragana, and lilac are also suitable for providing food and cover. The honeysuckle, Caragana, and lilac can be used as hedgerows within the fenced area. The conifers and lilacs enhance the beauty of the area for recreation.

Bromegrass and alfalfa make the best cover for nesting. Mowing should be delayed until after July 15 to protect birds that nest on the ground.

Use of the Soils for Engineering [3]

This soil survey contains information that can be used by engineers to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make estimates of runoff and erosion, for use in designing drainage systems and planning dams and other structures for conservation of soil and water.
3. Make evaluations of soil and ground conditions that will aid in selecting locations for highways and airports and in planning detailed soil surveys for the intended locations.
4. Locate sand and gravel for use in structures, and rock for crushing.
5. Correlate performance of engineering structures with soil mapping units, and thus develop information that will be useful in designing and maintaining the structures.
6. Determine the suitability of soil units for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and aerial photo-

[3] This section was prepared with the assistance of FRANKLIN R. HOEFT, area engineer, and ROSS A. ST. JOHN, State conservation engineer, Soil Conservation Service.

graphs to make maps and reports that can be used readily by engineers.

8. Make a general estimate of the hazards or useful properties of various soils for highways and earth construction when definite laboratory data are not available.

The mapping and descriptive reports are somewhat generalized, however, and should be used only in planning more detailed field surveys to determine the in-place condition of the soil at the site of the proposed engineering construction.

Only the data in table 5 are from actual laboratory tests. The estimates in tables 6 and 7 are based on a comparison of soils with those tested. At many construction sites major variations in the soils may be present within the depth of the proposed excavation, and several different soils may occur within a short distance. Specific laboratory data on mechanical analysis, liquid limit, and plasticity index should be determined for the soil at the site before any engineering work is planned in detail.

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some words—for example, soil texture, aggregate, and granular structure—have a special meaning in soil science. These terms, as well as other special terms used are defined in the Glossary at the back of this report.

Some of the information useful for engineering can be obtained from the soil map. It will often be necessary, however, to refer to other parts of the report. By using the information in the general soil map, the profile descriptions, and the tables in this section, the soils engineer can plan a detailed survey of the soil at the construction site.

Engineering classification systems

Agricultural scientists of the United States Department of Agriculture classify soils according to texture. In some ways this system of naming textural classes is comparable to the two systems used by engineers for classifying soils, that is, the system of the American Association of State Highway Officials (AASHO) and the Unified system. Following is a description of the classification systems used by engineers. Additional information is given in the PCA Soil Primer (*9*).

AASHO Classification System.—Most highway engineers classify soil materials in accordance with the system approved by AASHO (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1 (gravelly soils of high bearing capacity, the best soils for subgrade), to A–7 (clayey soils having low strength when wet, the poorest soils for subgrade).

Within each group the relative engineering value of the soil material is indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest. The group index number is shown in parentheses following the soil group symbol, as in table 5. The estimated AASHO classification for the soils of this county is given in table 6.

Unified Classification System.—Some engineers prefer to use the Unified soil classification system established by the Waterways Experiment Station, Corps of Engineers (*12*). In that system soil materials are identified as coarse grained (eight classes), fine grained (six classes), or highly organic. The estimated classification of all the soils of the county, according to the Unified system, is given in table 6. Table 5 shows the Unified classification of the soils that were tested.

Engineering test data

Soil samples from three extensive soil series of Wabasha County were taken from nine locations selected by the Soil Conservation Service. These samples were tested by standard procedures in the laboratories of the Minnesota Department of Highways to help evaluate the soils for engineering purposes. These samples do not represent the entire range of characteristics in this county, or even within the three soil series sampled, and not all layers of each profile were sampled. The test results, however, have been used as a general guide in estimating the physical properties of the soils of the county. To assist in estimating the properties of the soils that were not sampled, test results from other counties having similar soils were reviewed to make the estimates as nearly accurate as possible.

Mechanical analyses were made by combined sieve and hydrometer methods. The liquid limit and plasticity index were determined. The results of these tests and the classification of each sample according to both the AASHO and the Unified systems are given in table 5.

Table 5 also gives moisture-density, or compaction, data for the soils tested, as determined by the methods described in AASHO Designation: T 99–57 (*1*). If a soil material is compacted at successively higher moisture content, assuming that the same amount of force is used in compacting the soil, the density of the compacted material increases until the optimum moisture content is reached. After that, the density decreases with increase in moisture content. The ovendry weight in pounds per cubic foot of the soil material at the optimum moisture content is the maximum dry density. Data on the relationship of moisture to density are important in planning earthwork because, generally, the soil is most stable if it is compacted to about its maximum dry density when it is at approximately the optimum moisture content.

Engineering properties of soils

In table 6 the soils of the county and their mapping symbol are listed, and certain properties that are significant to engineering are described. Descriptions of color and other characteristics that are not important to engineering are omitted, except in a few places where they are needed to distinguish between soils that are otherwise similar. The classification according to the AASHO and the Unified classification systems is given for each important layer.

Depth to the water table, as shown in table 6, is based on field observations.

Permeability of the soil as it occurs in place was estimated. The estimates are based on the structure and consistence of the soil material and on field observations.

Available water capacity, given in inches per inch of soil depth, refers to the approximate amount of capillary water in the soil when the soil is wet to field capacity.

TABLE 5.—*Engineering test data* [1] *for*

Soil name and location	Parent material	Minnesota report No. SS60	Depth	Horizon	Moisture-density [2]	
					Maximum dry density	Optimum moisture
			Inches		*Lb. per cu. ft.*	*Percent*
Chaseburg silt loam:						
1,040 feet NW. of county road No. 14 in NW¼SW¼ sec. 23, T. 109 N., R. 10 W. (Modal profile.)	Recent alluvium.	3381	0–24	----------	98	21
		3382	24–44	----------	97	20
		3383	51–77	----------	94	24
		3384	89–112	----------	102	18
200 feet N. and 500 feet W. of SE. corner of SE¼ NE¼ sec. 5, T. 110 N., R. 14 W. (Shallow.)	Recent alluvium.	3378	0–21	----------	94	23
		3379	35–46	----------	98	22
		3380	50–64	----------	98	23
50 feet from township road and 300 feet from county road No. 4, SE¼SE¼ sec. 31, T. 110 N., R. 12 W. (Deep.)	Recent colluvial alluvium.	3388	0–13	----------	100	20
		3389	13–48	----------	96	22
		3390	48–78	----------	96	24
Downs silt loam:						
340 feet E. and 240 feet S. of NW. corner of NW¼SW¼ sec. 1, T. 108 N., R. 11 W. (Modal profile.)	Loess.	3385	0–6	A1	87	26
		3386	20–33	B22	100	20
		3387	41–75	C1	99	21
NW¼NW¼ sec. 14, T. 108 N., R. 12 W. (Almost a modal profile, in a cultivated area.)	Loess.	3394	0–8	Ap	98	20
		3395	20–30	B22	99	20
		3396	35–62	C1	106	18
200 feet E. of SW. corner of SW¼ sec. 17, T. 108 N., R. 12 W. (Profile has more characteristics of a soil formed under prairie than of a soil formed under forest.)	Loess.	3391	0–10	A1	97	21
		3392	28–41	B22	102	21
		3393	47–70	C1	107	16
Waukegan silt loam:						
800 feet W. and 120 feet S. of NE. corner of SE¼SW¼ sec. 33, T. 111 N., R. 10 W. (Modal profile.) [7]	Alluvium.	3397	0–7	Ap	102	18
		3398	24–34	B22	108	17
		3399	47–70	C	139	8
SW¼NW¼ sec. 27, T. 110 N., R. 10 W. (Shallower than modal profile.)	Alluvium.	3372	0–6	Ap	105	19
		3373	16–25	B21	102	20
		3374	49–65	C3	114	13
SE¼SE¼ sec. 14, T. 110 N., R. 11 W. (Clay loam subsoil.)	Alluvium.	3375	0–6	Ap	106	16
		3376	22–30	B22	117	14
		3377	39–61	C1	112	15

[1] Tests performed by the Minnesota Department of Highways, in cooperation with the U.S. Department of Commerce, Bureau of Public Roads (BPR).

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

[3] Mechanical analyses according to AASHO Designation T 88–57. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in

soil samples taken from selected soil profiles

Mechanical analysis [3]										Liquid limit	Plasticity index	Classification	
Percentage passing sieve—						Percentage smaller than—							
1 in.	¾ in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO [4]	Unified [5]
				100	98	88	46	13	6	[6] NP	NP	A–4(8)	ML.
				100	98	90	46	12	7	NP	NP	A–4(8)	ML.
			100	99	93	86	49	18	10	38	3	A–4(8)	ML.
			100	99	96	87	51	28	24	36	12	A–6(9)	ML–CL.
				100	99	84	41	19	11	36	9	A–4(8)	ML.
				100	99	90	59	23	14	30	2	A–4(8)	ML.
					100	92	60	28	22	36	11	A–6(8)	ML–CL.
			100	99	98	86	49	17	8	31	2	A–4(8)	ML.
				100	98	83	50	16	7	31	3	A–4(8)	ML.
				100	99	86	58	18	11	33	2	A–4(8)	ML.
			100	99	97	87	51	14	6	NP	NP	A–4(8)	ML.
					100	86	53	28	20	35	11	A–6(8)	ML–CL.
					100	89	50	25	22	33	8	A–4(8)	ML–CL.
			100	99	98	89	53	24	16	35	6	A–4(8)	ML.
				100	99	89	53	28	25	39	13	A–6(9)	ML–CL.
				100	99	90	39	16	12	26	1	A–4(8)	ML.
				100	98	90	52	23	17	36	6	A–4(8)	ML.
				100	98	88	47	24	22	37	13	A–6(9)	ML–CL.
				100	97	91	62	23	16	30	5	A–4(8)	ML.
			100	98	88	66	37	21	14	27	2	A–4(8)	ML.
		100	99	96	76	58	34	20	17	30	6	A–4(8)	ML–CL.
100	97	63	48	12	6					NP	NP	A–1–a(0)	GP–GM.
	100	99	96	85	75	70	46	22	14	33	9	A–4(8)	ML–CL.
		100	99	90	77	70	52	29	23	38	13	A–6(9)	ML–CL.
	100	96	91	37	2					NP	NP	A–1–b(0)	SP.
	100	99	98	80	55	49	32	15	12	31	2	A–4(4)	ML.
		100	99	72	42	36	26	13	10	26	4	A–4(1)	SM–SC.
100	99	95	92	30	2					NP	NP	A–1–b(0)	SP.

diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[4] Based on AASHO Designation M 145–49 (*1*).

[5] Based on Unified Soil Classification System (*12*). SCS and BPR have agreed to consider that all soils having plasticity indexes within two points from A-line are to be given a borderline classification. Examples of borderline classifications obtained by this use are ML–CL and SM–SC.

[6] NP = Nonplastic.

[7] Laboratory test data not corrected for the 20 percent that was discarded in field sampling.

TABLE 6.—*Estimated physical*

Map symbol	Soil name	Description of soil and site	Depth to water table	Depth from surface
			Feet	*Inches*
Ad Aw	Alluvial land. Alluvial land, wet.	These land types consist of mixed soil material from recent alluvium. They are on flood plains. Their texture ranges from sand to clay, and drainage ranges from good to poor. Floods occur nearly every spring and occasionally in other seasons.	(2)	
Az	Arenzville silt loam.	Deep silt loam that developed in recent, silty alluvium over older alluvium on flood plains. Drainage ranges from good to fair. Floods occur occasionally in spring and sometimes in other seasons.	(2)	0–36 36–84+
BbA BbB BbB2	Bixby loam, 0 to 2 percent slopes. Bixby loam, 2 to 6 percent slopes. Bixby loam, 2 to 6 percent slopes, moderately eroded.	Moderately deep, well-drained, medium-textured soils that developed in sandy alluvial deposits on stream terraces. The substratum is mainly sand, but in places there are thin bands of sandy loam, loam, or sandy clay loam.	10+	0–11 11–23 23–28 28–100+
BfE BhB BhC BhD	Boone loamy fine sand, 18 to 35 percent slopes. Boone and Chelsea loamy fine sands, 2 to 6 percent slopes. Boone and Chelsea loamy fine sands, 6 to 12 percent slopes. Boone and Chelsea loamy fine sands, 12 to 18 percent slopes.	Well-drained soils developed on uplands in loose, medium and fine sands derived from sandstone. Soft sandstone bedrock is at a depth of 12 to 42 inches or more. In places there are fragments of sandstone or pebbles of mixed origin on the surface.	10+	0–5 5–36 36+
BkA BkB2	Burkhardt gravelly sandy loam, 0 to 2 percent slopes. Burkhardt gravelly sandy loam, 2 to 6 percent slopes, moderately eroded.	Well-drained gravelly soils on stream terraces. The soils are shallow over coarse-textured outwash. About 25 percent of the gravelly material consists of fragments more than 3 inches in diameter.	10+	0–9 9–13 13–100+
BrA BrB BtA BtB BtB2 BtC2	Burkhardt loam, 0 to 2 percent slopes. Burkhardt loam, 2 to 6 percent slopes. Burkhardt sandy loam, 0 to 2 percent slopes. Burkhardt sandy loam, 2 to 6 percent slopes. Burkhardt sandy loam, 2 to 6 percent slopes, moderately eroded. Burkhardt sandy loam, 6 to 12 percent slopes, moderately eroded.	Shallow to moderately deep, well-drained loamy soils on stream terraces; these soils developed in coarse-textured outwash.	10+	0–14 14–27 27–100+
CaB	Chaseburg fine sandy loam, 2 to 6 percent slopes.	Well-drained soils that developed in material recently washed from uplands and deposited in drainageways. Some of the materials washed from soils derived from sandstone. In places these soils are underlain by a buried Fayette soil.	10+	0–30 30–48+
ChA ChB	Chaseburg silt loam, 0 to 2 percent slopes. Chaseburg silt loam, 2 to 6 percent slopes.	Moderately well drained soils that developed in material recently washed from surrounding uplands and deposited in drainageways. In places the soils are underlain by a buried Fayette soil. Some seepage occurs below a depth of 48 inches.	5–10	0–24 24–51 51–77 77–112
Co	Colo silty clay loam.	Deep, somewhat poorly drained to poorly drained soil that developed in alluvium on flood plains. Occasionally, the soils are flooded in spring, but rarely at other seasons.	1–4	0–54 54–72+
DdC2 DdD2	Dodgeville silt loam, 6 to 12 percent slopes, moderately eroded. Dodgeville silt loam, 12 to 18 percent slopes, moderately eroded.	Moderately deep, well-drained soils that developed on the uplands in loess over material weathered from limestone. Limestone bedrock underlies the weathered material. The uppermost 1 to 3 feet of the bedrock is shattered and is partly disintegrated.	(5)	0–13 13–32 32–34 34+
DgC2	Dodgeville silt loam, shallow, 6 to 12 percent slopes, moderately eroded.	Well-drained soils that developed on the uplands in loess that is 1 to 2 feet thick over material weath-	(5)	0–18

See footnotes at end of table.

properties significant to engineering

Classification			Estimated percentage passing sieve—			Permeability	Available water capacity [1]	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
[3]	[3]	[3]	[2]	[2]	[2]	*Inches per hour* [2]	*Inches per inch of soil* [2]	*pH value* [2]	[2].
Silt loam	ML	A–4	100	100	80–95	0. 8 – 2. 5	0. 18	6. 1– 7. 0	Low.
Silt loam to silty clay loam.	ML or CL	A–4 or A–6	100	100	80–95	0. 8 – 2. 5	. 17	6. 1– 6. 5	Moderate.
Loam	SC	A–4	90–100	80–90	40–45	0. 8 – 2. 5	. 17	5. 1– 5. 5	Low.
Clay loam	CL	A–6	90–100	80–90	55–60	0. 8 – 2. 5	. 17	4. 5– 5. 0	Moderate.
Sandy clay loam	SC	A–6	70–75	60–70	40–45	0. 8 – 2. 5	. 17	4. 5– 5. 0	Moderate.
Sand	SP	A–3	50–60	40–50	2–5	5. 0 –10. 0	. 04	4. 5– 5. 5	Low.
Loamy fine sand	SM	A–2–4	95–100	80–90	10–15	5. 0 –10. 0	. 07	5. 6– 6. 5	Low.
Fine sand	SP	A–3	90–100	75–85	2–5	5. 0 –10. 0	. 04	5. 1– 6. 0	Low.
Sandstone bedrock									
Gravelly sandy loam	GC	A–1	40–50	30–40	15–20	5. 0 –10. 0	. 07	5. 6– 6. 0	Low.
Gravelly sandy loam	GC	A–1	30–40	20–30	10–15	10. 0+	. 02	5. 1– 5. 5	Low.
Stratified sand and gravel.	GW or GP	A–1	30–40	20–30	2–5	10. 0+	. 02	5. 1–[4]5. 5	Low.
Loam	SC or SM	A–4	85–90	50–75	35–45	0. 8 – 2. 5	. 13	5. 1– 6. 0	Low.
Gravelly loam	SM	A–1	50–75	30–40	15–30	2. 5 – 5. 0	. 07	5. 1– 5. 5	Low.
Stratified sand and gravel.	GW or GP	A–1	30–40	20–30	2–5	10. 0+	. 02	5. 1–[4]5. 5	Low.
Fine sandy loam	SM or SC	A–4	100	100	35–45	2. 5 – 5. 0	. 13	5. 6– 6. 5	Low.
Silt loam	ML or CL	A–4	100	100	93–98	0. 8 – 2. 5	. 17	5. 6– 6. 5	Moderate.
Silt loam	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 18	6. 1– 7. 5	Low.
Silt loam	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 17	6. 1– 7. 5	Low.
Silt loam	ML	A–4	100	100	90–95	0. 8 – 2. 5	. 17	6. 1– 7. 5	Moderate.
Silty clay loam	ML–CL	A–6	100	100	90–95	0. 8 – 2. 5	. 17	6. 6– 7. 5	Moderate.
Silty clay loam	MH	A–7	100	80–90	80–85	0. 8 – 2. 5	. 25	6. 6– 7. 5	Moderate to high.
Fine sand	SP–SM	A–3	90	70–80	5–10	5. 0 –10. 0	. 04	6. 6– 7. 5	Low.
Silt loam	ML	A–4	100	100	90–100	0. 8 – 2. 5	. 20	5. 6– 6. 5	Low.
Heavy silt loam	CL	A–6	100	100	90–100	0. 8 – 2. 5	. 17	5. 1– 6. 0	Moderate.
Silty clay loam	CL	A–7	90–95	70–80	60–70	0. 2 – 0. 8	. 17	6. 1– 6. 5	Moderate to high.
Limestone bedrock									
Silt loam	ML	A–4	100	90–100	90–100	0. 8 – 2. 5	. 20	5. 6– 7. 5	Low to moderate.

TABLE 6.—*Estimated physical properties*

Map symbol	Soil name	Description of soil and site	Depth to water table	Depth from surface
			Feet	*Inches*
DgD	Dodgeville silt loam, shallow, 12 to 18 percent slopes.	ered from limestone. The soils are shallow over limestone bedrock. The uppermost 1 to 3 feet of the bedrock is shattered and is partly disintegrated.		18–20
DgD2	Dodgeville silt loam, shallow, 12 to 18 percent slopes, moderately eroded.			20+
DgE2	Dodgeville silt loam, shallow, 18 to 35 percent slopes, moderately eroded.			
DhA	Downs and Mt. Carroll silt loams, 0 to 2 percent slopes.	Deep, well-drained soils that developed on the uplands in loess that is 4 to 20 feet thick. The loess is calcareous at a depth of about 8 feet. Glacial till or limestone bedrock underlies the loess.	10+	0–15
DhB	Downs and Mt. Carroll silt loams, 2 to 6 percent slopes.			15–41
DhB2	Downs and Mt. Carroll silt loams, 2 to 6 percent slopes, moderately eroded.			41–100+
DhC	Downs and Mt. Carroll silt loams, 6 to 12 percent slopes.			
DhC2	Downs and Mt. Carroll silt loams, 6 to 12 percent slopes, moderately eroded.			
DhD	Downs and Mt. Carroll silt loams, 12 to 18 percent slopes.			
DhD2	Downs and Mt. Carroll silt loams, 12 to 18 percent slopes, moderately eroded.			
DmA	Downs and Mt. Carroll silt loams, benches, 0 to 2 percent slopes.	Deep, well-drained soils that developed from silty alluvium on stream terraces. The silt is between 6 and 8 feet thick in most places, but it ranges from 4½ to 20 feet or more in thickness. Stratified sand is below the silt.	10+	0–12
DmB	Downs and Mt. Carroll silt loams, benches, 2 to 6 percent slopes.			12–35
				35–96
				96–100+
DnB	Dubuque silt loam, 2 to 6 percent slopes.	Moderately deep, well-drained soils that developed on the uplands in loess that is 24 to 42 inches thick over material weathered from limestone. Limestone bedrock underlies the weathered materials. In most places the bedrock is massive and solid.	(5)	0–13
DnB2	Dubuque silt loam, 2 to 6 percent slopes, moderately eroded.			13–32
DnC	Dubuque silt loam, 6 to 12 percent slopes.			
DnC2	Dubuque silt loam, 6 to 12 percent slopes, moderately eroded.			32–34
DnD	Dubuque silt loam, 12 to 18 percent slopes.			34+
DnD2	Dubuque silt loam, 12 to 18 percent slopes, moderately eroded.			
DnE	Dubuque silt loam, 18 to 25 percent slopes.			
DnF	Dubuque silt loam, 25 to 35 percent slopes.			
DrB	Dubuque silt loam, shallow, 2 to 6 percent slopes.	Well-drained soils of the uplands that developed in loess that is 10 to 24 inches thick over material weathered from limestone. Limestone bedrock underlies the weathered material. In most places the bedrock is massive and solid.	(5)	0–8
DrB2	Dubuque silt loam, shallow, 2 to 6 percent slopes, moderately eroded.			8–17
DrC2	Dubuque silt loam, shallow, 6 to 12 percent slopes, moderately eroded.			17–24
DrD	Dubuque silt loam, shallow, 12 to 18 percent slopes.			24+
DrD2	Dubuque silt loam, shallow, 12 to 18 percent slopes, moderately eroded.			
DrE	Dubuque silt loam, shallow, 18 to 25 percent slopes.			
DrF	Dubuque silt loam, shallow, 25 to 35 percent slopes.			
DsD3	Dubuque soils, 12 to 18 percent slopes, severely eroded.			
DtD3	Dubuque soils, shallow, 12 to 18 percent slopes, severely eroded.			
DtE3	Dubuque soils, shallow, 18 to 25 percent slopes, severely eroded.			
Du	Dune land.	Loose, sandy material that is being reworked by wind; severe blowouts and fresh dunes produce dunelike topography. This soil is very droughty.	10+	0–60+

See footnotes at end of table.

significant to engineering—Continued

Classification			Estimated percentage passing sieve—			Permeability	Available water capacity [1]	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Clay loam to clay	CL	A–7	90–95	70–80	50–65	0. 2 – 0. 8	0. 18	5. 6– 6. 0	Moderate to high.
Limestone bedrock									
Silt loam	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 20	5. 6– 6. 5	Low.
Silt loam to silty clay loam.	ML–CL	A–6	100	100	95–100	0. 8 – 2. 5	. 17	5. 1– 5. 5	Moderate.
Silt loam or coarse silt loam.	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 17	5. 6– 7. 5	Low.
Silt loam	ML	A–4	100	95–100	75–90	0. 8 – 2. 5	. 20	6. 0– 7. 3	Low to moderate.
Silt loam	ML	A–4	100	95–100	75–90	0. 8 – 2. 5	. 17	5. 1– 5. 5	Moderate.
Silt loam	ML	A–4	95–100	95–100	75–90	0. 8 – 2. 5	. 17	5. 1– 5. 5	Low to moderate.
Stratified sand	SP–SM	A–2 or A–3	60–95	50–85	5–10	5. 0 –10. 0	. 04	5. 6– 6. 0	Low.
Silt loam	ML	A–4	100	100	90–95	0. 8 – 2. 5	. 18	5. 1– 6. 5	Low to moderate.
Heavy silt loam or silty clay loam.	CL	A–6	100	100	90–95	0. 8 – 2. 5	. 17	5. 6– 6. 0	Moderate.
Clay	CL	A–7	90–95	75–85	65–75	0. 2 – 0. 8	. 17	7. 4– 7. 8	Moderate to high.
Limestone bedrock									
Silt loam	ML	A–4	100	90–95	90–95	0. 8 – 2. 5	. 18	6. 1– 7. 3	Low to moderate.
Silty clay loam	CL	A–7	95–100	90–95	90–95	0. 8 – 2. 5	. 17	5. 6– 6. 0	Moderate.
Clay	CL	A–7	75–90	65–75	50–65	0. 2 – 0. 8	. 17	5. 1– 5. 5	Moderate to high.
Limestone bedrock									
Fine sand	SP	A–3	90–95	75–85	2–5	10. 0+	. 04	5. 1– 6. 0	Low.

TABLE 6.—*Estimated physical properties*

Map symbol	Soil name	Description of soil and site	Depth to water table	Depth from surface
			Feet	*Inches*
FaA	Fayette silt loam, uplands, 0 to 2 percent slopes.	Deep, well-drained soils that developed in loess on uplands and valley slopes. The loess is as deep as 20 feet on the ridgetops and is calcareous at a depth of 8 feet. Glacial till or limestone bedrock is at a depth of 4 to 6 feet in about one-fourth of the acreage. Large chunks and fragments of limestone or sandstone are in the solum of the valley phases.	10+	0–18
FaB	Fayette silt loam, uplands, 2 to 6 percent slopes.			18–40
FaB2	Fayette silt loam, uplands, 2 to 6 percent slopes, moderately eroded.			40–100+
FaC	Fayette silt loam, uplands, 6 to 12 percent slopes.			
FaC2	Fayette silt loam, uplands, 6 to 12 percent slopes, moderately eroded.			
FaC3	Fayette silt loam, uplands, 6 to 12 percent slopes, severely eroded.			
FaD	Fayette silt loam, uplands, 12 to 18 percent slopes.			
FaD2	Fayette silt loam, uplands, 12 to 18 percent slopes, moderately eroded.			
FaD3	Fayette silt loam, uplands, 12 to 18 percent slopes, severely eroded.			
FaE2	Fayette silt loam, uplands, 18 to 25 percent slopes, moderately eroded.			
FaE3	Fayette silt loam, uplands, 18 to 25 percent slopes, severely eroded.			
FaF2	Fayette silt loam, uplands, 25 to 35 percent slopes, moderately eroded.			
FcB	Fayette silt loam, valleys, 2 to 6 percent slopes.			
FcB2	Fayette silt loam, valleys, 2 to 6 percent slopes, moderately eroded.			
FcC	Fayette silt loam, valleys, 6 to 12 percent slopes.			
FcC2	Fayette silt loam, valleys, 6 to 12 percent slopes, moderately eroded.			
FcD	Fayette silt loam, valleys, 12 to 18 percent slopes.			
FcD2	Fayette silt loam, valleys, 12 to 18 percent slopes, moderately eroded.			
FcE2	Fayette silt loam, valleys, 18 to 25 percent slopes, moderately eroded.			
FcF	Fayette silt loam, valleys, 25 to 35 percent slopes.			
FbA	Fayette silt loam, benches, 0 to 2 percent slopes.	Deep, well-drained soils that developed in silty outwash and alluvium on stream terraces. In many places the silt is 6 to 8 feet thick, but it ranges from 4½ to 20 feet or more in thickness. Stratified sand underlies the silt.	10+	0–15
FbB	Fayette silt loam, benches, 2 to 6 percent slopes.			15–40
FbB2	Fayette silt loam, benches, 2 to 6 percent slopes, moderately eroded.			40–96
FbC	Fayette silt loam, benches, 6 to 12 percent slopes.			96–100+
FbC2	Fayette silt loam, benches, 6 to 12 percent slopes, moderately eroded.			
FrB2	Fayette-Renova silt loams, 2 to 6 percent slopes, moderately eroded.	These soils are in the uplands and are intermixed. The Fayette soils are deep and well drained, and they developed in loess. The Renova soils are also deep and well drained, but they developed in a thin silt cap over glacial till.	10+	0–12
FrC2	Fayette-Renova silt loams, 6 to 12 percent slopes, moderately eroded.			12–36
FrD2	Fayette-Renova silt loams, 12 to 18 percent slopes, moderately eroded.			36–[6]72+
				36–[7]72+
GaB2	Gale silt loam, 2 to 6 percent slopes, moderately eroded.	Moderately deep, well-drained soils that developed on the uplands in loess over sand or material weathered from soft sandstone. The loess is 24 to 42 inches thick. The soils are underlain by sandstone bedrock.	([5])	0–13
GaC2	Gale silt loam, 6 to 12 percent slopes, moderately eroded.			13–29
GaD2	Gale silt loam, 12 to 18 percent slopes, moderately eroded.			29–37
				37+

See footnotes at end of table.

significant to engineering—Continued

Classification			Estimated percentage passing sieve—			Permeability	Available water capacity [1]	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Silt loam	ML–CL	A–4	100	100	95–100	0. 8 – 2. 5	0. 18	5. 6– 6. 5	Low to moderate.
Silty clay loam	CL	A–7	100	100	95–100	0. 8 – 2. 5	. 17	5. 1– 5. 5	Moderate.
Silt loam	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 17	5. 6– 6. 0	Low to moderate.
Silt loam	ML or CL	A–4	100	95–100	95–100	0. 8 – 2. 5	. 18	5. 1– 6. 0	Low to moderate.
Heavy silt loam	CL	A–6	100	95–100	95–100	0. 8 – 2. 5	. 17	5. 1– 6. 0	Moderate.
Silt loam	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 17	5. 1– 6. 5	Low.
Stratified sand	SP–SM	A–2 or A–3	60–95	50–85	5–10	5 – 10	. 04	5. 6– 6. 0	Low.
Silt loam	ML or CL	A–4	100	90–100	85–100	0. 8 – 2. 5	. 18	5. 1– 6. 5	Moderate.
Clay loam or silty clay loam.	CL	A–7	85–100	75–100	65–100	0. 8 – 2. 5	. 17	5. 1– 5. 5	Moderate.
Silt loam	ML or CL	A–4 or A–6	100	100	95–100	0. 8 – 2. 5	. 17	5. 5– 6. 0	Low to moderate.
Sandy clay loam	CL	A–6	85–90	75–85	50–65	0. 8 – 2. 5	. 17	6. 6– 7. 5	Moderate.
Silt loam	ML	A–4	100	95–100	95–100	0. 8 – 2. 5	. 18	5. 1– 6. 0	Low.
Silty clay loam	CL	A–6	100	95–100	90–100	0. 8 – 2. 5	. 17	5. 1– 5. 5	Moderate.
Fine sand	SP–SM	A–2 or A–3	90–100	50–60	5–10	10. 0+	. 04	5. 1– 5. 5	Low.
Sandstone bedrock									

TABLE 6.—*Estimated physical properties*

Map symbol	Soil name	Description of soil and site	Depth to water table	Depth from surface
			Feet	*Inches*
GhC2	Gale-Hixton complex, shallow, 6 to 12 percent slopes, moderately eroded.	These soils are in the uplands and are intermixed. The Gale soils are shallow and well drained. They developed in a thin layer of loess over sand and sandstone. The Hixton soils are also shallow and well drained, but they developed in sandy material derived from sandstone. The sandy material is mixed with loess. In places the loess is as thick as 24 inches. The underlying sandstone is soft.	(5)	0–8 8–16 16–20 20+
GhD2	Gale-Hixton complex, shallow, 12 to 18 percent slopes, moderately eroded.			
GhE2	Gale-Hixton complex, shallow, 18 to 25 percent slopes, moderately eroded.			
Gm	Garwin silt loam.	Deep, very poorly drained soil that developed in loess on the uplands. The content of organic matter in the surface layer is high.	(8)	0–11 11–28 28–40+
Gn	Genesee sandy loam.	Deep, well drained to moderately well drained soil that developed in alluvium on flood plains. This soil is flooded frequently in spring and occasionally at other seasons.	5–10	0–12 12–40 40–60+
Gs	Genesee silt loam.	Deep, well drained to moderately well drained soil that developed in silty alluvium on flood plains. This soil is flooded frequently in spring and occasionally at other seasons.	5–10	0–39 39–44 44–60+
HfB	Hixton fine sandy loam, 2 to 6 percent slopes.	Moderately deep, well-drained soils that developed in sandy material derived from sandstone. Some fine material has been mixed with the sand. The depth to soft sandstone ranges from 20 inches to several feet.	(5)	0–8 8–21 21–26 26–31 31+
HfC	Hixton fine sandy loam, 6 to 12 percent slopes.			
HfD	Hixton fine sandy loam, 12 to 18 percent slopes.			
HfE	Hixton fine sandy loam, 18 to 35 percent slopes.			
Hu	Huntsville silt loam.	Deep, well drained to moderately well drained soil that developed in silty alluvium on flood plains. This soil is flooded occasionally in spring, and rarely, at other seasons.	5–10	0–85+
JuA	Judson silt loam, 0 to 2 percent slopes.	Deep, moderately well drained soils that developed in material washed from surrounding uplands and deposited in waterways. In places Downs, Mt. Carroll, or Port Byron soils are buried beneath these soils at a depth of 3 feet or more. In places seepage occurs at a depth between 3 and 5 feet.	3–5+	0–35 35–48 48+
JuB	Judson silt loam, 2 to 6 percent slopes.			
LnB	Lindstrom silt loam, 2 to 6 percent slopes.	Deep, well-drained soils that developed in loess on valley slopes. The loess is 4 to 10 feet thick and is underlain by sand, sandstone, or limestone bedrock. In many places the bedrock is shattered to a depth of several feet. A few large chunks of limestone or sandstone are on the surface and in the solum.	10+	0–15 15–26 26–60 60–84+
LnC	Lindstrom silt loam, 6 to 12 percent slopes.			
LnC2	Lindstrom silt loam, 6 to 12 percent slopes, moderately eroded.			
LnD	Lindstrom silt loam, 12 to 18 percent slopes.			
LnD2	Lindstrom silt loam, 12 to 18 percent slopes, moderately eroded.			
LnE2	Lindstrom silt loam, 18 to 25 percent slopes, moderately eroded.			
MbA	Medary silt loam, brown variant, 0 to 2 percent slopes.	Deep, moderately well drained soils that developed in lacustrine deposits of silt and clay on stream terraces. In places stratified sand, silt, and clay are below a depth of 6 feet.	10+	0–8 8–14 14–72+
MbB	Medary silt loam, brown variant, 2 to 6 percent slopes.			
MdA	Meridian sandy loam, 0 to 2 percent slopes.	Moderately deep, well-drained soils that developed in sandy alluvial deposits on stream terraces. Stratified sand is at a depth between 24 and 42 inches. In places this sandy substratum contains thin bands of sandy loam, loam, or sandy clay loam.	10+	0–11 11–23 23–28 28–100+
MdB	Meridian sandy loam, 2 to 6 percent slopes.			
MdB2	Meridian sandy loam, 2 to 6 percent slopes, moderately eroded.			
MdC	Meridian sandy loam, 6 to 12 percent slopes.			
MdC2	Meridian sandy loam, 6 to 12 percent slopes, moderately eroded.			

See footnotes at end of table.

significant to engineering—Continued

Classification			Estimated percentage passing sieve—			Permeability	Available water capacity [1]	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Silt loam or loam	ML	A-4	90–100	85–90	75–90	0.8 – 2.5	0.17	5.1– 6.0	Low.
Loam	ML	A-4	70–85	65–75	50–60	0.8 – 2.5	.17	5.1– 5.5	Low.
Fine sand	SP–SM	A-2 or A-3	60–65	50–60	5–10	5.0 –10.0+	.04	5.1– 5.5	Low.
Sandstone bedrock									
Silt loam	OL	A-7	100	95–100	95–100	0.8 – 2.5	.25	6.1– 6.5	Moderate.
Silty clay loam	CL	A-7	100	95–100	95–100	0.2 – 0.8	.20	5.6– 6.5	Moderate.
Silt loam	CL	A-6	100	95–100	95–100	0.8 – 2.5	.17	5.6– 6.5	Moderate.
Sandy loam	SM	A-2 or A-4	95–100	85–95	30–45	2.5 – 5.0	.13	6.6– 7.5	Low.
Mixed sandy loam and silt loam.	SM and ML.	A-4	95–100	85–95	50–60	0.8 – 2.5	.17	6.6– 7.5	Low.
Sandy loam	SM	A-2 or A-4	95–100	85–95	30–45	2.5 – 5.0	.13	7.5	Low.
Silt loam	ML	A-4	95–100	90–95	90–95	0.8 – 2.5	.18	6.6– 7.5	Low.
Loam	ML	A-4	95–100	90–95	80–90	0.8 – 2.5	.17	6.6– 7.5	Low.
Fine sandy loam	SM	A-2 or A-4	95–100	85–90	30–45	2.5 – 5.0	.13	7.5	Low.
Fine sandy loam	SM	A-2	90–95	75–85	30–35	2.5 – 5.0	.13	5.6 –6.0	Low.
Loam	SM–SC	A-4	90–95	75–85	40–45	2.5 – 5.0	.17	5.1– 6.0	Low.
Fine sandy loam	SM	A-2	80–90	60–70	30–35	2.5 – 5.0	.13	4.5– 5.0	Low.
Sand	SP	A-3 or A-2	70–80	50–60	2–5	5.0 –10.0	.04	4.5– 5.0	Low.
Sandstone									
Silt loam	ML	A-4	100	90–100	90–100	0.8 – 2.5	.18	6.6– 7.5	Low to moderate.
Silt loam	ML or CL	A-4	100	100	95–100	0.8 – 2.5	.20	6.1– 6.5	Moderate.
Silt loam to silty clay loam.	CL	A-6	100	100	95–100	0.8 – 2.5	.18	6.1– 6.5	Moderate.
Silt loam	CL	A-6	100	100	95–100	0.8 – 2.5	.17	5.5 –7.0	Moderate.
Silt loam	ML	A-4	100	95–100	90–95	0.8 – 2.5	.20	5.6– 6.5	Low.
Heavy silt loam	CL	A-6	100	95–100	90–95	0.8 – 2.5	.17	5.6– 6.0	Moderate.
Silt loam	ML	A-4	100	95–100	90–95	0.8 – 2.5	.17	5.6– 6.5	Low.
Coarse silt loam to very fine sandy loam.	ML	A-4	95–100	90–95	75–80	0.8 – 2.5	.17	6.1– 6.5	Low.
Silt loam	ML	A-4	100	100	90–100	0.8 – 2.5	.18	6.6– 7.3	Moderate.
Silty clay loam to silty clay.	CL or CH	A-6 or A-7	100	100	90–100	0.8 – 2.5	.17	6.1– 6.5	Moderate to high.
Clay	CH	A-7	100	100	85–90	0.05– 0.2	.17	4.5– 7.5	High.
Sandy loam	SM	A-2	90–100	80–90	30–35	2.5 – 5.0	.13	5.6– 6.0	Low.
Loam	SM or SC	A-4	80–90	75–80	40–45	0.8 – 2.5	.17	5.6– 6.0	Low.
Fine sandy loam	SM or SC	A-2	80–90	75–80	30–35	2.5 – 5.0	.13	5.6– 6.0	Low.
Fine sand	SP	A-3	80–90	70–75	2–5	5.0 –10.0	.04	5.6– 6.0	Low.

TABLE 6.—*Estimated physical properties*

Map symbol	Soil name	Description of soil and site	Depth to water table	Depth from surface
			Feet	*Inches*
Mn	Minneiska silt loam.	Moderately deep, moderately well drained to somewhat poorly drained soil that developed in silty alluvium on flood plains. Coarse-textured alluvium is at a depth of 18 to 30 inches beneath the silt.	1–5	0–21 21–27 27–33 33–60+
MuA	Muscatine silt loam, 0 to 2 percent slopes.	Deep, somewhat poorly drained soils that developed in loess on the uplands. In places the loess is underlain by glacial till at a depth of 4 to 6 feet or deeper.	2–5	0–12 12–30 30–100+
MuB	Muscatine silt loam, 2 to 6 percent slopes.			
Os	Osseo silt loam.	Deep, somewhat poorly drained or poorly drained soil that developed in silty alluvium on flood plains. Flooding occurs at any time during spring and summer. In places peat, muck, or clay underlies the silty surface layer at a depth of 2 to 4 feet.	2–4	0–29 29–35 35–60+
PaA	Plainfield fine sand, 0 to 2 percent slopes.	Deep, excessively drained soils that developed in alluvial sand on stream terraces. In places varying amounts of fine gravel are mixed with the sand.	10+	0–7 7–60+
PaB	Plainfield fine sand, 2 to 6 percent slopes.			
PaC	Plainfield fine sand, 6 to 12 percent slopes.			
PbA	Port Byron silt loam, 0 to 2 percent slopes.	Deep, well-drained soils developed in loess on the uplands. The loess is silty and is 6 to 8 feet thick over loam or clay loam glacial till. The substratum is calcareous below a depth of 6 feet.	10+	0–11 11–39 39–60+
PbB	Port Byron silt loam, 2 to 6 percent slopes.			
PbB2	Port Byron silt loam, 2 to 6 percent slopes, moderately eroded.			
PbC	Port Byron silt loam, 6 to 12 percent slopes.			
PbC2	Port Byron silt loam, 6 to 12 percent slopes, moderately eroded.			
PoA	Port Byron silt loam, benches, 0 to 2 percent slopes.	Deep, well-drained soils that developed in silty alluvium on stream terraces. In most places stratified sand or gravel is at a depth below 8 feet.	10+	0–16 16–31 31–80 80–100+
PoB	Port Byron silt loam, benches, 2 to 6 percent slopes.			
RaA	Racine silt loam, 0 to 2 percent slopes.	Deep, well-drained soils that developed in a thin silt cap over glacial till on the uplands. Below the silt loam, gravel and small stones are common, and the till contains pockets of sand and gravel. The silt cap is 12 to 18 inches thick in most places.	10+	0–13 13–37 37–51+
RaB	Racine silt loam, 2 to 6 percent slopes.			
RaB2	Racine silt loam, 2 to 6 percent slopes, moderately eroded.			
RaC2	Racine silt loam, 6 to 12 percent slopes, moderately eroded.			
RaD2	Racine silt loam, 12 to 18 percent slopes, moderately eroded.			
ReB	Renova silt loam, 2 to 6 percent slopes.	Deep, well-drained soils developed in a thin silt cap over glacial till on the uplands. Below a depth of 12 to 18 inches, small stones and pebbles are common. The till contains some pockets of sand and gravel. The silt cap is 12 to 18 inches thick in most places.	10+	0–13 13–36 36–60+
ReB2	Renova silt loam, 2 to 6 percent slopes, moderately eroded.			
ReC	Renova silt loam, 6 to 12 percent slopes.			
ReC2	Renova silt loam, 6 to 12 percent slopes, moderately eroded.			
ReD	Renova silt loam, 12 to 18 percent slopes.			
ReD2	Renova silt loam, 12 to 18 percent slopes, moderately eroded.			
ReE2	Renova silt loam, 18 to 25 percent slopes, moderately eroded.			
ReF2	Renova silt loam, 25 to 35 percent slopes, moderately eroded.			
RkB2	Renova-Wykoff loams, 2 to 6 percent slopes, moderately eroded.	The Renova soils are deep and well drained. They are on uplands and developed in a thin silt cap over medium-textured glacial till. The Wykoff soils are also well drained, but moderately deep. They developed in a thin silt cap or in medium-textured glacial till over coarse-textured till. The coarse till is at a depth of 24 to 42 inches. These two soils are intermixed.	10+	0–12 12–36 36–[7]60+ 36–[9]60+
RkC2	Renova-Wykoff loams, 6 to 12 percent slopes, moderately eroded.			
RkD2	Renova-Wykoff loams, 12 to 18 percent slopes, moderately eroded.			

See footnotes at end of table.

significant to engineering—Continued

Classification			Estimated percentage passing sieve—			Permeability	Available water capacity [1]	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Silt loam	ML or CL	A–4 or A–6	90–100	80–90	80–85	0. 8 – 2. 5	0. 20	7. 4– 7. 8	Low to moderate.
Sandy loam to loam	SM or SC	A–4	80–90	75–80	40–45	0. 8 – 2. 5	. 17	7. 4– 7. 8	Low.
Medium sand	SP–SM	A–3	80–90	75–80	2–5	5. 0 –10. 0	. 04	6. 1– 6. 5	Low.
Fine sand with some fine gravel.	GP–GM or SP–SM.	A–1 or A–2	45–65	45–50	2–5	10. 0+	. 02	6. 6– 7. 5	Low.
Silt loam	OL	A–7	100	100	95–100	0. 8 – 2. 5	. 20	6. 6– 7. 3	Low to moderate.
Heavy silt loam	CL	A–6	100	100	95–100	0. 8 – 2. 5	. 18	6. 6– 7. 3	Moderate.
Silt loam	CL	A–6	100	100	95–100	0. 8 – 2. 5	. 17	6. 6– 7. 3	Moderate.
Silt loam	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 18	6. 6– 7. 5	Moderate.
Silty clay loam	CL	A–6	100	100	95–100	0. 8 – 2. 5	. 17	6. 1– 6. 5	Moderate.
Silty clay loam to silty clay.	CL	A–7	100	100	90–100	0. 2 – 0. 8	. 17	6. 6– 7. 3	Moderate to high.
Loamy fine sand to fine sand.	SP-SM	A–2	95–100	85–90	5–10	5. 0 –10. 0	. 07	5. 6– 6. 0	Low.
Medium sand	SP	A–3 or A–1	90–95	85–90	2–5	10. 0+	. 04	5. 1– 6. 0	Low.
Silt loam	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 20	5. 6– 6. 5	Low.
Silt loam to silty clay loam.	CL	A–6	100	100	95–100	0. 8 – 2. 5	. 18	5. 1– 5. 5	Moderate.
Coarse silt loam or very fine sandy loam.	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 17	5. 1– 5. 5	Low.
Silt loam	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 20	5. 6– 6. 5	Low.
Silty clay loam	CL	A–6	100	100	95–100	0. 8 – 2. 5	. 18	5. 6– 6. 0	Moderate.
Silt loam	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 17	5. 6– 7. 3	Low.
Medium sand	SP-SM	A–2 or A–3	60–75	50–60	5–10	5. 0 –10. 0	. 04	6. 6– 7. 3	Low.
Silt loam	ML–CL	A–4	100	90–95	70–85	0. 8 – 2. 5	. 20	5. 6– 6. 5	Low to moderate.
Fine sandy loam to clay loam.	SC or CL	A–6 or A–4	85–90	80–85	40–60	0. 8 – 2. 5	. 18	4. 5– 5. 5	Low to moderate.
Fine sandy loam to clay loam.	SC or CL	A–6 or A–4	80–90	70–80	40–60	0. 8 – 2. 5	. 17	4. 5– 5. 5	Low to moderate.
Silt loam	ML or CL	A–4	100	95–100	70–85	0. 8 – 2. 5	. 18	6. 6– 7. 3	Low to moderate.
Silty clay loam	CL	A–6	85–95	80–85	50–65	0. 8 – 2. 5	. 17	5. 0– 6. 0	Moderate.
Sandy clay loam	CL	A–6	85–90	70–80	50–55	0. 8 – 2. 5	. 17	5. 6– 6. 0	Moderate.
Silt loam and gravelly loam.	ML or CL	A–4	100	95–100	75–85	0. 8 – 2. 5	. 18	6. 6– 7. 3	Low to moderate.
Clay loam	CL	A–6	85–95	80–85	50–65	0. 8 – 2. 5	. 17	5. 0– 6. 0	Moderate.
Sandy clay loam	CL	A–6	85–90	70–80	50–55	0. 8 – 2. 5	. 17	5. 6– 6. 0	Moderate.
Stratified sand and gravel.	GP–GM	A–1 or A–3	40–50	40–50	5–10	10. 0+	. 02	5. 6– 6. 0	Low.

TABLE 6.—*Estimated physical properties*

Map symbol	Soil name	Description of soil and site	Depth to water table	Depth from surface
			Feet	*Inches*
Rv	Riverwash.	Bare alluvial land, commonly sandy, exposed along streams when the water is low.		
SbD2	Seaton-Bold soils, 12 to 18 percent slopes, moderately eroded.	Deep, well-drained soils developed in loess on the uplands. The loess is coarse silt loam and is calcareous. It is 4 to 8 feet thick over glacial till or limestone.	10+	0–27 27–50 50–60+
So	Sogn soils.	Shallow, well-drained soils that developed on the uplands in loess and material weathered from limestone. Fragmented limestone bedrock is at a depth of 6 inches to 1 foot.	(5)	0–7 7+
SpA	Sparta loamy fine sand, 0 to 2 percent slopes.	Deep, excessively drained soils that developed in alluvial sand on stream terraces.	10+	0–40
SpB	Sparta loamy fine sand, 2 to 6 percent slopes.			40–72+
Sr	Steep, stony, and rocky land.	Soils that are generally 24 inches or less deep over sandstone or limestone bedrock. The slopes are 18 percent or steeper.		
St	Stony colluvial land.	Recently deposited soil material made up largely of chunks and fragments of limestone, chert, and sandstone. Fast, turbulent waters have deposited additional large pieces of stone during periods of rapid runoff. The stones are mixed with silt.		
ThA ThB ThB2	Tell silt loam, 0 to 2 percent slopes. Tell silt loam, 2 to 6 percent slopes. Tell silt loam, 2 to 6 percent slopes, moderately eroded.	Moderately deep, well-drained soils developed in silty alluvium on stream terraces. In most places the substratum is sand, but in a few places there is stratified sand and gravel. Depth to sand or to stratified sand and gravel ranges from 24 to 42 inches.	10+	0–12 12–26 26–41 41–52+
Tm	Terrace escarpments, loamy.	Narrow, steep areas between different terrace levels and between terraces and bottom lands. The slopes are more than 12 percent. In places medium-textured material overlies sand or gravel at a depth of 3 feet or more.	10+	0–60+
Ts	Terrace escarpments, sandy.	Narrow, steep areas between different terrace levels and between terraces and bottom lands. The slopes are more than 12 percent.	10+	0–60+
WaA WaB WaB2 WaC2	Waukegan silt loam, 0 to 2 percent slopes. Waukegan silt loam, 2 to 6 percent slopes. Waukegan silt loam, 2 to 6 percent slopes, moderately eroded. Waukegan silt loam, 6 to 12 percent slopes, moderately eroded.	Moderately deep, well-drained soils that developed from silty outwash and alluvium on stream terraces. Stratified sand and gravel is at a depth between 24 and 47 inches.	10+	0–19 19–34 34–47 47–70+
WhB2 WhC2 WhD2	Whalan silt loam, 2 to 6 percent slopes, moderately eroded. Whalan silt loam, 6 to 12 percent slopes, moderately eroded. Whalan silt loam, 12 to 18 percent slopes, moderately eroded.	Moderately deep, well-drained soils that developed in a thin silt cap over glacial till on the uplands. The silt and glacial till are 24 to 42 inches thick over material weathered from limestone and limestone bedrock. The lower part of the subsoil contains small stones, gravel, and fragments of limestone. The thickness of the silt cap ranges from 10 to 18 inches. The top of the bedrock is only slightly shattered.	(5)	0–17 17–28 28–31 31+
WsB2 WsC	Whalan silt loam, shallow, 2 to 6 percent slopes, moderately eroded. Whalan silt loam, shallow, 6 to 12 percent slopes.	Shallow, well-drained soils that developed in a thin silt cap over thin glacial till on the uplands. The silt and glacial till are 12 to 24 inches thick over limestone bedrock. The lower part of the subsoil	(5)	0–9 9–12 12–15 15+

See footnotes at end of table.

significant to engineering—Continued

Classification			Estimated percentage passing sieve—			Permeability	Available water capacity [1]	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
[3]	[3]	[3]							
Silt loam	ML	A-4	100	100	95–100	0.8 – 2.5	0.17	6.6–7.3	Low.
Coarse silt loam	ML	A-4	100	100	95–100	0.8 – 2.5	.17	6.6–7.5	Low.
Very fine sandy loam	ML	A-4	100	100	85–90	2.5 – 5.0	.17	7.5–7.8	Low.
Silt loam	ML or CL	A-4 or A-6	50–90	45–75	50–60	0.8 – 2.5	.18	7.9–8.4	Low to moderate.
Limestone bedrock									
Loamy fine sand	SP–SM	A-2	95–100	90–95	10–15	5.0 –10.0	.07	5.1–6.0	Low.
Medium sand	SP	A-3 or A-1	85–95	85–95	2–5	5.0 –10.0	.04	5.1–5.5	Low.
[3]	[3]	[3]							
[3]	[3]	[3]							
Silt loam	ML	A-4	100	90–95	85–90	0.8 – 2.5	.18	6.0– 6.5	Low.
Heavy silt loam	CL	A-6	100	90–95	75–85	0.8 – 2.5	.17	5.6– 6.5	Moderate.
Coarse silt loam and very fine sandy loam.	SM or ML	A-4	95–100	75–85	35–65	2.5 – 5.0	.13	5.1– 5.5	Low.
Fine sand	SP–SM	A-3	90–100	75–85	5–10	5.0 –10.0	.04	5.1– 5.5	Low.
Silt loam or silty clay loam.	ML or CL	A-4 or A-6	100	85–100	75–95	0.8 – 2.5	.17	4.5– 7.5	Low to moderate.
Stratified gravel and sand.	GW–GM to SW–SM.	A-1 or A-3	60–75	30–50	2–5	10.0+	.02	6.0– 7.5	Low.
Silt loam	ML	A-4	100	100	55–90	0.8 – 2.5	.20	5.6– 6.0	Low.
Silt loam to silty clay loam.	ML–CL or SM–SC.	A-4 or A-6	100	95–100	40–75	0.8 – 2.5	.18	5.1– 6.0	Low to moderate
Gravelly sandy loam	GM or SM	A-1 or A-2	70–90	50–65	10–20	2.5 – 5.0	.12	5.6– 6.0	Low.
Gravel and sand	GP–GM or SP.	A-1	60–90	40–60	2–6	10.0+	.02	6.0– 7.5	Low.
Silt loam to heavy silt loam.	ML–CL	A-4 or A-6	100	95–100	95–100	0.8– 2.5	.18	5.1– 7.3	Moderate.
Loam to clay loam	CL	A-6	95–100	95–100	95–100	0.8– 2.5	.17	5.1– 5.5	Moderate.
Gravelly or cherty clay.	CL	A-7	75–90	65–85	60–65	0.2– 0.8	.17	5.6– 6.0	Moderate to high.
Limestone bedrock									
Silt loam	ML–CL	A-4	100	100	70–80	0.8– 2.5	.18	6.0– 7.3	Moderate
Clay loam	CL	A-7	90–95	75–95	60–95	0.8– 2.5	.17	6.0– 7.3	Moderate.
Cherty loam	CL	A-7	60–75	55–70	50–60	0.2– 0.8	.71	6.6– 7.5	Moderate to high.
Limestone bedrock									

TABLE 6.—*Estimated physical properties*

Map symbol	Soil name	Description of soil and site	Depth to water table	Depth from surface
			Feet	*Inches*
WsC2	Whalan silt loam, shallow, 6 to 12 percent slopes, moderately eroded.	contains small stones, gravel, and fragments of limestone. In places a thin layer of stiff clay overlies the limestone. The top of the bedrock is only slightly shattered.		
WsD	Whalan silt loam, shallow, 12 to 18 percent slopes.			
WsD2	Whalan silt loam, shallow, 12 to 18 percent slopes, moderately eroded.			
WsE2	Whalan silt loam, shallow, 18 to 25 percent slopes, moderately eroded.			
WsF2	Whalan silt loam, shallow, 25 to 35 percent slopes, moderately eroded.			
WvB	Wykoff gravelly loam, 2 to 6 percent slopes.	Shallow, well-drained soils developed in coarse-textured glacial till on the uplands. The substratum is gravelly and is less than 2 feet below the surface.	10+	0–12
WvC2	Wykoff gravelly loam, 6 to 12 percent slopes, moderately eroded.			12–21
WvD2	Wykoff gravelly loam, 12 to 18 percent slopes, moderately eroded.			21–60+
WvE2	Wykoff gravelly loam, 18 to 35 percent slopes, moderately eroded.			
Zb	Zumbro loamy fine sand.	Deep, well drained or moderately well drained soil developed in alluvial sand on the flood plains. This soil is flooded occasionally.	3–6	0–9 9–23 23–50+
ZgA	Zwingle silt loam, 0 to 2 percent slopes.	Deep, somewhat poorly drained or poorly drained soils developed in lacustrine deposits of silt and clay on stream terraces. In places stratified sand, silt, and clay are below a depth of 6 feet.	10+	0–14
ZgB	Zwingle silt loam, 2 to 6 percent slopes.			14–40
ZgB2	Zwingle silt loam, 2 to 6 percent slopes, moderately eroded.			40+

[1] Estimates of available water capacity based on textural class and content of organic matter.
[2] Variable.
[3] Classification not established.
[4] The reaction is 7.5 at a depth of 8 feet.

When the soil is air dry, this same amount of water will wet the soil material to a depth of 1 inch without deeper percolation. If reliable estimates are to be made, data on representative soils are needed from undisturbed soil samples or from field measurements.

The shrink-swell potential is an indication of the volume change to be expected of the soil material with the change in moisture content. It is estimated on the basis of the amount and type of clay in the soil layers. In general, soils classified as A–7 and CH have high shrink-swell potential. Clean sands and gravels (single grain structure) and those having a small amount of nonplastic to slightly plastic fines have low shrink-swell potential, as does most other nonplastic to slightly plastic soil material.

If a highway is to be located in an area where the water table is permanently or intermittently high, drainage ditches should be constructed before earthwork is started. The ditch will make the soils more suitable for borrow and for roadway excavation. Underdrains may be required where either a perched water table or a normal water table might cause the soil to be unstable. Roads through areas of bottom lands that are flooded each year ought to be built on a continuous embankment, and the roadbed should be above the highest level reached by the floodwaters. Suitable material for use in the embankment can be taken from most soils of the bottom lands, except from Alluvial land, wet.

Table 7 rates the soils according to their suitability as a source of topsoil, sand, gravel, and road fill. It also gives some soil characteristics that affect the suitability of the soils as a site for highways and for agricultural engineering. The information is based partly on estimates. It is also based on data obtained by testing soils from this county and partly on data for similar soils from other counties. Some features mentioned in the table may be helpful in one kind of engineering work and a hindrance in another. For example, a highly permeable substratum makes a soil unsuitable as a site for a farm pond, but the soil may be favorable for artificial drainage. One of the main features considered in rating the suitability of the soils for various purposes was susceptibility to frost heaving.

In this county frost heaving is a serious problem. Soils that consist of a mixture of clay, silt, and coarser textured material are less susceptible to frost heaving and to subsequent frost boils than soils that contain a large amount of silt or very fine sand. A soil is susceptible to damaging frost action if about 10 percent or more of the soil material passes a No. 200 sieve.

significant to engineering—Continued

Classification			Estimated percentage passing sieve—			Permeability	Available water capacity [1]	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200	*Inches per hour*	*Inches per inch of soil*	*pH value*	
Gravelly loam to loam.	SM or GM	A–2	50–75	50–75	30–35	2. 5– 5. 0	. 13	5. 6– 6. 0	Low.
Sandy loam to loam	SM or GM	A–2	50–75	50–75	30–35	2. 5– 5. 0	. 13	5. 6– 6. 0	Low.
Gravel and sand	GW–GM	A–1	50–60	50–60	5–10	10. 0+	. 02	5. 6– 6. 0	Low.
Loamy fine sand	SM–SP	A–2	95–100	80–90	10–15	5. 0 –10. 0	. 07	7. 4– 7. 8	Low.
Sand or loamy sand	SP–SM	A–2 or A–3	95–100	80–90	5–10	5. 0 –10. 0	04	6. 0– 7. 3	Low.
Sand	SP	A–3	80–90	60–70	2–5	10. 0+	. 04	5. 6– 6. 5	Low.
Silt loam	ML	A–4	100	100	95–100	0. 8 – 2. 5	. 18	5. 6– 6. 5	Low to moderate.
Silty clay loam to silty clay.	CL	A–7	100	100	95–100	0. 2 – 0. 8	. 17	5. 1– 5. 5	Moderate to high.
Heavy silt loam	CL	A–4 or A–6	100	100	90–95	0. 2 – 0. 8	. 17	5. 6– 6. 0	Moderate.

[5] In the bedrock.
[6] Fayette soils.
[7] Renova soils.
[8] Ranges from 0 to 3 feet.
[9] Wykoff soils.

Using soil material that is uniform is important in earthwork because damage from frost action results where there are differences in expansion between one material and another. Some deposits of glacial till contain lenses or pockets of fine sand and silt that cause differential frost heave. Where the subgrade for the highway is laid over glacial till, it should contain a thick enough layer of material that is not susceptible to frost heave so that the pavement will not be damaged when freezing occurs.

Features that affect the suitability of the soils for dikes or levees are shown in table 7. That table also gives features that affect the suitability of the soils for farm ponds.

Ponds for watering livestock are needed in Wabasha County. However, because of the peculiarities of the limestone that underlies much of the county, sinkholes may develop in the bedrock. Water that percolates through the cracks in the limestone dissolves the limestone, and eventually it causes caverns to develop in the bedrock. If water concentrates above one of the cracks, it may work down through highly permeable soil material, carrying the soil material with it. Then, a sinkhole may form that is difficult to plug. In some places a sinkhole does not form, but water seeps out in many places in the bottom of the pond because the soil material is too permeable for holding water.

Before the person who plans to build a pond begins construction, he needs to know whether the soils at the pond site will hold water. Table 7 gives some features that affect the suitability of the soils for a pond site and rates the soils according to their suitability for a pond reservoir and for embankments. The permeability of most of the soils is rather high. If a pond is planned in an area where the soils have rather high permeability, some of the following practices may be used to help seal the pond:

1. Obtain borrow material for the embankment outside the pond area. Remove and discard the sod and surface soil; build the embankment if possible with subsoil that contains considerable clay.
2. Scarify and compact the bottom of the reservoir.
3. Cover the bottom of the reservoir with about 6 inches of material that is at least 24 percent clay if highly permeable silt or very fine sand is present. Then scarify and compact the material.
4. Use a commercial pond sealer. This is expensive, and the sealer may not be effective.
5. Place a plastic liner in pond area.

TABLE 7.—*Estimated suitability of the soils for use in construction*

Soil series and map symbol	Suitability as a source of—				Soil features affecting engineering practices	
	Topsoil [1]	Sand [2]	Gravel	Road fill [3]	Highway location	Dikes and levees
Alluvial land (Ad, Aw).	Poor to good; check each site.	Not suitable	Not suitable	Poor to good; check each site; variable high water table.	Flooding and high water table; variable susceptibility to frost action.	Fair stability; poor to fair resistance to piping.
Arenzville (Az)	Fair to good	Not suitable	Not suitable	Generally not suitable; poor stability; susceptible to liquefaction.	Subject to flooding; very poor bearing value; subject to liquefaction; high susceptibility to frost action.	Poor stability; piping hazard; good to poor compaction characteristics; medium compressibility.
Bixby (BbA, BbB, BbB2).	Fair	Good; mixed medium to coarse sand and fine gravel; wash for concrete.	Fair; mixed medium to coarse sand and fine gravel; wash for concrete.	Good; good compaction characteristics; fair stability; erodes easily; good shear strength.	Fair stability; good compaction characteristics; good shear strength; low susceptibility to frost action.	Reasonably stable; piping hazard.
Boone and Chelsea (BfE, BhB, BhC, BhD).[4]	Not suitable	Suitable for poorly graded fine and medium sands; not suitable for concrete.	Not suitable	Good; erodes easily; good shear strength; good compaction characteristics; very low compressibility.	High permeability; low susceptibility to frost action; good compaction characteristics; easily eroded in places; soft sandstone in the uppermost 42 inches of the Boone soils.	Reasonably stable; good compaction characteristics; slight compressibility.
Burkhardt (BkA, BkB2, BrA, BrB, BtA, BtB, BtB2, BtC2).	Loams and sandy loams are fair.	Good source of sand, but mixed with gravel; wash for concrete.	Good source of gravel, but mixed with sand; wash for concrete.	Good; good compaction characteristics; very stable; good shear strength.	Very stable; good compaction characteristics; good shear strength; low susceptibility to frost action.	Very stable; pervious shells of dikes and dams.
Chaseburg (CaB, ChA, ChB).	Fair to good	Not suitable	Not suitable	Fair; poor stability; high susceptibility to frost action; susceptible to liquefaction.	Poor stability; high susceptibility to frost action; susceptible to liquefaction; good to poor compaction characteristics; medium compressibility.	Poor stability; medium compressibility; good to poor compaction characteristics.
Colo (Co)	Good	Not suitable	Not suitable	Not suitable; content of organic matter is high; poor stability; fair to poor shear strength; moderate susceptibility to frost action.	High content of organic matter; water table is at a depth of 1 to 4 feet; subject to flooding; poor stability.	Poor stability; fair to good compaction characteristics; medium compressibility.

See footnotes at end of table.

and selected characteristics that affect engineering practices

Soil features affecting engineering practices—Continued						Limitations for septic tank fields
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	
Reservoir area	Embankment [3]					
Piping hazard; generally not suitable, because of flooding.	Reasonably stable; piping hazard.	Flooding is frequent; needs surface drainage; outlets difficult to obtain.	Suitability for irrigation is questionable.	Not needed	Flooding causes scouring and deposition of debris.	Severe because of flooding.
Piping hazard; moderate permeability.	Good to poor compaction characteristics; piping hazard; poor stability; medium compressibility.	Not needed; moderately well drained; occasional flooding.	Good water-holding capacity, but must have flood protection.	Not needed	Subject to flooding.	Severe because of flooding.
Piping hazard; highly permeable substratum.	Reasonably stable; good compaction characteristics; possible piping hazard; very slight compressibility.	Not needed; well drained.	Moderate water-holding capacity.	Suitable	Substratum very pervious; difficult to establish sod on substratum.	Slight; soil material very permeable.
Piping hazard; high permeability; not suitable.	Piping hazard; high permeability; not suitable.	Not needed; excessively drained.	Low water-holding capacity and rapid intake rate; not suitable.	High water intake makes terraces unnecessary; bedrock may interfere with construction.	Sod is difficult to establish; bedrock may interfere with construction.	Moderate; the sand and sandstone bedrock are a good filter; bedrock may interfere with construction on the Boone soils.
High permeability; not suitable.	High permeability; not suitable.	Somewhat excessively drained to excessively drained; drainage not needed.	Low to moderate water-holding capacity; irrigation may not be economically feasible.	Gravel near the surface makes terraces unsuitable.	Substratum very pervious; difficult to establish sod on the substratum.	Slight; very permeable substratum.
Piping hazard; possible sinkhole problem; subject to flash flooding.	Good to poor compaction characteristics; poor stability; fair shear strength; moderate permeability when compacted; medium compressibility.	Well drained to moderately well drained; subject to floods of short duration.	Generally good characteristics for irrigation; subject to flash floods.	These soils are in drainageways and are normally the place to put outlets for terraces and diversions.	Subject to flash floods and erosion; sod should be established as rapidly as possible.	Severe; subject to frequent light flooding.
Subject to flooding; medium to low permeability; dugout pits feasible.	Poor stability; poor compaction characteristics; fair to poor shear strength; high compressibility; good core material.	Subject to flooding; outlets difficult to obtain.	Must be protected from flooding, and drainage should be installed.	Not needed	Ordinarily not needed on bottom land.	Severe because of flooding, high water table, and slow permeability.

TABLE 7.—*Estimated suitability of the soils for use in construction and*

Soil series and map symbol	Suitability as a source of—				Soil features affecting engineering practices	
	Topsoil [1]	Sand [2]	Gravel	Road fill [3]	Highway location	Dikes and levees
Dodgeville (DdC2, DdD2, DgC2, DgD, DgD2, DgE2).	Good	Not suitable	Not suitable; the bedrock may be suitable for crushed rock.	Limited amount of material above the bedrock; subject to frost heave.	High susceptibility to frost heave; bedrock makes cuts expensive; shattered rock is in upper part in most places.	Limited amount of material.
Downs and Mt. Carroll (DhA, DhB, DhB2, DhC, DhC2, DhD, DhD2, DmA, DmB).	Good	Not suitable; sand is below a depth of 6 to 8 feet in bench phases.	Not suitable	Fair; poor stability; high susceptibility to frost action; susceptible to liquefaction; fair shear strength.	Poor stability; high susceptibility to frost action; susceptible to liquefaction; piping hazard; needs close control for compaction.	Poor stability; piping hazard; good to poor compaction characteristics.
Dubuque (DnB, DnB2, DnC, DnC2, DnD, DnD2, DnE, DnF, DrB, DrB2, DrC2, DrD, DrD2, DrE, DrF, DsD3, DtD3, DtE3).	Fair to good	Not suitable	Not suitable; bedrock may be suitable for crushed rock.	Fair; limited amount of material above the bedrock; subject to frost heave.	High susceptibility to frost action; bedrock massive and solid.	Limited amount of material.
Dune land (Du)	Not suitable	Suitable for poorly graded fine sands.	Not suitable	Fair; poorly graded sands; erodes easily.	Highly permeable; low susceptibility to frost action; easily eroded.	Fair strength and stability; piping hazard; easily eroded; good compaction characteristics.
Fayette (FaA, FaB, FaB2, FaC, FaC2, FaC3, FaD, FaD2, FaD3, FaE2, FaE3, FaF2, FbA, FbB, FbB2, FbC, FbC2, FcB, FcB2, FcC, FcC2, FcD, FcD2, FcE2, FcF).	Fair to good	Not suitable	Not suitable	Fair; erodes easily; subject to liquefaction; fair shear strength; fair workability.	Very poor bearing value; subject to liquefaction; erodes easily; high susceptibility to frost action.	Good to poor compaction characteristics; poor stability; moderate permeability; poor to very poor piping resistance.
Fayette-Renova complexes (FrB2, FrC2, FrD2).	See the Fayette and Renova series for individual soil features that affect engineering.					
Gale (GaB2, GaC2, GaD2).	Fair to good	Not suitable; in most places the sandy substratum is thin above the sandstone bedrock.	Not suitable	Fair; erodes easily; fair shear strength.	Fair bearing value; erodes easily; moderate to low susceptibility to frost action; shallow to soft sandstone.	Limited amount of material above the soft sandstone; fair strength and stability; piping hazard.

See footnotes at end of table.

selected characteristics that affect engineering practices—Continued

Soil features affecting engineering practices—Continued						Limitations for septic tank fields
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	
Reservoir area	Embankment [3]					
Sinkholes form when ponds are built; not suitable.	Limited amount of soil material; fair to good compaction characteristics; fairly stable.	Not needed; well drained.	Shallow phases have low water-holding capacity; shallow root zone.	Too shallow over bedrock to be suitable.	Bedrock limits excavation; shallow phases have low water-holding capacity.	Severe because soils are shallow over limestone bedrock that contains solution crevices.
Piping hazard; moderate permeability; possible problem of sinkholes.	Poor stability; good to poor compaction characteristics; piping hazard.	Not needed; well drained.	Suitable; generally good characteristics for irrigation.	Suitable for terraces on slopes of 12 percent or less; diversions may be used where slopes are greater than 12 percent.	These soils are erodible.	Slight; permeability is moderate.
Underlying bedrock subject to formation of sinkholes; not suitable.	Limited amount of material; clay residuum makes an impervious embankment.	Not needed; well drained.	Shallow phases have low water-holding capacity; shallow root zone.	Shallow depth to bedrock; not suitable.	Bedrock limits excavation.	Severe; limited soil material; limestone bedrock contains solution caverns and crevices.
High permeability; not suitable.	Piping hazard; not suitable.	Not needed; excessively drained.	Low water-holding capacity and rapid intake rate require frequent application of water; not suitable.	High water intake makes terraces unnecessary.	Difficult to establish sod; low water-holding capacity; low fertility.	Slight; very permeable.
Semipervious to impervious when compacted; sinkholes may develop; piping hazard.	Good to poor compaction characteristics; poor stability; medium permeability and compressibility; poor to very poor piping resistance; fair shear strength.	Not needed; well drained.	Moderately high water-holding capacity; not suitable where slopes are more than 12 percent.	Slopes of 12 percent or less suitable for terraces; diversions may be used where slopes are greater then 12 percent.	Erosion critical; fertilizing and mulching necessary for establishing sod rapidly.	Moderate; moderately permeable.
Underlain by sand and sandstone; not suitable; high permeability.	Limited amount of material; piping hazard.	Not needed; well drained.	Moderate water-holding capacity; not suitable where slopes are more than 12 percent.	Shallow over bedrock; moderately deep soils may be suitable.	Erosion critical; difficult to establish sod on permeable substratum.	Severe because bedrock is near the surface.

TABLE 7.—*Estimated suitability of the soils for use in construction and*

Soil series and map symbol	Suitability as a source of—				Soil features affecting engineering practices	
	Topsoil [1]	Sand [2]	Gravel	Road fill [3]	Highway location	Dikes and levees
Gale-Hixton complexes (GhC2, GhD2, GhE2).	See the Gale and Hixton series for individual soil features that affect engineering.					
Garwin (Gm)	Good	Not suitable	Not suitable	Not suitable; high water table; high content of organic matter.	Fair to poor shear strength; high compressibility; poor workability; poor compaction characteristics; semipervious to impervious when compacted; high susceptibility to frost action.	High water table; high compressibility; poor workability; semipervious to impervious when compacted.
Genesee (Gn, Gs)	Fair to good	Not suitable	Not suitable	Generally not suitable; good to poor compaction characteristics; medium compressibility.	Subject to flooding; very poor bearing value; subject to liquefaction; high susceptibility to frost action.	Good to poor compaction characteristics; poor stability; medium compressibility.
Hixton (Hfb, HfC, HfD, HfE).	Not suitable	Generally not suitable, but may be a source of poorly graded fine sand.	Not suitable	Good; limited amount of material; fairly stable; good to fair shear strength; fair workability; semipervious to pervious when compacted; easily eroded.	Soft sandstone bedrock near the surface; fair stability; very slight compressibility; low susceptibility to frost action.	Limited amount of material above the sandstone bedrock.
Huntsville (Hu)	Good	Not suitable	Not suitable	Generally not suitable; fair shear strength; poor stability; medium compressibility; good to poor compaction characteristics.	Subject to flooding; very poor bearing value; subject to liquefaction; high susceptibility to frost action.	Poor stability; good to poor compaction characteristics; medium compressibility.
Judson (JuA, JuB)	Good	Not suitable	Not suitable	Generally not suitable; fair shear strength; poor stability; medium compressibility; good to poor compaction characteristics.	Subject to minor floodings; very poor bearing value; subject to liquefaction; high susceptibility to frost action.	Poor stability; good to poor compaction characteristics; medium compressibility.
Lindstrom (LnB, LnC, LnC2, LnD, LnD2, LnE2).	Good	Not suitable	Not suitable	Fair; erodes easily; contains some large chunks of limestone or sandstone; good to fair shear strength; fairly stable; medium compressibility; fair to good compaction characteristics.	Good to poor bearing value; fairly steep slopes in most places; fairly stable; fair to good compaction characteristics; moderate to high susceptibility to frost action.	Fair to good compaction characteristics; fair to good stability; medium compressibility.

See footnotes at end of table.

selected characteristics that affect engineering practices—Continued

Soil features affecting engineering practices—Continued						Limitations for septic tank fields
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	
Reservoir area	Embankment [3]					
High water table; suitable for dugout ponds.	Surface soil high in organic matter; lower material is stable and is suitable for impervious cores and blankets.	Tile or ditch drainage is effective; waterways necessary in most places to remove surface water.	Not suitable; high water table.	Not suitable; in depressions.	Must be drained before waterways are established.	Severe because of high water table.
Generally not suitable, because of flooding.	Some piping hazard; good to poor compaction characteristics; medium permeability; medium compressibility.	Not needed; moderately well drained bottom lands.	Good water-holding capacity, but subject to flooding.	Not needed	Ordinarily not needed.	Severe because of flooding.
Highly permeable; not suitable.	Fairly stable; poor resistance to piping; good compaction characteristics; medium permeability; slight compressibility.	Not needed; somewhat excessively drained.	Low water-holding capacity and rapid intake rate require frequent application of water.	Shallow over bedrock or sand; generally not suitable.	Shallow over bedrock or sand; low fertility; low water-holding capacity; difficult to establish sod; erodible.	Severe; bedrock is near the surface.
Piping hazard; subject to flooding.	Good to poor compaction characteristics; piping hazard; poor stability; fair shear strength; medium compressibility.	Not needed; moderately well drained bottom lands.	Good water-holding capacity; subject to flooding.	Not needed	Ordinarily not needed.	Severe because of flooding.
Piping hazard; subject to flooding.	Good to poor compaction characteristics; piping hazard; poor stability; fair shear strength; medium compressibility.	May be needed for control of seepage in some places.	Good water-holding capacity; subject to flooding.	These soils occur in waterways and are normally the outlets for terraces and diversions.	Fertilizing and mulching are necessary to establish sod rapidly.	Severe because of frequent light overflow.
Semipervious to impervious when compacted; possible piping hazard.	Fairly stable; fair to good compaction characteristics.	Not needed; well drained.	Good water-holding capacity; suitable where slopes are less than 12 percent.	Slopes of 12 percent or less are suitable if water from higher areas is diverted.	Fertilizing and mulching are necessary to establish sod rapidly; subject to erosion, especially on the steeper slopes.	Moderate; moderately permeable; some steep slopes.

733-993—65——7

TABLE 7.—*Estimated suitability of the soils for use in construction and*

Soil series and map symbol	Suitability as a source of—				Soil features affecting engineering practices	
	Topsoil [1]	Sand [2]	Gravel	Road fill [3]	Highway location	Dikes and levees
Medary (MbA, MbB).	Fair to good	Not suitable	Not suitable	Good to fair; fairly stable; poor shear strength; good to fair workability; fair to poor compaction characteristics; high compressibility.	Fairly stable; poor shear strength; high compressibility; fair to poor bearing value; high susceptibility to frost action; plastic clay layer below 1 to 1½ feet.	Fairly stable; good to fair resistance to piping; fair to good compaction characteristics.
Meridian (MdA, MdB, MdB2, MdC, MdC2).	Fair	Suitable for fine and medium sand; must be washed if used in concrete.	Not suitable	Good; good compaction characteristics; fair stability; erodes easily; slight compressibility; good shear strength.	Fair stability; good shear strength; slight compressibility; low susceptibility to frost action.	Reasonably stable; good compaction characteristics; slight compressibility.
Minneiska (Mn)	Good	Suitable for coarse sand and fine gravel; must be washed for concrete; high water table.	Not suitable; mostly fine gravel.	Good; subject to flooding and high water table.	Subject to flooding and high water table; material in the substratum is suitable for embankments; good bearing value; reasonably stable; variable frost susceptibility.	Reasonably stable; substratum has good compaction characteristics; slight compressibility.
Muscatine (MuA, MuB).	Fair to good	Not suitable	Not suitable	Poor to fair; water table at a depth of 2 to 5 feet; high content of organic matter in the surface layer; fair shear strength; poor stability; high susceptibility to frost action; good to poor compaction characteristics.	High water table; surface layer high in content of organic matter; high susceptibility to frost action.	Poor stability; moderate permeability; good to poor compaction characteristics; medium compressibility.
Osseo (Os)	Fair	Not suitable	Not suitable	Not suitable; high water table; susceptible to flooding; high in content of organic matter; poor stability; high susceptibility to frost action.	Some peat present; susceptible to flooding; not suitable; high susceptibility to frost action.	Poor stability; organic matter must be removed; medium compressibility; good to poor compaction characteristics.
Plainfield (PaA, PaB, PaC).	Not suitable	Suitable for poorly graded fine and medium sands.	Not suitable	Good; erodes easily; good shear strength; very low compressibility; good compaction characteristics.	Highly permeable; low susceptibility to frost action; easily eroded; good compaction characteristics.	Reasonably stable; fair stability; good compaction characteristics; piping hazard.

See footnotes at end of table.

selected characteristics that affect engineering practices—Continued

Soil features affecting engineering practices—Continued						Limitations for septic tank fields
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	
Reservoir area	Embankment [3]					
Good to fair resistance to piping; low permeability.	Fair to poor bearing value; fairly stable; good to fair resistance to piping; fair to good compaction characteristics; high compressibility.	Not needed; moderately well drained.	Good water-holding capacity.	Suitable in sloping areas only.	Difficult to establish sod on clay; do not excavate through silt.	Severe; clay has low permeability.
Highly permeable; piping hazard.	Reasonably stable; good compaction characteristics; very slight compressibility; piping hazard.	Not needed; well drained.	Moderate water-holding capacity.	Suitable in sloping areas only.	Substratum very pervious; difficult to establish sod on it; do not excavate too deep.	Slight; very permeable.
Possible piping hazard; highly permeable when compacted; flood hazard.	Reasonably stable; good compaction characteristics; fair to poor resistance to piping; highly permeable.	Not feasible, because of fluctuating water table as the result of river dams.	Moderate water-holding capacity.	Not needed; bottom land.	Not needed in most places.	Severe; subject to flooding and fluctuating high water table.
Suitable for pits	Reasonably stable; poor to good compaction characteristics; medium compressibility; fair shear strength; medium permeability.	Needed; tile drainage is suitable.	Not necessary in most places, but suitable; drainage should be installed first.	Not needed; poorly drained.	Drainage must be installed before constructing waterway; generally needs waterway to carry off surface water.	Severe; fluctuating water table.
Possibly suited to pits; subject to flooding.	Material generally unsuitable for embankments.	Outlets difficult to obtain; flooding is a hazard.	Flooding and poor drainage should be taken care of before irrigation system is installed.	Not needed; bottom land.	Not needed	Severe; subject to a high water table and flooding.
Not suitable; highly permeable; piping hazard.	Piping hazard; fair stability; good compaction characteristics; highly permeable when compacted.	Not needed; excessively drained.	Low water-holding capacity and rapid intake rate; require frequent application of water.	High water intake makes terraces unnecessary.	Difficult to establish sod; low fertility; low water-holding capacity.	Slight; very permeable.

TABLE 7.—*Estimated suitability of the soils for use in construction and*

Soil series and map symbol	Suitability as a source of—				Soil features affecting engineering practices	
	Topsoil [1]	Sand [2]	Gravel	Road fill [3]	Highway location	Dikes and levees
Port Byron (PbA, PbB, PbB2, PbC, PbC2, PoA, PoB).	Good	Not suitable; in bench phases stratified sand or gravel is present in most places below a depth of 8 feet.	Not suitable	Fair; subject to frost heave; poor stability; susceptible to liquefaction; fair shear strength; medium compressibility.	High susceptibility to frost action; easily eroded; good to poor compaction characteristics; poor stability; susceptible to liquefaction.	Poor to very poor resistance to piping; medium compressibility; good to poor compaction characteristics.
Racine (RaA, RaB, RaB2, RaC2, RaD2).	Good	Not suitable	Not suitable	Fair to good; stable; fair to good compaction characteristics; fair shear strength.	Stable; fair to good compaction characteristics; medium compressibility; fair shear strength; good to fair workability; moderate susceptibility to frost action.	Stable; impervious when compacted; fair to good compaction characteristics.
Renova (ReB, ReB2, ReC, ReC2, ReD, ReD2, ReE2, ReF2).	Fair to good	Not suitable	Not suitable	Fair to good; stable; fair to good compaction characteristics; fair shear strength.	Stable; fair to good compaction characteristics; medium compressibility; fair shear strength; good to fair workability; moderate susceptibility to frost action.	Stable; impervious when compacted; fair to good compaction characteristics.
Renova-Wykoff complexes (RkB2, RkC2, RkD2).	See the Renova and Wykoff series for individual soil features that affect engineering.					
Riverwash (Rv)	Variable	Variable	Variable	Variable	Variable	Variable
Seaton-Bold complexes (SbD2).	Fair	Not suitable	Not suitable	Fair; subject to frost heave; poor stability; subject to liquefaction; fair shear strength; medium compressibility.	High susceptibility to frost action; easily eroded; poor stability; susceptible to liquefaction.	Poor to very poor resistance to piping; medium compressibility; good to poor compaction characteristics; poor stability.
Sogn (So)	Not suitable	Not suitable	Not suitable	Not suitable; very limited amount of material over bedrock.	Bedrock near the surface makes cuts expensive; in most places the upper part of the bedrock is shattered; low susceptibility to frost action.	Very limited amount of material over bedrock; not suitable.

See footnotes at end of table.

selected characteristics that affect engineering practices—Continued

Soil features affecting engineering practices—Continued						Limitations for septic tank fields
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	
Reservoir area	Embankment [3]					
Piping hazard; highly permeable.	Poor stability; good to poor compaction characteristics; piping hazard; fair shear strength; medium compressibility.	Not needed; well drained.	Generally good characteristics for irrigation.	Slopes of 12 percent or less are suitable for terraces; diversions may be used where slopes are greater than 12 percent.	Fertilizing and mulching necessary for establishing sod rapidly.	Moderate; perability is moderate.
Impervious when compacted.	Stable; good for impervious cores and blankets; fair to good compaction characteristics; low permeability when compacted; medium compressibility.	Not needed; well drained.	Generally good characteristics for irrigation; not suitable where slopes are more than 12 percent.	Slopes of 12 percent or less are suitable for terraces; diversions may be used where slopes are greater than 12 percent; occasional stones and boulders may interfere with construction.	Fertilizing and mulching necessary for establishing sod rapidly; occasional stones and boulders may interfere with construction; steep slopes subject to erosion.	Moderate; permeability is moderate; steep slopes not suitable.
Impervious when compacted.	Stable; good for impervious cores and blankets; fair to good compaction characteristics; low permeability when compacted; medium compressibility.	Not needed; well drained.	Generally good characteristics for irrigation; not suitable where slopes are more than 12 percent.	Slopes of 12 percent or less are suitable for terraces; diversions may be used where slopes are greater than 12 percent; occasional stones and boulders may interfere with construction.	Fertilizing and mulching necessary for establishing sod rapidly; occasional stones and boulders may interfere with construction; steep slopes subject to erosion.	Moderate; permeability is moderate; steep slopes not suitable.
Variable	Variable	Variable	Variable	Variable	Variable	Variable.
Piping hazard	Poor stability; good to poor compaction characteristics; piping hazard; medium compressibility.	Not needed; well drained.	Generally good characteristics for irrigation, but steep slopes are a limiting factor.	Suitable for diversions.	Easily eroded; fertilizing and mulching necessary for establishing sod rapidly.	Moderate; permeability is moderate; steep slopes not suitable.
Shallow to bedrock; sinkholes form when ponds are made; not suitable.	Very limited amount of material over bedrock; not suitable.	Not needed; excessively drained.	Not suitable; nonagricultural soil.	Not suitable; nonagricultural soil.	Not suitable; too shallow to bedrock.	Severe; shallow over limestone bedrock.

TABLE 7.—*Estimated suitability of the soils for use in construction and*

Soil series and map symbol	Suitability as a source of—				Soil features affecting engineering practices	
	Topsoil [1]	Sand [2]	Gravel	Road fill [3]	Highway location	Dikes and levees
Sparta (SpA, SpB)	Not suitable	Suitable for poorly graded fine and medium sands.	Not suitable	Good; erodes easily; good shear strength; very low compressibility; good compaction characteristics.	High permeability; low susceptibility to frost action; easily eroded.	Reasonably stable; good compaction characteristics; fair stability; easily eroded; very low compressibility.
Steep, stony, and rocky land (Sr).	Variable	Variable	Variable	Variable	Variable	Variable
Stony colluvial land (St).	Not suitable	Not suitable	Not suitable	Fair; made up mainly of large pieces and fragments of limestone, chert, and sandstone.	Subject to frequent flooding; receives stones that are carried in by fast water.	Reasonably stable.
Tell (ThA, ThB, ThB2).	Fair	Suitable below a depth of 24 to 42 inches; needs screening and washing if used for concrete.	Suitable below a depth of 24 to 42 inches; needs screening and washing if used for concrete.	Good; erodes easily; good shear strength; very low compressibility; good compaction characteristics.	Highly permeable; low susceptibility to frost action; easily eroded.	Reasonably stable; good compaction characteristics.
Terrace escarpments, loamy (Tm).	Fair to good	Generally not suitable; in places sand is below a depth of 3 feet.	Generally not suitable; in places gravel is below a depth of 3 feet.	Good to poor, depending on material; CL good, ML poor.	Steep slopes; erodes easily; stability ranges from good to poor; high susceptibility to frost action where the soil material is silt; medium compressibility.	Reasonably stable; erodes easily; good to poor compaction characteristics; medium compressibility.
Terrace escarpments, sandy (Ts).	Not suitable	Suitable for well-graded sand and gravel; should be washed if used for concrete.	Suitable for well-graded sand and gravel; should be washed if used for concrete.	Good; very stable; slopes need protection from erosion; good compaction characteristics.	Steep slopes; erodes easily; low susceptibility to frost heave.	Very stable; good compaction characteristics; highly pervious when compacted; easily eroded.
Waukegan (WaA, WaB, WaB2, WaC2).	Good	Suitable for well-graded sand and gravel below a depth of 2 to 4 feet; should be washed if used for concrete.	Suitable for well-graded sand and gravel below a depth of 2 to 4 feet; should be washed if used for concrete.	Good; very stable; slopes need protection from erosion; good compaction characteristics.	Stable substratum; uppermost 3 feet moderately susceptible to frost heave.	Very stable; good compaction characteristics; highly pervious when compacted; slight compressibility.

See footnotes at end of table.

selected characteristics that affect engineering practices—Continued

Soil features affecting engineering practices—Continued						Limitations for septic tank fields
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	
Reservoir area	Embankment [3]					
Piping hazard; highly permeable.	Piping hazard; highly permeable when compacted; easily eroded; good compaction characteristics; very low compressibility.	Not needed; excessively drained.	Low water-holding capacity and rapid intake rate; require frequent application of water.	High intake of water makes terraces unnecessary.	Difficult to establish sod; low fertility; low water-holding capacity.	Slight; very permeable.
Variable	Variable	Variable	Variable	Variable	Variable	Variable.
Highly permeable	Highly permeable	Not needed; well drained.	Not suitable; frequent damaging floods; nonagricultural land.	Not suitable; nonagricultural land.	Not suitable	Severe; subject to flooding.
Highly permeable; piping hazard.	Highly permeable when compacted; good compaction characteristics; easily eroded; very low compressibility.	Not needed; well drained.	Moderate water-holding capacity.	Suitable	Substratum very pervious; difficult to establish sod on it; excavations should not be too deep.	Slight; very permeable substratum.
Too steep; piping hazard; in places subtratum is highly permeable.	Variable	Not needed	Too steep	Too steep	Too steep; gullies form rapidly if water is concentrated.	Severe; steep slopes.
Highly permeable; too steep; unsuitable for ponds.	Can be used for pervious shells of dikes and dams; highly pervious when compacted.	Not needed; excessively drained.	Too steep	Too steep; gullies form rapidly if water is allowed to concentrate; terraces and diversions should be located to protect these areas.	Too steep; gullies form rapidly if water is concentrated.	Severe; material is suitable for filter fields, but slopes are too steep.
Highly permeable	Highly permeable; can be used for pervious shells of dikes and dams; good compaction characteristics; slight compressibility.	Not needed; well drained.	Moderate water-holding capacity.	Suitable	Substratum very pervious; difficult to establish sod on it; excavation should not be too deep.	Slight; very permeable in substratum.

TABLE 7.—*Estimated suitability of the soils for use in construction and*

Soil series and map symbol	Suitability as a source of—				Soil features affecting engineering practices	
	Topsoil [1]	Sand [2]	Gravel	Road fill [3]	Highway location	Dikes and levees
Whalan (WhB2, WhC2, WhD2, WsB2, WsC, WsC2, WsD, WsD2, WsE2, WsF2).	Fair	Not suitable	Not suitable, but bedrock may be suitable for crushed rock.	Fair; limited amount of material above the bedrock; subject to frost heave.	High susceptibility to frost heave; bedrock massive and solid.	Limited amount of material.
Wykoff (WvB, WvC2, WvD2, WvE2).	Not suitable	Suitable, but must be washed if used for concrete.	Suitable, but must be washed if used for concrete.	Good; very stable; slopes need protection from erosion; good compaction characteristics.	Very stable substratum; highly permeable; low susceptibility to frost heave.	Very stable; good compaction characteristics; highly pervious when compacted; slight compressibility.
Zumbro (Zb)	Not suitable	Suitable for poorly graded fine sands.	Not suitable	Good; erodes easily; good shear strength; very low compressibility; good compaction characteristics.	Highly permeable; low susceptibility to frost heave; easily eroded; subject to flooding; very slight compressibility.	Reasonably stable; good compaction characteristics; high permeability when compacted; fair to poor resistance to piping; fair to poor stability.
Zwingle (ZgA, ZgB, ZgB2).	Fair	Not suitable	Not suitable	Fair; clay is fairly stable, but silts are not; silts highly susceptible to frost action; silts subject to liquefaction.	Fair shear strength; fair to poor stability; high susceptibility to frost heave in silts, which are also subject to liquefaction.	Good to fair resistance to piping; slow permeability; clays have fair to good compaction characteristics; medium to high compressibility.

[1] Refers to the surface layer only.
[2] The term "poorly graded sand" means sands that are of uniform size. Well-graded sands are a mixture of sands of all sizes in approximately equal proportions.

Before choosing a site for a pond, make a thorough investigation of the area by making deep soil borings. Avoid constructing a pond in material that is high in coarse silt or very fine sand. Also avoid areas where there is no glacial till or red clay weathered from limestone between the silty loess and the underlying limestone bedrock. The glacial till or clay forms a sealer for the pond. Avoid using coarse silt or very fine sand for the embankment of the pond, but construct the embankment of material that is 15 to 20 percent clay. If the mantle of loess is thin over limestone bedrock, or if there is no clay or only a thin layer of clay, water will be likely to leak from the pond.

Formation, Morphology, and Classification of Soils

The soils of Wabasha County will be easier to understand if we first consider how they formed and then classify them into large groups that have certain characteristics in common. Facts about the formation of the soils

seletced characteristics that affect engineering practices—Continued

Soil features affecting engineering practices—Continued						Limitations for septic tank fields
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	
Reservoir area	Embankment [3]					
Poor because of underlying bedrock; bedrock subject to formation of sinkholes.	Limited amount of material; clay residuum makes impervious embankment when used as borrow material.	Not needed; well drained.	Shallow phases have low water-holding capacity.	Not suitable, because bedrock is near the surface.	Difficult to establish sod on clay residuum; excavation should not be too deep.	Severe because the soils are shallow over limestone that contains solution channels and caverns.
Highly permeable.	Highly permeable; may be used for pervious shells for dams; good compaction characteristics; slight compressibility.	Not needed; excessively drained.	Low water-holding capacity and rapid intake rate require frequent application of water.	Not suitable; too shallow over gravel.	Shallow over gravel; difficult to establish sod; low-water-holding capacity; low fertility.	Slight; very permeable.
Piping hazard; highly permeable.	Piping hazard; highly permeable when compacted.	Not needed; drainage adequate.	Must be protected from flooding.	Not needed; flat.	Not needed.	Severe; possibility of flooding and high water table.
Good to fair resistance to piping; low permeability.	Good to poor bearing value; clay fairly stable; good for impervious cores and blankets; good to fair resistance to piping; fair to good compaction characteristics.	Needed; evaluate the compact clay layer carefully; results of tile drainage vary.	Irrigation limited by clay subsoil and substratum; drainage needed.	Slow permeability of clay limits intake of water; not suitable.	Drain before constructing waterway.	Severe; clay has slow permeability.

[3] Refers to the underlying material or substratum, unless otherwise specified.

[4] The underlying sandstone may be suitable for plaster.

and a discussion of the different soil groups are given in the following pages.

Formation of Soils

The characteristics of the soils in any particular place are determined by (1) the physical and mineralogical composition of the parent material, (2) the length of time the forces of development have acted on the material, (3) the relief, or lay of the land, and the drainage that results from it, (4) the plant and animal life on and in the soil, and (5) the climate under which the soil material has accumulated and has existed since accumulation. These five factors of soil formation are interdependent, and each modifies the effects of the other.

Parent material

Many of the soils of Wabasha County formed in deposits laid down by wind (loess) or in glacial till. Some of them, however, formed in material weathered from limestone or sandstone, and some formed in relatively recent alluvium or colluvium. The differences in parent

material account for many of the differences between soil series. In the following paragraphs the different kinds of parent material are described.

Loess.—This material consists largely of silty sediments that have been transported to their present location by wind. An extensive mantle of this windblown material was deposited during the Iowan and Cary glaciations, or after them, in the Peorian interglacial stage. Most of the loess was blown from the mud flats that were created when melt water flowed from the receding glaciers. The loess accumulated mainly in areas of rough topography, where vegetation was established in places. The Fayette, Downs, and Port Byron soils formed mainly in loess.

The mantle of loess that covers the uplands and valley slopes ranges from a few inches to more than 20 feet in thickness. From 70 to 85 percent of the unweathered loess is silt, but part of it is very fine sand or clay. Near the edges of areas covered by loess, near the major streams, and in scattered islands of loess, this windblown material contains less silt and more very fine sand than in other areas. The original loess was calcareous, but the coarser textured loess is now leached to a depth of 4 to 4½ feet, and the finer textured loess is leached to a depth of 5½ to 6 feet.

In a recent study of the depth of loess in this county, borings were made on ridgetops where erosion or accumulation would have had little or no effect. As a result of these borings, it was found that the loess is more than 200 inches deep on the ridgetops adjoining the Zumbro River. On the ridges above the Mississippi River, it is 100 to 200 inches deep; on the broad ridges in Chester, Gillford, and Mount Pleasant Townships, it is 50 to 100 inches deep; and on the slopes it is 9 to more than 200 inches deep.

Glacial till.—Two glaciers, the Kansan and the Iowan, entered the area that is now Wabasha County. The Kansan glacier covered all of the county, but the Iowan probably covered only the western side. Deposits of glacial drift of Kansan or of Iowan age are exposed in the western part of the county and in isolated spots in other areas. The depth of these deposits ranges from a few inches in the eastern part of the county to 50 to 70 feet in the western part. Some material of preglacial (Cretaceous) age outcrops near Bellechester and in Mazeppa and Zumbro Townships.

All of the glacial till was calcareous at the time it was deposited. The carbonates have now leached out to a depth of at least 3½ feet, and in most places to a depth of 6 feet or more. The texture of the glacial till is generally clay loam to loam. Slack water clays were deposited, however, along East Indian, Snake, Miller, and Gilbert Creeks, which are minor tributaries of the Mississippi River. During the time when the greatest amount of melt water flowed from the glaciers, coarse-textured sediments were also deposited. As a result, lenses and pockets of sand and gravel are now common in the finer textured till. In the period following the time when the coarse-textured sediments were deposited, considerable medium-textured material, probably of local origin, was deposited over the sand and gravel.

In large areas east of Mazeppa, medium-textured till that is 2 to 4 feet thick is underlain by gravelly drift. In that area a complex of Renova and Wykoff soils is mapped. In some areas of medium-textured till, there is a silt cap 5 to 18 inches thick over the till. In those areas a complex of Fayette and Renova soils is mapped.

The valleys of the Zumbro and Mississippi Rivers were outlets for melt water from the Cary Keewatin, Cary Patrician, and Mankato substages of the Wisconsin glacier. The terraces along the Zumbro, Mississippi, and Whitewater Rivers and along their tributaries formed from deposits left by the melt water from the retreating glaciers.

The melt water that flowed through the valley of the Zumbro River came from the Cary Keewatin and Mankato substages of the Wisconsin glacier. This melt water carried gray, calcareous sediments. The melt water that flowed through the valley of the Mississippi River carried material from all three substages. The water that flowed through the valleys of the Minnesota and Mississippi Rivers, above the present site of St. Paul, carried sediments from the Mankato and Cary Keewatin substages and left calcareous, gray alluvial deposits. The melt water that entered the Mississippi River below St. Paul, from the St. Croix, Chippewa, and other rivers of northwestern Wisconsin, carried sediments from the Cary Patrician substage and left acid alluvial deposits that were redder than those from the area above St. Paul.

The Burkhardt soils developed over sediments from the Cary Patrician substage. The Waukegan soils developed mainly over sediments from the Cary Keewatin and Mankato substages.

Bedrock.—The parent material of some of the soils in the county weathered from bedrock or consists partly of material weathered from bedrock. The Dodgeville, Dubuque, Sogn, and Whalan soils, for example, are underlain by limestone bedrock, and those soils formed partly or entirely in material weathered from limestone. In the Dodgeville and Dubuque soils, the profile developed mainly in loess and only partly in material weathered from limestone. In the Whalan soils, the profile developed mainly in loess and glacial till and partly in material weathered from limestone. In all of these soils, the horizon of reddish clay just above the bedrock consists of material weathered from limestone. The Sogn soils have no subsoil or clayey horizon, and their surface layer rests directly on fragmented limestone bedrock. The Dodgeville soils are underlain by Shakopee limestone; the Dubuque and Whalan soils, by Oneota dolomitic limestone; and the Sogn soils, in most places, by Platteville limestone.

Several soils formed wholly or in part from material weathered from sandstone. The Boone and Chelsea soils, for example, formed in material weathered from St. Peter, New Richmond, or Jordan sandstone. The Gale, Hixton, Lindstrom, and the valley phases of the Fayette soils formed in a mixture of loess and material weathered from sandstone. The Gale and Hixton soils are underlain by St. Peter, New Richmond, and Jordan sandstone. The Lindstrom soils and the valley phases of the Fayette soils are on valley slopes below outcrops of Jordan sandstone. They receive some wash or colluvial material from the Jordan sandstone, but they formed primarily in loess. Additional facts about the formations that underlie the county are given in the section "Underlying Rocks."

Alluvium and colluvium.—The soils of bottom lands are made up principally of recent alluvium. Their texture ranges from clay to sand, and their color, from light to dark. In reaction, they are neutral to slightly calcareous. The soils of stream terraces formed in older alluvium deposited during glacial times. The alluvium brought down from the northeast is redder and less grayish than that from the west and northwest. It is also more acid and less calcareous. Examples of soils formed in alluvium are the Huntsville and Genesee. The soils of two series, the Chaseburg and Judson, formed from both colluvial and alluvial sediments. These soils are mostly silts, but they include some fine sandy loams. In reaction they are slightly acid to mildly calcareous.

Time

The oldest soils in the county developed in glacial till. The oldest glacial tills in the county are from the Kansan and Nebraskan glaciations. Above these tills is Iowan till left about 24,000 years ago during the Iowan glaciation. None of the present-day soils formed in the buried Kansan and Nebraskan tills. The soils formed in Iowan till and the soils formed in loess are of about the same age.

The Cary Keewatin, Cary Patrician, and Mankato substages of the Wisconsin glaciation occurred about 12,000 to 15,000 years ago, and the terraces along the rivers formed in deposits from their melt waters. Thus, this material is younger than the normal loess and glacial till in the county. Some of the coarser textured loess may be of the same age as these terraces.

The youngest parent material in the county is the alluvial material on bottom lands and in waterways. In those places new deposits of alluvium are left by every flood. After heavy rains, overwash covers some soils of uplands. Little or no profile development has taken place in this overwash or in the alluvial material left on the bottom lands and in waterways.

The Fayette and Renova soils are probably among the oldest soils in the county. The Burkhardt and Waukegan are of intermediate age, and the Huntsville and Genesee are among the youngest soils.

Relief and drainage

Relief and drainage are important factors in the development of soils. Maximum profile development takes place in well-drained, gently sloping soils. Little or no profile development takes place in depressions or in nearly level areas where there is a permanent high water table. Profile development is also slow on steep slopes where runoff is rapid and where infiltration of water is slow. In such areas geologic erosion removes the soil material almost as fast as it is deposited. The soil material is deeper and contains more organic matter in areas favorable for the growth of prairie grasses than in areas where the growth of forest is favored.

In this county the soils that have the most highly developed profiles are the Fayette, Renova, Racine, Downs, Mt. Carroll, and Port Byron. These soils are gently sloping to moderately sloping.

The Garwin soils, in wet drainageways, show little profile development. The Sogn soils have no visible development of a subsoil. Their surface layer immediately overlies the parent material. The Sogn soils are steep and are subject to erosion.

Plant and animal life

Plants and animals are active in the soil-forming processes. The nature of the changes they bring about depends, among other things, upon the kind of life and life processes peculiar to the dominant species present. The kinds of plants and animals that live on and in the soil are affected, in turn, by the climate, the parent material, relief, and age of the soil, and by other living organisms.

Most of Wabasha County is in the southern part of the Minnesota Big Woods area. At the time the county was settled, much of it was forested, but tall prairie grasses flourished in the townships of Plainview, Elgin, Highland, and Oakwood (fig. 17). There were small tracts of prairie in the forested areas. Along the Mississippi River a large, sandy area, too droughty to support trees continuously, had a cover of prairie grasses. This area is now known as Sand Prairie.

The two types of vegetation, forest and prairie, have strongly influenced the development of the soils in this county. The boundaries between prairie and forest have shifted back and forth. Therefore, many of the soils in the prairie and brush prairie areas developed partly under prairie vegetation and partly under forest. They are lighter colored and have less development in the profile than typical soils of the Brunizem great soil group. They have characteristics both of Brunizems and of Gray-Brown Podzolic soils.

The surface layer of soils that have formed partly under prairie vegetation and partly under forest is moderately dark because of the influence of prairie grasses. The subsurface layer, however, is a gray, podzolized horizon characteristic of forest soils. This podzolized horizon is thinner in the area known as brush prairie than in border areas of aspen-oak land and aspen-birch hardwoods. It is thickest in the areas of aspen-birch hardwoods and in the Big Woods areas. The soils that have this podzolized horizon are true forest soils, and they belong to the Gray-Brown Podzolic great soil group.

The Port Byron soils are examples of soils developed under prairie grasses, and the Fayette are examples of soils developed under forest. The Downs and Mt. Carroll soils developed both under prairie and under forest.

Climate

Climate, as a genetic factor, affects the physical, chemical, and biological relationships in the soil profile, primarily through the influence of precipitation and temperature. Water dissolves minerals, supports biological activity, and transports mineral and organic residues through the soil profile. The amount of water that percolates through the soil at a given point depends upon the amount and intensity of rainfall, relative humidity, length of the frost-free period, soil permeability, and physiographic position. Temperature influences the kinds and growth of organisms and the speed of physical and chemical reactions in the soils.

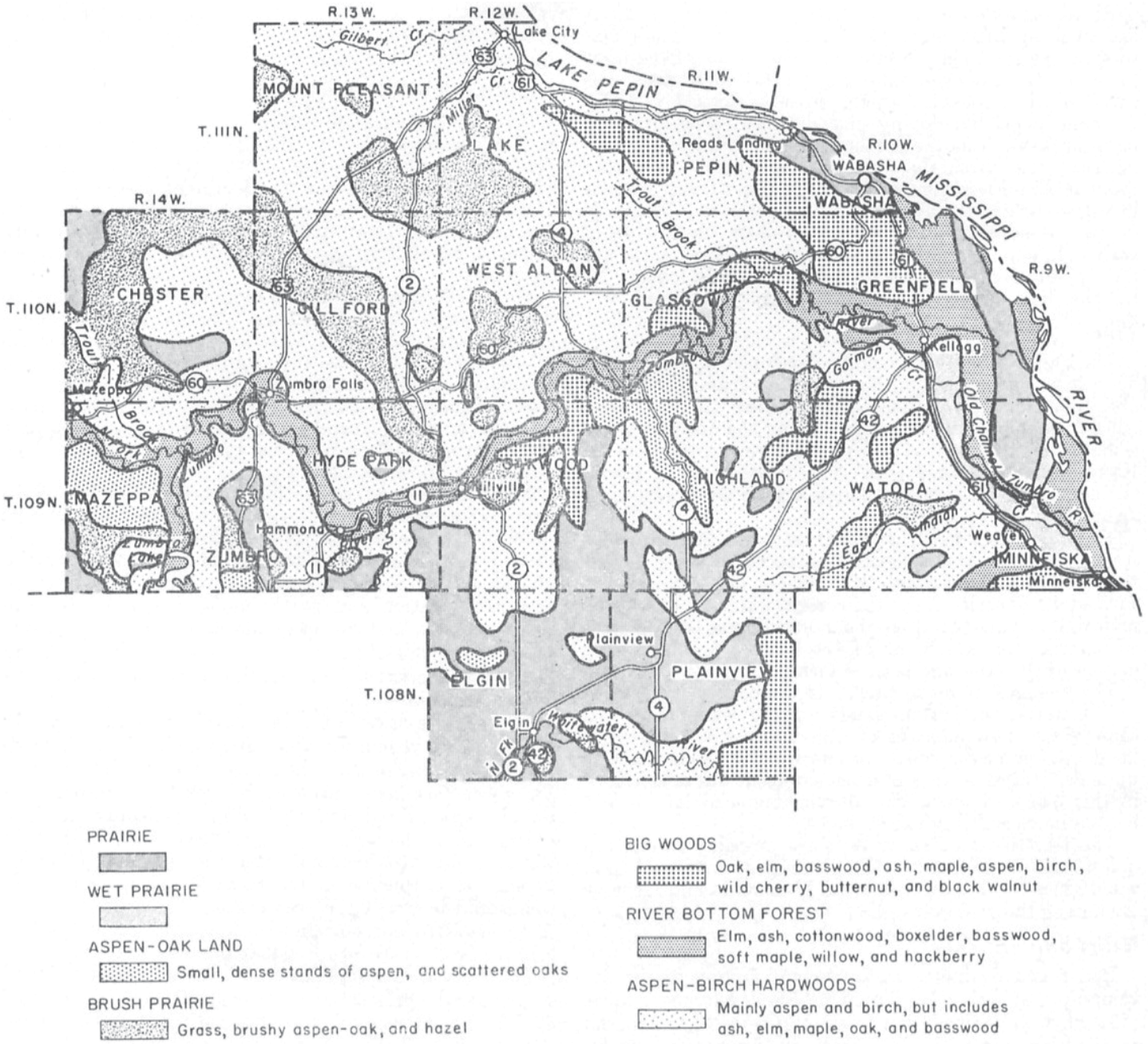

Figure 17.—**Original vegetation in Wabasha County.**

Classification of Soils

The broadest groups of soil classification are the three orders—zonal, intrazonal, and azonal (*11*). Zonal soils are those that strongly reflect the influence of vegetation and climate. Intrazonal soils have distinct horizons, but their dominant characteristics are those that depend on the nature of the parent material or on the drainage, rather than on vegetation or climate. Azonal soils are those that are so young or so steep or are developing in such resistant material that little progress in soil formation has been made.

Within the soil orders are the great soil groups. A great soil group is made up of soils that have generally similar profiles. The soil series are divisions within the great soil groups. All of the soils in one series are similar in all profile characteristics, except the texture of the surface layer.

In the following pages the great soil groups in the county and the principal intergrades are defined, and a typical profile is described for each series in the group. The classification of the soil series by orders and great soil groups is shown in table 8. For each series, the soil-forming factors of parent material, native vegetation, relief, and drainage are also shown. The factors of time and climate are not shown in the table, because in this county they are less important than other factors in causing differences among soil series.

TABLE 8.—*Classification of the soil series by great soil groups, and some factors that have contributed to development of the soils*

ZONAL SOILS

Great soil group and series	Parent material	Native vegetation	Topography			
			Position on landscape	Dominant relief	Range in slope	Natural drainage
Brunizems:						
Burkhardt	Glacial outwash or alluvium.	Prairie grasses	Outwash plains or stream terraces.	Level or nearly level.	Nearly level to moderately sloping.	Excessive.
Dodgeville	Thin silt cap over material weathered from limestone.	Prairie grasses	Uplands	Strongly sloping	Gently sloping to steep.	Good.
Lindstrom	Loess-covered talus.	Prairie grasses	Valley slopes of uplands.	Moderately to strongly sloping.	Gently sloping to steep.	Good.
Muscatine	Loess	Grasses that tolerate water.	Uplands	Nearly level	Nearly level to gently sloping.	Moderately good to somewhat poor.
Port Byron	Loess	Prairie grasses	Uplands	Gently sloping	Nearly level to moderately sloping.	Good.
Waukegan	Silty deposits over sandy and gravelly outwash.	Prairie grasses	Outwash plains or stream terraces.	Nearly level	Nearly level to moderately sloping.	Good.
Brunizems intergrading toward Alluvial soils:						
Judson	Recent alluvium and colluvium in waterways and on alluvial fans.	Grasses	Uplands	Nearly level	Nearly level to gently sloping.	Moderately good.
Gray-Brown Podzolic soils:						
Bixby	Medium-textured alluvial deposits over stratified sand and fine gravel.	Deciduous forest.	Outwash plains or stream terraces.	Nearly level	Nearly level to gently sloping.	Good to somewhat excessive.
Dubuque	Thin deposit of loess over material weathered from limestone.	Deciduous forest.	Uplands	Moderately to strongly sloping.	Gently sloping to steep.	Good.
Fayette	Loess	Deciduous forest.	Uplands, high stream terraces, and valley slopes.	Gently to moderately sloping.	Nearly level to steep.	Good.
Gale	Loess over material weathered from sandstone.	Deciduous forest.	Uplands and valley slopes.	Moderately sloping.	Gently sloping to strongly sloping.	Good.
Hixton	Material weathered from fine-grained sandstone.	Deciduous forest.	Uplands	Moderately sloping.	Gently sloping to steep.	Good to somewhat excessive.
Medary, brown variant.	Slack water deposits of silt and clay.	Deciduous forest.	High stream terraces.	Gently sloping	Nearly level to gently sloping.	Moderately good.
Meridian	Sandy alluvial deposits over stratified sand and fine gravel.	Deciduous forest.	Outwash plains or stream terraces.	Nearly level	Nearly level to strongly sloping.	Good to somewhat. excessive.
Renova	Thin silt cap over Iowan glacial till.	Deciduous forest.	Uplands	Moderately to strongly sloping.	Gently sloping to steep.	Good.
Seaton	Coarse-textured loess.	Deciduous forest.	Uplands	Strongly sloping	Moderately sloping to steep.	Good.

TABLE 8.—*Classification of the soil series by great soil groups, and some factors that have contributed to development of the soils*—Continued

ZONAL SOILS

Great soil group and series	Parent material	Native vegetation	Topography			
			Position on landscape	Dominant relief	Range in slope	Natural drainage
Gray-Brown Podzolic soils—Con.						
Tell	Silty alluvial deposits over sandy and gravelly outwash.	Deciduous forest.	Stream terraces	Nearly level	Nearly level to gently sloping.	Good.
Whalan	Iowan glacial till over limestone; in some places the till is covered by a thin layer of silt.	Deciduous forest.	Uplands	Strongly sloping	Gently sloping to steep.	Good.
Wykoff	Coarse-textured Iowan till.	Deciduous forest.	Uplands	Moderately to strongly sloping.	Gently sloping to steep.	Somewhat excessive.
Gray-Brown Podzolic soils intergrading toward Regosols:						
Chelsea	Wind-deposited sand.	Dedicuous forest.	Uplands	Moderately sloping.	Gently sloping to strongly sloping.	Excessive.
Gray-Brown Podzolic soils intergrading toward Brunizems:						
Downs	Loess	Transitional from prairie grasses to deciduous forest.	Uplands	Gently sloping	Nearly level to strongly sloping.	Good.
Mt. Carroll	Loess	Transitional from prairie grasses to deciduous forest.	Uplands	Gently sloping	Nearly level to strongly sloping.	Good.
Racine	Thin silt cap over Iowan glacial till.	Transitional from prairie grasses to deciduous forest.	Uplands	Moderately sloping.	Nearly level to strongly sloping.	Good.

INTRAZONAL SOILS

Humic Gley soils: Garwin	Loess	Grasses that tolerate water.	Uplands	Nearly level	Nearly level	Very poor.
Humic Gley soils intergrading toward Alluvial soils: Colo	Recent alluvium	Grasses	Bottom lands	Level or nearly level.	Level or nearly level.	Somewhat poor to poor
Planosols: Zwingle	Slack water deposits of silt and clay.	Deciduous forest.	High stream terraces.	Nearly level	Nearly level to gently sloping.	Somewhat poor to poor

TABLE 8.—*Classification of the soil series by great soil groups, and some factors that have contributed to development of the soils*—Continued

AZONAL SOILS

Great soil group and series	Parent material	Native vegetation	Topography			
			Position on landscape	Dominant relief	Range in slope	Natural drainage
Alluvial soils:						
Arenzville	Recent alluvium	Grasses and forest.	Bottom lands	Level or nearly level.	Level or nearly level.	Moderately good.
Chaseburg	Recent alluvium and colluvium in waterways and alluvial fans.	Deciduous forest.	Uplands	Gently sloping	Nearly level to gently sloping.	Moderately good.
Genesee	Recent alluvium	Deciduous forest.	Bottom lands	Level or nearly level.	Level or nearly level.	Good to moderately good.
Huntsville	Recent alluvium	Grasses	Bottom lands	Level or nearly level.	Level or nearly level.	Good to moderately good.
Minneiska	Recent silty alluvium over sandy alluvium.	Grasses and forest.	Bottom lands	Level or nearly level.	Level or nearly level.	Moderately good.
Osseo	Recent alluvium	Deciduous forest.	Bottom lands	Level or nearly level.	Level or nearly level.	Somewhat poor to poor.
Zumbro	Recent sandy alluvium.	Grasses and forest.	Bottom lands	Level or nearly level.	Level or nearly level.	Moderately good to somewhat poor.
Lithosols:						
Sogn	Very thin loess or till over material weathered from limestone.	Prairie grasses	Uplands	Strongly sloping	Gently sloping to steep.	Somewhat excessive.
Regosols:						
Bold	Loess	Deciduous forest.	Uplands	Moderately steep	Strongly sloping to steep.	Good.
Boone	Material weathered from sandstone.	Deciduous forest.	Uplands	Steep	Gently sloping to steep.	Excessive.
Plainfield	Outwash sand	Oaks	Outwash plains or stream terraces.	Gently sloping	Nearly level to moderately sloping.	Excessive.
Regosols intergrading toward Brunizems:						
Sparta	Outwash sand	Sparse grasses	Outwash plains or stream terraces.	Nearly level	Nearly level to gently sloping.	Excessive.

Brunizems

The Brunizems are zonal soils that developed under tall grasses in a relatively humid climate. These soils have a very dark brown to black A1 horizon. The soil material below the surface layer grades through a brown and yellowish-brown subsoil to lighter colored parent material, at a depth of 2½ to 5 feet. Normally, calcium carbonate has not accumulated in any part of the profile.

In Wabasha County the Burkhardt, Dodgeville, Lindstrom, Muscatine, Port Byron, and Waukegan soils are in the Brunizem great soil group. The Judson soils are also in that group, but they have some characteristics of Alluvial soils.

BURKHARDT SERIES

The Burkhardt series consists of dark-colored, excessively drained Brunizems that are shallow over gravel. The soils are nearly level to moderately sloping and are on stream terraces. The finer textured material above the gravel is 10 to 24 inches thick.

The Burkhardt soils are shallower over gravel and sand than the Waukegan soils. Their B horizon is finer textured than that of the Sparta soils. The Burkhardt loams have moderately rapid permeability, and the sandy loams and gravelly sandy loams have rapid permeability. The natural fertility and available moisture capacity are low to very low. The following describes two profiles of soils that are typical of the Burkhardt series.

Representative profile of a Burkhardt loam in a gravel pit on the western side of the city of Wabasha (NW¼ NW¼ sec. 32, T. 111 N., R. 10 W.):

A1—0 to 9 inches, black (10YR 2/1) loam; weak to moderate, fine, granular structure; friable; medium acid; abrupt, smooth boundary.

A3—9 to 14 inches, very dark brown (10YR 2/2) loam that contains some fine gravel; weak to moderate, medium, subangular blocky structure; friable; strongly acid; clear, wavy boundary.

B2—14 to 24 inches, dark reddish-brown (5YR 3/3) gravelly loam; weak, medium, subangular blocky structure; friable to firm; strongly acid; abrupt, smooth boundary.

C—24 to 100 inches +, dark yellowish-brown (10YR 4/4) and dark-brown (7.5YR 4/4) sand and gravel; single grain; loose; strongly acid; the sand is mildly alkaline at a depth of 8 feet.

Range in characteristics.—The surface layer ranges from 5 to 10 inches in thickness and is medium acid to neutral. The subsoil ranges from 8 to 15 inches in thickness and is very strongly acid to slightly acid.

Representative profile of a Burkhardt gravelly sandy loam (slope between 10 and 12 percent) in a cultivated field near U.S. Highway No. 61 (NE¼SE¼ sec. 4, T. 110 N., R. 10 W.):

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

B2—5 to 9 inches, dark-brown (10YR 3/3) gravelly sandy loam; weak, very fine, subangular blocky structure; friable; medium acid; clear, wavy boundary.

B3—9 to 13 inches, dark-brown (10YR 3/3) to dark yellowish-brown (10YR 3/4) gravelly loamy sand; structureless; loose; medium acid; clear, wavy boundary.

C—13 to 100 inches +, dark yellowish-brown (7.5YR 4/4) stratified sand and gravel; structureless; loose; medium acid.

Range in characteristics.—The surface layer ranges from 3 to 6 inches in thickness. Pebbles in this layer and in the subsoil are as large as 3 inches in diameter and make up more than 50 percent of the soil mass. The underlying material is less gravelly, and the pebbles are smaller. Some profiles are more acid than the one described as representative of the series.

DODGEVILLE SERIES

The Dodgeville series consists of well-drained Brunizems that are moderately deep. These soils developed under prairie vegetation in a thin mantle of loess over limestone. Limestone bedrock or reddish, brownish, or yellowish clay weathered from limestone is at a depth ranging from 24 to 42 inches. The slopes range from gentle to steep.

The Dodgeville soils are dark colored, but they are similar in other respects to the Dubuque soils. They are not so deep over limestone as the Port Byron, Downs, and Mt. Carroll soils.

The Dodgeville soils are moderately permeable. They have moderate to moderately low available moisture capacity. Their natural fertility is moderate.

Representative profile of a Dodgeville silt loam, 13 percent slope, in a pasture (SW¼SE¼NE¼ sec. 4, T. 108 N., R. 11 W.):

A1—0 to 5 inches, very dark brown (10YR 2/2) silt loam; moderate, medium, granular and platy structure; very friable; slightly acid; clear, smooth boundary.

A12—5 to 10 inches, very dark brown (10YR 2/2) silt loam streaked with dark brown (10YR 3/3); weak to moderate, very fine and fine, angular blocky structure, or weak to moderate, medium, granular structure; very friable; medium acid; abrupt, wavy boundary.

A3—10 to 13 inches, very dark grayish-brown (10YR 3/2) and dark-brown (10YR 3/3) silt loam; weak to moderate, very fine and fine, angular blocky structure; friable; medium acid; abrupt, wavy boundary.

B21—13 to 28 inches, brown to dark-brown (10YR 4/3), heavy silt loam; weak to moderate, fine, subangular blocky structure; friable; medium acid; clear, wavy boundary.

B22—28 to 32 inches, brown to dark-brown (10YR 4/3), heavy silt loam; moderate, medium, subangular blocky structure; friable; strongly acid; abrupt, wavy boundary.

IIC—32 to 34 inches, brown to dark-brown (10YR 4/3) silty clay loam and very pale brown (10YR 7/4) pulverized limestone; weak, coarse, subangular blocky structure to massive (structureless); firm; slightly acid; abrupt, wavy boundary.

R—34 inches +, limestone bedrock.

Range in characteristics.—The thickness of the combined A horizons ranges from 8 to 13 inches. Depth to bedrock ranges from 24 to 42 inches. In places the IIC horizon is absent, and in other places it is several inches thicker than shown in the representative profile. The profile of the shallow phases of Dodgeville soils is similar to that of the normal Dodgeville soils, except that the depth to bedrock is only 10 to 24 inches.

JUDSON SERIES

The Judson series consists of well drained to moderately well drained Brunizems intergrading toward Alluvial soils. These soils developed in colluvial and alluvial materials, largely from loess. They are at the base of upland slopes, in upland drainageways, and on alluvial fans.

The Judson soils are closely associated with the well-drained Port Byron, Downs, and Mt. Carroll soils. In places profiles of these associated soils are buried beneath the profile of the Judson soil. The Judson soils are dark colored, rather than light colored like the Chaseburg soils.

Representative profile of a Judson silt loam in a pasture north of State Highway No. 42 (SW¼SE¼NE¼ sec. 4, T. 108 N., R. 11 W.):

A1—0 to 35 inches, very dark brown (10YR 2/2) silt loam; weak to moderate, thin, platy structure; friable; very thin streaks or lenses of very dark grayish-brown fine sand; medium acid; abrupt, smooth boundary.

A1b—35 to 45 inches, black (10YR 2/1) silt loam; weak, fine, granular structure; friable; medium acid; clear, smooth boundary.

A3b—45 to 49 inches, very dark grayish-brown (10YR 3/2) and very dark brown (10YR 2/2) silt loam; weak to moderate, very fine, angular blocky structure; friable; medium acid; abrupt, smooth boundary.

B21b—49 to 57 inches, dark-brown (10YR 3/3) to dark grayish-brown (10YR 4/2) silt loam; moderate, fine, subangular blocky structure; friable; slightly sticky when wet; medium acid; abrupt, wavy boundary.

B22b—57 to 68 inches, dark grayish-brown (10YR 4/2) silt loam with some very dark grayish-brown (10YR 3/2) streaks of organic matter; moderate, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

Cb—68 to 72 inches +, dark grayish-brown (10YR 4/2) silt loam with a few, fine, faint mottles of grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/4)

and some very dark grayish-brown (10YR 3/2) streaks of organic matter; massive (structureless); friable; strongly acid.

Range in characteristics.—The depth to a buried soil ranges from 24 to 72 inches or more. In places the color of the surface layer is black instead of very dark brown.

LINDSTROM SERIES

The Lindstrom series consists of Brunizems that developed in talus material from dark-colored loessal soils. Glacial material and material weathered from sandstone or limestone is present in the lower part of the profile. The soils are on the lower part of slopes where colluvial material collects.

The Lindstrom soils are steeper than the Judson soils, and their dark A1 horizon is thinner. Their A1 horizon is thicker than that of the Port Byron, Downs, and Mt. Carroll soils. In many places it is as much as 18 to 24 inches thick.

Representative profile of a Lindstrom silt loam, 18 to 25 percent slopes, in a road cut on the north side of a road in a wooded area of oak, aspen, and basswood (east side of NW¼SE¼ sec. 8, T. 109 N., R. 10 W.):

A1—0 to 10 inches, black (10YR 2/1) to very dark brown (10YR 2/2) silt loam; moderate, very fine, subangular blocky structure; very friable; abundant fibrous and woody roots; medium acid; abrupt, wavy boundary.

A3—10 to 15 inches, very dark gray (10YR 3/1) to very dark brown (10YR 2/2) silt loam; moderate to strong, very fine, subangular blocky structure; very friable; abundant fibrous and woody roots; slightly acid to medium acid; abrupt, wavy boundary.

B1—15 to 26 inches, very dark grayish-brown (10YR 3/2) to dark-brown (10YR 3/3), heavy silt loam; moderate to strong, fine, subangular blocky structure; friable; many woody roots; medium acid; abrupt, wavy boundary.

B21—26 to 42 inches, brown (10YR 4/3) to dark yellowish-brown (10YR 4/4) silt loam; moderate, medium, subangular blocky structure; friable; structural blocks coated with dark-brown (10YR 3/3) material; medium acid; abrupt, wavy boundary.

B22—42 to 48 inches, dark yellowish-brown (10YR 4/4) silt loam; moderate, medium, subangular blocky structure; friable; structural blocks coated with dark-brown (10YR 3/3) materials; many woody roots; medium acid; abrupt, wavy boundary.

C1—48 to 60 inches, brown (10YR 4/3) to yellowish-brown (10YR 5/4) silt loam; massive (structureless); friable; some fragments of sandstone; slightly acid; abrupt, wavy boundary.

C2—60 to 84 inches +, yellowish-brown (10YR 5/4 to 10YR 5/6) coarse silt loam to very fine sandy loam; massive (structureless); very friable; some fragments of sandstone; slightly acid.

Range in characteristics.—The thickness of the combined A horizons ranges from 12 to 24 inches. Some profiles show the influence of a forest cover in that they have a thin A2 horizon that is lighter colored than the A1. Normally, the structure of the surface layer is less strongly developed than that shown in the representative profile.

MUSCATINE SERIES

The Muscatine series consists of somewhat poorly drained Brunizems that developed under prairie grasses in deep, neutral to slightly acid loess. These soils are in the heads of upland drainageways. They are nearly level to gently sloping.

The Muscatine soils are better drained than the very poorly drained Garwin soils. They are associated with the well-drained Port Byron, Downs, and Mt. Carroll soils.

The Muscatine soils have moderate to moderately slow permeability. They have high natural fertility and high available moisture capacity. Normally, the surface layer is slightly acid to neutral, and the subsoil is medium acid.

Representative profile of a Muscatine silt loam in a pasture where the slope is 2 percent (NE¼NW¼ sec. 18, T. 110 N., R. 14 W.):

Ap—0 to 8 inches, black (10YR 2/1) silt loam; weak, thin, platy structure; friable; slightly acid; gradual boundary.

A12—8 to 13 inches, black (10YR 2/1) silt loam; moderate fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B1—13 to 19 inches, very dark grayish-brown (2.5Y 3/2), heavy silt loam; moderate, very fine, subangular blocky structure; friable when moist, slightly plastic when wet; medium acid; clear, wavy boundary.

B2—19 to 32 inches, dark grayish-brown (2.5Y 4/2) and very dark grayish-brown (2.5Y 3/2), heavy silt loam; many, medium, distinct mottles of yellowish brown (10YR 5/6 and 10YR 5/8); moderate, medium, subangular blocky structure that breaks to moderate, very fine, subangular blocky; friable when moist, slightly plastic when wet; shows some vertical cleavage and very dark grayish-brown (10YR 3/2) coatings; many, fine, iron or manganese concretions; medium acid; clear, wavy boundary.

C—32 to 40 inches +, grayish-brown (2.5Y 5/2) silt loam; many, medium, distinct mottles of yellowish brown (10YR 5/8); massive; friable; slightly acid.

Range in characteristics.—The combined A horizons range from 12 to 20 inches in thickness. The color of the surface layer is somewhat lighter in areas where the Muscatine soils are associated with the Fayette soils than in other areas. During wet seasons the water table is in the lower part of the B horizon. Glacial till, limestone, or material weathered from limestone are at a depth of about 5 feet. These soils range from slightly acid to medium acid throughout the profile. The C horizon is clay loam in some areas where this soil is underlain by glacial till.

PORT BYRON SERIES

The Port Byron series consists of dark-colored, well-drained Brunizems that developed in deep, coarse-textured loess. The soils are nearly level to moderately sloping and are on broad ridges in the uplands. In most places the loess is 6 to 8 feet thick. It is underlain by loam or clay loam glacial till, by sandstone, by material weathered from sandstone, or by limestone bedrock. The original vegetation was tall prairie grasses.

The Port Byron soils are associated with the moderately dark colored Mt. Carroll soils. They are also associated with the Judson soils, but they have a much thinner surface layer than those soils and are on ridges rather than in drainageways.

Representative profile of Port Byron silt loam, 2 to 6 percent slopes, moderately eroded, in a pasture where the slope is 5 percent (SW¼SW¼ sec. 13, T. 108 N., R. 12 W.):

Ap—0 to 7 inches, very dark brown (10YR 2/2) silt loam; moderate, fine, granular structure; friable; abundant fibrous roots; slightly acid; abrupt, wavy boundary.

AB—7 to 11 inches, very dark grayish-brown (10YR 3/2) to dark-brown (10YR 3/3) silt loam; moderate, very fine, angular blocky and moderate, fine, granular structure; friable; abundant fibrous roots; medium acid; abrupt, smooth boundary.

B21—11 to 20 inches, dark yellowish-brown (10YR 3/4) silt loam; weak, coarse, subangular blocky structure that breaks to weak, fine, subangular blocky and moderate, fine, granular structure; friable; abundant fibrous roots; strongly acid; abrupt, wavy boundary.

B22—20 to 30 inches, dark-brown to brown (10YR 4/3) silt loam; moderate to strong, fine and medium, angular blocky structure; friable; strongly acid; abrupt, wavy boundary.

B3—30 to 39 inches, dark yellowish-brown (10YR 4/4) silt loam; moderate, medium and coarse, angular blocky structure; friable; strongly acid; abrupt, wavy boundary.

C—39 to 60 inches +, dark yellowish-brown (10YR 4/4) coarse silt loam; massive (structureless); friable; strongly acid.

Range in characteristics.—The surface layer is normally 10 to 11 inches thick in areas that are not eroded. The thickness of the subsoil ranges from 20 to 28 inches. In places the subsoil has strong structure, but normally the structure is not stronger than moderate.

WAUKEGAN SERIES

The Waukegan series consists of well-drained Brunizems developed under prairie vegetation. These soils formed in medium-textured material over a mixture of loose outwash sand and gravel at a depth of 24 to 42 inches. These soils are on high stream terraces.

The Waukegan soils are associated with the bench phases of the Fayette soils and with the Downs, Mt. Carroll, and Port Byron soils. They are also the dark-colored associates of the light-colored Tell soils.

Representative profile of Waukegan silt loam, 0 to 2 percent slopes, in a cultivated field where the slope is 1 percent (SE¼SW¼ sec. 33, T. 111 N., R. 10 W.):

Ap—0 to 7 inches, very dark brown (10YR 2/2) silt loam; cloddy, but breaks to weak, fine, granular structure; friable; medium acid; abrupt, smooth boundary.

A1—7 to 11 inches, very dark brown (10YR 2/2) silt loam; weak, very fine and fine, angular blocky and subangular blocky structure; friable; in places peds have black coatings or stains; medium acid; clear, wavy boundary.

A3—11 to 19 inches, very dark grayish-brown (10YR 3/2) silt loam; weak to moderate, fine and medium, subangular blocky structure that breaks to weak, very fine, subangular blocky structure; friable; some earthworm activity that has caused very dark brown (10YR 2/2) streaks; medium acid; clear, wavy boundary.

B21—19 to 24 inches, very dark grayish-brown (10YR 3/2), mixed with dark-brown (10YR 4/3), heavy silt loam; weak, medium, subangular blocky structure that breaks to weak, very fine, subangular blocky structure; friable; medium acid; abrupt, wavy boundary.

B22—24 to 34 inches, brown to dark-brown (10YR 4/3), heavy silt loam to light silty clay loam; weak, medium, subangular blocky structure; friable to firm; worm casts of very dark grayish brown (10YR 3/2); strongly acid; abrupt, smooth boundary.

B3—34 to 47 inches, brown to dark-brown (10YR 4/3) gravelly sandy loam; single grain or massive (structureless); slightly hard and somewhat cemented when dry, but softens and is slightly sticky when wet; medium acid; clear, wavy boundary.

C—47 to 70 inches +, brown to dark-brown (10YR 4/3) gravel and small stones; single grain (structureless); loose; content of coarse fragments is 15 to 20 percent, and the diameter of the fragments ranges from 1 to 10 inches; slightly acid.

Range in characteristics.—The thickness of the combined Ap and A1 horizons ranges from 10 to 12 inches, and the thickness of the subsoil ranges from 17 to 28 inches. The B3 layer is not present in all places. In many profiles the underlying material is more sandy than that underlying the representative profile. The thickness of the silty material above the gravel ranges from 30 to 42 inches.

In areas west of Kellogg on terraces of the Zumbro River, soils that are slightly shallower over gravel and small stones are mapped with the Waukegan soils. These included soils contain more grit than the typical Waukegan soils, and coarse fragments are at a depth of 28 to 36 inches.

Gray-Brown Podzolic soils

Gray-Brown Podzolic soils are zonal soils developed under deciduous forest in a temperate, moist climate. They have a thin, dark-colored A1 horizon, a grayish-brown, leached A2 horizon, and an illuviated subsoil that is brown to yellowish brown.

In Wabasha County the soil series in the Gray-Brown Podzolic great soil group are the Bixby, Dubuque, Fayette, Gale, Hixton, Medary, Meridian, Renova, Seaton, Tell, Whalen, and Wykoff. The Downs, Mt. Carroll, and Racine soils are also in this great soil group, but they have some characteristics of Brunizems. The Chelsea soils, also in this great soil group, have some characteristics of Regosols.

BIXBY SERIES

The Bixby series consists of well-drained Gray-Brown Podzolic soils developed under hardwoods in medium-textured glacial outwash of Iowan or Cary age. The medium-textured material is 20 to 36 inches thick and overlies stratified sand and gravel. These soils are on stream terraces. They are nearly level to gently sloping.

The Bixby soils are associated with the Tell and Meridian soils. They are loamy, rather than silty like the Tell soils or sandy like the Meridian soils.

Representative profile of Bixby loam, 2 to 6 percent slopes, in a cultivated field where the slope is 5 percent (SW¼NW¼NE¼ sec. 24, T. 110 N., R. 11 W.):

Ap—0 to 11 inches, dark grayish-brown (10YR 4/2) loam; weak, medium and coarse, granular structure; friable; strongly acid; abrupt, smooth boundary.

B21—11 to 23 inches, dark-brown (10YR 4/3) to dark yellowish-brown (10YR 4/4) clay loam; weak, coarse, angular blocky structure; firm; very strongly acid; abrupt, wavy boundary.

B22—23 to 28 inches, yellowish-brown (10YR 5/4) sandy clay loam; weak, coarse, subangular blocky structure; firm; very strongly acid; abrupt, wavy boundary.

IIB3—28 to 40 inches, dark-brown to brown (7.5YR 4/4) sand; single grain (structureless); loose; very strongly acid; abrupt, wavy boundary.

IIC—40 to 100 inches +, yellowish-brown (10YR 5/4) sand; single grain (structureless); loose; strongly acid.

Range in characteristics.—The surface layer varies in thickness, and its color ranges from very pale brown to very dark grayish brown. The depth to the substratum of sand or gravel ranges from 20 to 36 inches.

DOWNS SERIES

The Downs series consists of moderately dark colored, deep, well-drained Gray-Brown Podzolic soils that intergrade toward Brunizems. These soils developed under mixed grasses and forest in deep, slightly acid to neutral loess that is 6 to 8 feet thick in most places. The loess is underlain by loam and clay loam glacial till or by limestone bedrock. These soils are on broad ridges and are nearly level to strongly sloping.

The Downs soils have a more strongly developed profile than the Mt. Carroll soils. More than 26 percent of their B horizon is clay, which is a greater amount of clay than is in the B horizon of the Mt. Carroll soils. The Downs soils are moderately dark rather than light colored like the Fayette and Seaton soils.

Representative profile of a Downs silt loam (NW¼ SW¼ sec. 1, T. 108 N., R. 11 W.):

A1—0 to 6 inches, very dark brown (10YR 2/2) silt loam; weak to moderate, fine and medium, granular structure and weak, thin and medium, platy structure; very friable; slightly acid; abrupt, smooth boundary.

A2—6 to 10½ inches, very dark grayish-brown (10YR 3/2) to dark grayish-brown (10YR 4/2) silt loam; weak to moderate, thin and medium, platy structure; friable; slightly acid to medium acid; abrupt, wavy boundary.

A3—10½ to 15 inches, very dark grayish-brown (10YR 3/2) to dark grayish-brown (10YR 4/2) silt loam; moderate, fine and medium, subangular blocky structure; friable; medium acid; abrupt, wavy boundary.

B21—15 to 22 inches, dark-brown (10YR 3/3 to 10YR 4/3), light silty clay loam; moderate to strong, fine and medium, subangular blocky structure; firm; strongly acid; clear, wavy boundary.

B22—22 to 33 inches, brown to dark-brown (10YR 4/3), light silty clay loam; moderate to strong, medium, subangular blocky structure; slightly sticky when wet; peds coated with very dark grayish brown (10YR 3/2); strongly acid; clear, wavy boundary.

B3—33 to 41 inches, brown to dark-brown (10YR 4/3), heavy silt loam; weak to moderate, medium and coarse, subangular blocky structure; plastic when wet; very dark grayish-brown coatings on the surfaces of peds; strongly acid; abrupt, wavy boundary.

C1—41 to 75 inches, brown (10YR 5/3) silt loam with a few, medium, prominent mottles of strong brown (7.5YR 5/8); massive; very friable; medium acid; abrupt, wavy boundary.

C2—75 to 87 inches, brown (10YR 5/3) to pale-brown (10YR 6/3) coarse silt loam that has common, large, prominent mottles of strong brown (7.5YR 5/6); massive; very friable; mildly calcareous; abrupt, wavy boundary.

C3—87 to 100 inches +, pale-brown (10YR 6/3) coarse silt loam streaked with dark brown (10YR 3/3) and mottled with yellowish brown (10YR 5/6 and 10YR 5/8); massive; very friable; mildly calcareous; weakly effervescent with dilute hydrochloric acid.

Range in characteristics.—In cultivated fields the material in the A2 horizon has been mixed with that in the A1 horizon in many places, and the plow layer consists of material from both horizons. In some areas the A2 horizon lacks a platy structure, and in some areas it is slightly darker or lighter colored than that in the profile described. In the area where the A2 horizon is darker than that in the profile described, coatings that are dark colored, rather than light colored, are on the surfaces of the peds in the subsoil. In a few places calcareous material is within 4 feet of the surface, but it is at a depth of 5 to 6 feet in most places. In a few areas glacial till is within 3 feet of the surface, but bedrock or clay loam glacial till is at a depth of 6 to 8 feet or more in most places.

DUBUQUE SERIES

The Dubuque series consists of well-drained Gray-Brown Podzolic soils developed in loess over limestone or material weathered from limestone. Limestone bedrock or reddish, brown, or yellowish clay weathered from limestone is at a depth ranging from 24 to 42 inches. The soils formed under hardwoods. They range from gently sloping to steep.

The Dubuque soils are similar to the Dodgeville soils, except that they are lighter colored. Dubuque soils lack the glacial till that underlies the Whalan soils.

Representative profile of a Dubuque silt loam under forest in a road cut where the slope is 10 percent (SE¼SW¼ sec. 28, T. 109 N., R. 12 W.):

A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) to dark grayish-brown (10YR 4/2) silt loam; weak, very fine, granular structure; friable; slightly acid; abrupt, wavy boundary.

A2—3 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; weak to moderate, thin, platy structure; friable; strongly acid; abrupt, wavy boundary.

AB—8 to 13 inches, brown to dark-brown (10YR 4/3) silt loam; weak, fine, granular structure mixed with weak, fine and medium, subangular blocky structure; friable; medium acid; abrupt, wavy boundary.

B21—13 to 24 inches, brown to dark-brown (7.5YR 4/4) silt loam; moderate, very fine and fine, subangular blocky structure; friable; medium acid; abrupt, wavy boundary.

B22—24 to 32 inches, dark yellowish-brown (10YR 4/4), heavy silt loam coated with dark brown to brown (10YR 4/3); moderate to strong, fine and medium, angular blocky structure; friable to firm; medium acid; abrupt, wavy boundary.

IIB3—32 to 34 inches, very dark grayish-brown (10YR 3/2) silt loam mixed with residual clay; massive; friable to firm; mildly calcareous.

R—34 inches +, limestone bedrock.

Range in characteristics.—The thickness of the loess ranges from 24 to 42 inches. In some places the AB horizon is absent, and in some profiles there is an A3 horizon or a B1 horizon. The material weathered from clay is absent in some places, and in other places is as much as 12 inches thick. Shattered limestone overlies the solid bedrock in places. In the shallow phases of the Dubuque soils, limestone or material weathered from limestone is at a depth of 12 to 24 inches.

FAYETTE SERIES

The Fayette series consists of deep, well-drained Gray-Brown Podzolic soils that are nearly level to steep. The upland phases are on ridges and broad uplands; the valley phases are on valley slopes; and the bench phases are on high stream terraces. These soils developed under mixed hardwood forest in deep, silty loess that is generally 8 to 10 feet thick. In most places the loess is underlain by a thin deposit of loam or clay loam glacial till over sandstone or limestone bedrock, but in places the till is absent.

The Fayette soils surround the waterways where the Chaseburg soils occur, and they are associated with the Dubuque and Downs soils. Their profile is more highly developed than that of the Chasburg soils. They are deeper over bedrock than the Dubuque soils. The Fayette soils have a thinner, lighter colored A1 horizon

and a lighter colored A2 horizon than the Downs soils. Their B horizon also has more distinct, subangular blocky structure.

Representative profile of a Fayette silt loam, uplands, in a wooded area where the slope is 5 percent (NE¼SW¼ sec. 18, T. 109 N., R. 12 W.):

A1—0 to 2 inches, very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) silt loam; weak, very fine, granular structure; very friable; many fibrous roots; slightly acid; abrupt, smooth boundary.

A21—2 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, thin, platy structure; very friable; many fibrous roots; strongly acid; clear, wavy boundary,

A22—8 to 11 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, medium, platy structure; friable; few woody roots; strongly acid; abrupt, wavy boundary.

B21—11 to 19 inches, dark yellowish-brown (10YR 4/4) silt loam; moderate, fine and medium, subangular blocky structure; peds coated with light-gray (10YR 7/2) silica flour and very dark grayish-brown (10YR 3/2) stains of organic matter; friable; few woody roots; strongly acid; clear, wavy boundary.

B22—19 to 30 inches, dark yellowish-brown (10YR 4/4) silty clay loam; strong, medium, subangular blocky structure; peds lightly coated with light-gray (10YR 7/2) silica flour and dark-brown (10YR 3/3 to 10YR 3/4) stains of organic matter; firm; few woody roots; strongly acid; clear, wavy boundary.

B3—30 to 41 inches, dark yellowish-brown (10YR 4/4) silty clay loam, but some peds have a dark-brown (10YR 3/3 to 10YR 3/4) surface; moderate to strong, medium and coarse, subangular blocky structure; firm; strongly acid; clear, wavy boundary.

C1—41 to 46 inches, dark yellowish-brown (10YR 4/4) silt loam, but some peds have a dark-brown (10YR 3/3 to 10YR 3/4) surface; moderate, coarse, subangular blocky structure to massive; firm to friable; strongly acid; clear, wavy boundary.

C2—46 to 100 inches +, dark yellowish-brown (10YR 4/4) silt loam; massive; very friable; strongly acid.

Range in characteristics.—The texture of the subsoil ranges from heavy silt loam to silty clay loam. When the soil material is dry, light-gray silica coatings are apparent in the lower part of the surface layer. They are more prominent in the upper part of the subsoil than in the surface layer, and they fade out in the lower part of the subsoil. In places calcareous loess is at a depth of 5 to 7 feet. The A1 and A2 horizons are much lighter colored when dry than when moist. In many, but not all, areas there is a B1 horizon. The bench phases are underlain by stratified silt, very fine sand, fine sand, and medium sand at a depth of 4 to 8 feet.

GALE SERIES

The Gale series consists of well-drained Gray-Brown Podzolic soils that are moderately deep. These soils developed under hardwood forest in thin deposits of loess over sandstone or sand that has weathered from sandstone. Depth to sand or sandstone ranges from 24 to 42 inches.

The Gale soils are associated with the Fayette and Hixton soils. They developed in a thinner mantle of loess than the Fayette soils, and they show the influence of sandstone in the lower part of the solum. The Gale soils are somewhat similar to the Hixton soils, but they formed partly in loess instead of almost entirely in material weathered from sandstone and shale.

Representative profile of a Gale silt loam in a cultivated field where the slope is 8 percent (NE¼SE¼SW¼ sec. 20, T. 109 N., R. 10 W.):

Ap—0 to 7 inches, dark-brown (10YR 3/3) silt loam; cloddy; friable; medium acid; abrupt, smooth boundary.

B1—7 to 13 inches, dark yellowish-brown (10YR 3/4 to 10YR 4/4) silt loam; weak to moderate, fine, subangular blocky structure; friable; peds lightly coated with silica flour; strongly acid; abrupt, wavy boundary.

B21—13 to 18 inches, brown to dark-brown (10YR 4/3), heavy silt loam; moderate to strong, very fine and fine, subangular blocky structure; friable to firm; peds lightly coated with silica flour; strongly acid; abrupt, wavy boundary.

B22—18 to 27 inches, brown to dark-brown (10YR 4/3), light silty clay loam; strong, fine and medium, subangular blocky structure; friable to firm; peds lightly coated with silica flour or covered by thin, patchy clay films; strongly acid; abrupt, smooth boundary.

B3—27 to 29 inches, brown to dark-brown (10YR 4/3) silt loam that contains fragments of chert; weak to moderate, coarse, subangular blocky structure; friable; strongly acid; abrupt, smooth boundary.

IIC—29 to 37 inches, yellowish-brown (10YR 5/6 to 10YR 5/8) fine sand, spotted with strong brown (7.5YR 5/8); single grain; loose; strongly acid; abrupt, smooth boundary.

IIR—37 inches +, sandstone.

Range in characteristics.—Depth to sandstone or to material weathered from sandstone ranges from 24 to 42 inches, and the thickness of the surface layer and subsoil vary accordingly. In areas that have not been disturbed, the profile contains typical A1 and A2 horizons that have a combined thickness of 10 to 11 inches.

In this county shallow phases of the Gale soils are mapped in complexes with the Hixton soils. In those areas the loess is only 12 to 24 inches thick over sandstone or sand that has weathered from sandstone.

HIXTON SERIES

The Hixton series consists of well-drained Gray-Brown Podzolic soils developed under deciduous forest in material weathered from fine-grained sandstone. The soils are on valley slopes below outcrops of sandstone, or in areas where sandstone is thinly covered in the more nearly level uplands. They are gently sloping to steep.

The Hixton soils are closely associated with the Gale and Boone soils. They contain more sand than the Gale soils, and they have a moderately developed B horizon, which is lacking in the Boone soils.

Representative profile of a Hixton fine sandy loam in a cultivated field (NE¼SE¼ sec. 35, T. 108 N., R. 12 W.):

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; cloddy or weak, thick, platy structure; very friable; few fibrous roots; medium acid; abrupt, smooth boundary.

B1—8 to 13 inches, very dark grayish-brown (10YR 3/2) and dark yellowish-brown (10YR 3/4) loam; weak, thick, platy and weak, fine and coarse, subangular blocky structure; friable; medium acid; abrupt, wavy boundary.

B2—13 to 21 inches, brown to dark-brown (7.5YR 4/4) loam; weak to moderate, fine and medium, subangular blocky structure; friable; thin, patchy clay films on the surfaces of peds; strongly acid; abrupt, wavy boundary.

B3—21 to 26 inches, brown to dark-brown (7.5YR 4/4) fine sandy loam; weak, medium, subangular blocky structure to massive; friable; very strongly acid; abrupt, smooth boundary.

C—26 to 31 inches, brown to dark-brown (7.5YR 4/4) sand; single grain (structureless); loose; very strongly acid.

R—31 inches +, brownish-yellow (10YR 6/8) and very pale brown (10YR 7/4) St. Peter sandstone.

Range in characteristics.—In areas where the Hixton soils are mapped in complexes with the Gale soils, the texture of the surface layer is loam. Depth to sandstone ranges from about 20 inches to several feet. In a few places some glacial gravel is in the profile or is scattered on the surface.

MEDARY SERIES (BROWN VARIANT)

The Medary series consists of moderately well drained Gray-Brown Podzolic soils developed under hardwood forest in slack water deposits of silt and clay. These soils are nearly level to gently sloping and are on high terraces along the tributaries of the Mississippi River. They have a thin, silty surface layer that overlies a subsoil of plastic heavy silty clay or silty clay loam. Permeability is slow to moderately slow.

These soils are associated with the Zwingle soils, which are poorly drained. They formed in the same kind of material as those soils.

No typical Medary soils are mapped in Wabasha County, but soils that have a brown subsoil, rather than a reddish one like that of the typical Medary soils, are mapped as brown variants of the Medary series.

Representative profile of Medary silt loam, brown variant, 0 to 2 percent slopes, in a pasture (SW¼NW¼ sec. 26, T. 109 N., R. 10 W.):

Ap—0 to 8 inches, mixed dark-gray (10YR 4/1) to dark grayish-brown (10YR 4/2) and brown (10YR 5/3) silt loam; weak, thin, platy structure; friable; neutral; abrupt, smooth boundary.

B1—8 to 14 inches, brown (10YR 5/3) silty clay loam to silty clay; moderate to strong, fine, angular blocky structure; firm when moist, plastic when wet; the structural blocks are coated with light-gray silt when dry; slightly acid; abrupt, wavy boundary.

B2—14 to 25 inches, brown to dark-brown (7.5YR 4/4) clay; strong, very fine and fine, angular blocky structure; very firm when moist; very plastic when wet; continuous clay films on the surfaces of peds; very strongly acid; abrupt, smooth boundary.

C1—25 to 40 inches, grayish-brown (10YR 5/2) to brown (10YR 5/3) clay; moderate, very fine, angular blocky structure to massive (structureless); firm when moist, plastic when wet; slightly acid; abrupt, smooth boundary.

C2—40 to 64 inches, bands of reddish-brown (2.5YR 4/4) and grayish-brown (10YR 5/2) clay; massive (structureless); very firm when moist, very plastic when wet; neutral, clear, wavy boundary.

C3—64 to 72 inches +, bands of reddish-brown (2.5YR 4/4) and grayish-brown (10YR 5/2) clay; massive (structureless); very firm when moist; mildly alkaline.

Range in characteristics.—Depth to clay ranges from 12 to about 20 inches. In some profiles the clay is 2 to 3 feet thick and is underlain by silt. In places stratified sand is at a depth of 6 feet or more.

MERIDIAN SERIES

The Meridian series consists of well-drained Gray-Brown Podzolic soils developed in sandy deposits on stream terraces in the Driftless Area. These deposits were derived primarily from sandstone mixed with a small amount of loess and material weathered from limestone or, in a few places, mixed with glacial outwash. The soils are underlain by stratified sand at a depth ranging from 2 to 3 feet. Thin strata of more coherent material, ranging from sandy clay loam to sandy loam, are within the stratified sand.

The Meridian soils are commonly associated with the Bixby and Tell soils. They are coarser textured than those soils.

Representative profile of Meridian sandy loam, 2 to 6 percent slopes, in a cultivated field where the slope is 4 percent (SE¼NW¼NE¼ sec. 24, T. 110 N., R. 11 W.):

Ap—0 to 11 inches, very dark grayish-brown (10YR 3/2) sandy loam; weak, coarse, angular blocky structure; very friable; medium acid; abrupt, smooth boundary.

B21—11 to 23 inches, dark-brown to brown (10YR 4/3) loam; weak, coarse, angular blocky structure; friable; medium acid; abrupt, wavy boundary.

B22—23 to 28 inches, dark-brown to brown (7.5YR 4/4) fine sandy loam; weak, coarse, subangular blocky structure; friable; medium acid; abrupt, wavy boundary.

C1—28 to 44 inches, yellowish-brown (10YR 5/6) fine sand; single grain (structureless); loose; medium acid; abrupt, wavy boundary.

C2—44 to 100 inches +, light yellowish-brown (10YR 6/4) fine sand; single grain (structureless); loose; medium acid.

Range in characteristics.—The thickness of the surface layer varies. An A2 horizon is present where the soil has not been disturbed. In some places thin bands of sandy loam, loam, or sandy clay loam are present in the stratified sand in the underlying material. The thickness of the subsoil ranges from 12 to 18 inches.

MT. CARROLL SERIES

The Mt. Carroll series consists of moderately dark, deep, well-drained Gray-Brown Podzolic soils that intergrade toward Brunizems. The soils are on broad ridges and are nearly level to strongly sloping. They developed under mixed grasses and forest in deep, coarse-textured loess.

Mt. Carroll soils have some characteristics like those of the light-colored Seaton soils and some like those of the dark-colored Port Byron soils. They are similar to the Downs soils, but the texture of their B horizon is silt loam rather than silty clay loam.

Representative profile of a Mt. Carroll silt loam (NW¼NW¼ sec. 14, T. 108 N., R. 12 W.):

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

B1—8 to 13 inches, dark-brown to brown (10YR 4/3) silt loam; weak to moderate, very fine, subangular blocky structure; friable; tongues of very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) material from the Ap horizon extend into this horizon; neutral; clear, wavy boundary.

B21—13 to 20 inches, dark-brown to brown (10YR 4/3) silt loam; weak to moderate, fine, subangular blocky structure; friable to firm; surfaces of peds coated with a material that is slightly darker brown than the silt loam; medium acid; clear, wavy boundary.

B22—20 to 30 inches, dark-brown to brown (10YR 4/3) silt loam; weak to moderate, fine and medium, subangular blocky structure; friable to firm; thin, patchy coatings of silt on the surfaces of peds; medium acid; abrupt, wavy boundary.

B3—30 to 35 inches, yellowish-brown (10YR 5/4) silt loam; weak, medium and coarse, subangular blocky struc-

ture; friable; peds coated with dark yellowish brown (10YR 4/4); medium acid; abrupt, wavy boundary.

C1—35 to 62 inches, yellowish-brown (10YR 5/4) silt loam; massive; friable; medium acid; abrupt, smooth boundary.

C2—62 to 72 inches, yellowish-brown (10YR 5/4) to light yellowish-brown (10YR 6/4) coarse silt loam; many, medium, prominent mottles of brownish yellow (10YR 6/8); massive; friable; mildly effervescent with dilute hydrochloric acid; abrupt, smooth boundary.

C3—72 to 84 inches, light brownish-gray (2.5Y 6/2) coarse silt loam, splotched with strong brown (7.5YR 5/8) and reddish yellow (7.5YR 6/8); massive; very friable; lime concretions present; strongly effervescent with dilute hydrochloric acid.

Range in characteristics.—The chief variations are in the color of the surface layer and in the degree of development of the B horizon. The color of the surface layer ranges from the dark color of the Port Byron soils to the light color of the Seaton soils. The texture of the subsoil ranges from medium silt loam to very light silty clay loam. The depth to coarse silty material in the C horizon ranges from about 35 inches to about 62 inches. In places the C horizon is calcareous at a depth of 3 feet. The bench phases of these soils are underlain by stratified materials, which are mostly silt and very fine sand. In a few places, however, these materials are clay, coarse sand, and gravel. The stratified materials are at a depth of 4 to 8 feet.

RACINE SERIES

The Racine series consists of moderately dark colored, deep, well-drained Gray-Brown Podzolic soils that intergrade toward Brunizems. These soils developed in medium-textured Iowan till under vegetation alternating between grasses and hardwoods. In this county most of the till has been covered with a silt cap of loess that is normally less than 24 inches thick. The soils are on broad ridges and are nearly level to strongly sloping.

The Racine soils are associated with the Renova soils, but they have a darker, thicker A1 horizon and a thinner A2 horizon. Their subsoil has slightly less structural development.

Representative profile of Racine silt loam, 6 to 12 percent slopes, moderately eroded, in a cultivated field where the slope is 10 percent (northeastern corner of SW¼NW¼ sec. 36, T. 109 N., R. 14 W.):

Ap—0 to 6 inches, very dark brown (10YR 2/2) loam to silt loam; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—6 to 13 inches, very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) loam to silt loam; weak, very fine, subangular blocky structure; friable; medium acid; abrupt, wavy boundary.

B1—13 to 19½ inches, dark yellowish-brown (10YR 3/4) loam to clay loam; weak to moderate, very fine and fine, subangular blocky structure; friable to firm; strongly acid; abrupt, wavy boundary.

B21—19½ to 30 inches, dark yellowish-brown (10YR 4/4) loam to clay loam; weak to moderate, fine, subangular blocky structure; friable to firm; very strongly acid; abrupt, wavy boundary.

B22—30 to 37 inches, dark-brown (7.5YR 4/4) fine sandy loam with spots of yellowish brown (10YR 5/6); weak, fine, subangular blocky structure; friable; strongly acid; abrupt, wavy boundary.

C1—37 to 40 inches, light olive-brown (2.5Y 5/4) and brown or dark-brown (10YR 4/3) silt loam; massive (structureless); friable; some light olive-gray (5Y 6/2) fragments of shale; very strongly acid; abrupt, wavy boundary.

C2—40 to 43 inches, dark yellowish-brown (10YR 4/4) fine sandy loam; massive (structureless); friable; strongly acid; abrupt, wavy boundary.

C3—43 to 51 inches +, yellowish-brown (10YR 5/4) clay loam streaked with very pale brown (10YR 7/4); massive (structureless); friable when moist; very strongly acid.

Range in characteristics.—In areas that have not been disturbed, the color of the A1 horizon ranges from very dark brown to very dark grayish brown (10YR 2/2 to 10YR 3/2). In such areas the A2 horizon also varies in thickness, and its color ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) or dark grayish brown (10YR 4/2). The texture of the surface layer is silt loam in areas where the silt cap is present, but it is loam in areas where the silt cap is lacking. The silt loam predominates. A few boulders and stones are in the profile and are scattered on the surface. The development of the B horizon ranges from weak to strong, but in most places it is moderate.

RENOVA SERIES

The Renova series consists of well-drained Gray-Brown Podzolic soils that developed in medium-textured glacial till of Iowan age. In this county most of the till has been covered by a thin cap of loess that is normally less than 24 inches thick. The vegetation under which these soils developed was a hardwood forest. The soils are on broad ridges where the slopes range from gentle to steep.

The Renova soils are associated with the Racine, Wykoff, and Whalan soils. They are lighter colored than the Racine soils. In areas that have not been disturbed, they have a thinner A1 horizon and a thicker A2 horizon than the Racine soils, and they also have a more strongly developed B horizon. The till in which the Renova soils formed is finer textured than the till that was the parent material of the Wykoff soils. Unlike the Whalan soils, the Renova soils are more than 42 inches deep over limestone or material weathered from limestone.

Representative profile of Renova silt loam, 12 to 18 percent slopes, moderately eroded, in a cultivated field where the slope is 15 percent (SE¼NW¼ sec. 18, T. 110 N., R. 13 W.):

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) to dark grayish-brown (10YR 4/2) and dark yellowish-brown (10YR 4/4) silt loam; weak, very fine and fine, granular structure; friable; neutral; abrupt, smooth boundary.

B1—8 to 13 inches, dark yellowish-brown (10YR 4/4) to yellowish-brown (10YR 5/4), heavy silt loam; cloddy, but breaks to weak, fine, subangular blocky structure; friable; neutral; abrupt, wavy boundary.

B21—13 to 20 inches, brown to dark-brown (10YR 4/3), light silty clay loam; moderate, fine, subangular blocky structure; firm; peds lightly coated with stains of organic matter; medium acid; clear, wavy boundary.

IIB22—20 to 27 inches, dark yellowish-brown (10YR 4/4) to yellowish-brown (10YR 5/4) clay loam; moderate, medium, subangular blocky structure; firm; peds coated with light-gray (10YR 7/2) silica flour; medium to strongly acid; clear, wavy boundary.

IIB3—27 to 36 inches, brown to dark-brown (7.5YR 4/4) sandy loam to sandy clay loam; moderate, medium and coarse, subangular blocky structure; firm; peds

coated with dark-brown (7.5YR 3/3) stains; medium acid; gradual, wavy boundary.

IIC1—36 to 60 inches +, brown to dark-brown (7.5YR 4/4) sandy clay loam; massive (structureless); firm; medium acid.

Range in characteristics.—In areas that have not been disturbed, there is a thin A1 horizon and a thick A2 horizon that combined are 10 to 11 inches thick. The thickness of the silt cap ranges from 0 to 24 inches. In many profiles light-gray coatings of silica flour are evident in the upper part of the B horizon. In most areas where the surface layer is less than 6 inches thick, the texture is loam. In areas that have not been disturbed, the surface layer is commonly grayish brown. There is a band of pebbles between the silty material and the till in some places. In other places gravel is below a depth of 42 inches. Cretaceous material is in the profile in some areas.

SEATON SERIES

The Seaton series consists of well-drained Gray-Brown Podzolic soils formed under hardwood forest in deep, coarse-textured loess. These soils have a weakly developed profile. They are generally rolling or steep.

The Seaton soils are associated with the Fayette and Bold soils, which are also light colored and developed in loess. The Seaton soils, however, formed in a coarser textured loess than the Fayette soils. They have a less developed profile than those soils, and they are not leached to so great a depth. The Seaton soils are unlike the Bold soils in that they have a distinct B horizon, and they lack the calcareous material that is at or near the surface in the Bold soils.

Representative profile of a moderately eroded Seaton silt loam in a cultivated field where the slope is 17 percent (NW¼NW¼ sec. 24, T. 109 N., R. 14 W.):

Ap—0 to 9 inches, very dark gray (10YR 3/1) to very dark grayish-brown (10YR 3/2) silt loam; weak to moderate, fine, subangular blocky structure; very friable; neutral; abrupt, smooth boundary.

B2—9 to 18 inches, yellowish-brown (10YR 5/4) silt loam coated with dark brown (10YR 4/3); weak, coarse, subangular blocky structure; very friable; neutral; abrupt, wavy boundary.

B3—18 to 27 inches, dark yellowish-brown (10YR 4/4) silt loam; very weak to weak, coarse, subangular blocky structure; very friable; neutral; abrupt, wavy boundary.

C1—27 to 50 inches, dark yellowish-brown (10YR 4/4) coarse silt loam; massive (structureless); very friable; mildly calcareous; abrupt, wavy boundary.

C2—50 to 60 inches +, pale-brown (10YR 6/3) very fine sandy loam; structureless; very friable; moderately calcareous; strong effervescence with dilute hydrochloric acid.

Range in characteristics.—In undisturbed areas the profile contains an A1 and an A2 horizon. The thickness of the B horizon ranges from 9 to 18 inches. In some places light-gray coatings of silt are present in the upper part of the B horizon. Depth to calcareous material ranges from 24 to 42 inches.

TELL SERIES

The Tell series consists of well-drained Gray-Brown Podzolic soils on stream terraces. These soils developed under hardwood forest in moderately deep, silty alluvium or in a thin layer of loess. They are underlain by stratified sand at a depth ranging from 24 to 42 inches. The soils are nearly level to gently sloping.

The Tell soils are associated with bench phases of the Fayette soils, but they are much shallower over sand than those soils. They are also associated with the Bixby and Waukegan soils. The Tell soils are finer textured throughout the profile than the Bixby soils, and they are lighter colored than the Waukegan soils.

Representative profile of Tell silt loam, 0 to 2 percent slopes, in a cultivated field on a terrace along the Zumbro River, where the slope is 1 percent (west side of NW¼NW¼ sec. 27, T. 109 N., R. 14 W.):

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam; weak to moderate, fine, granular structure; friable; few fibrous roots; slightly acid; abrupt, smooth boundary.

A2—7 to 12 inches, dark-brown (10YR 3/3) silt loam spotted with very dark grayish brown (10YR 3/2); weak to moderate, fine, subangular blocky structure; friable; slightly acid; abrupt, smooth boundary.

B21—12 to 18 inches, brown (10YR 4/3) to dark yellowish-brown (10YR 4/4), heavy silt loam or light silty clay loam; moderate, fine and medium, subangular blocky structure; friable to firm; slightly acid; abrupt, smooth boundary.

B22—18 to 26 inches, dark-brown (7.5YR 4/4) to dark yellowish-brown (10YR 4/4), heavy silt loam; moderate to strong, fine, subangular blocky structure; firm; medium acid; abrupt, wavy boundary.

B23—26 to 36 inches, dark yellowish-brown (10YR 4/4) very fine sandy loam and coarse silt; moderate to strong, medium, subangular blocky structure; friable; strongly acid; abrupt, smooth boundary.

B3—36 to 41 inches, dark grayish-brown (10YR 4/2) very fine sandy loam; massive (structureless); very friable; strongly acid; abrupt, wavy boundary.

C—41 to 52 inches +, pale-brown (10YR 6/3) fine sand; single grain (structureless); loose; strongly acid.

Range in characteristics.—The thickness of the Ap horizon and A2 horizon combined ranges from 8 to 12 inches. The thickness of the B horizon ranges from 16 to 30 inches. Depth to sand ranges from 24 to 42 inches. In a few places the C horizon consists of stratified sand and gravel.

WHALAN SERIES

The Whalan series consists of well-drained Gray-Brown Podzolic soils developed under hardwood forest in a thin layer of glacial till. The till is of Iowan age. It is underlain by limestone or material weathered from limestone, which is at a depth of 24 to 42 inches. In some places there is a thin mantle of loess that is normally 12 to 18 inches thick. The soils are on uplands and are gently sloping to steep.

The Whalan soils are somewhat similar to the Dubuque and Dodgeville soils, but they formed mainly in glacial till rather than in loess. They are associated with the Renova soils but are less deep than those soils.

Representative profile of a moderately eroded Whalan silt loam, in a pasture where the slope is 20 percent (SE¼NE¼ sec. 17, T. 110 N., R. 14 W.):

Ap—0 to 4 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, very fine, fine and medium, subangular blocky structure; very friable; neutral; abrupt, smooth boundary.

AB—4 to 7 inches, mixed dark grayish-brown (10YR 4/2) and dark yellowish-brown (10YR 4/4), heavy silt loam; weak, very thin and thin, platy structure and

weak, medium, subangular blocky structure; friable; medium acid; abrupt, smooth boundary.

B21—7 to 17 inches, dark yellowish-brown (10YR 4/4), heavy silt loam; weak to moderate, medium, subangular blocky structure; friable; strongly acid; abrupt, smooth boundary.

IIB22—17 to 28 inches, dark yellowish-brown (10YR 4/4) loam to clay loam; weak, fine, medium, and coarse, subangular blocky structure; friable; strongly acid; abrupt, wavy boundary.

IIIC—28 to 31 inches, dark reddish-brown (5YR 3/3) gravelly or cherty clay; massive (structureless); firm when moist, sticky when wet; medium acid.

IIIR—31 inches +, pale-yellow (2.5Y 8/4) limerock; upper part fragmentary and does not react to hydrochloric acid above a depth of 40 inches.

Range in characteristics.—In areas that have not been disturbed, the combined A1 and A2 horizons are normally 8 to 11 inches thick, and the combined B horizons are 14 to 24 inches thick. In those places where there is material weathered from limestone, the material is reddish, brownish, or yellowish and is 2 to 12 inches thick. The texture of the surface layer is loam in those areas that are not covered by a silt cap. The shallow phases of the Whalan soils have limestone or material weathered from limestone at a depth ranging from 12 to 24 inches.

WYKOFF SERIES

The Wykoff series consists of well-drained to excessively drained Gray-Brown Podzolic soils that developed under hardwoods, chiefly oak, in sandy and gravelly glacial drift. In some places the drift is overlain by a thin silt cap of loess. These soils are on uplands where the slopes are complex and irregular, and they range from undulating to hilly.

The Wykoff soils are associated with well-drained Renova and Racine soils, but they formed in coarser textured glacial till than those soils. They are more reddish than the Bixby soils, and they have bands and lenses of loam or clay loam till in the substratum.

Representative profile of Wykoff gravelly loam, 6 to 12 percent slopes, moderately eroded (SE¼SW¼ sec. 26, T. 109 N., R 14 W.):

Ap—0 to 4 inches, dark yellowish-brown (10YR 3/4) gravelly loam; cloddy; very friable; medium acid; abrupt, smooth boundary.

B1—4 to 8 inches, dark yellowish-brown (10YR 3/4) loam; weak to moderate, medium and thick, platy structure, which breaks to weak to moderate, thin, platy structure; very friable; medium acid; abrupt, wavy boundary.

B21—8 to 12 inches, dark yellowish-brown (10YR 3/4) loam; moderate, medium, angular blocky structure; friable; medium acid; abrupt, wavy boundary.

B22—12 to 21 inches, yellowish-brown (10YR 5/6) sandy loam to loam; moderate, medium, angular blocky structure; friable; medium acid; abrupt, wavy boundary.

C—21 to 60 inches +, yellowish-brown (10YR 5/6) gravel underlain by medium sand that contains some gravel; single grain (structureless); loose; medium acid.

Range in characteristics.—In some areas a few nuggets of iron ore are embedded in the till. In places sandy loam is at a depth of 14 inches and the entire profile is shallower over glacial drift than the representative profile. In a few places the gravel in the upper part of the C horizon is cemented.

Humic Gley soils

Humic Gley soils are poorly drained or very poorly drained intrazonal soils that developed under swamp grasses and sedges. The B horizon is neutral gray and gleyed or mottled, which results from waterlogging and lack of oxygen. These are mineral soils, but the A1 horizon is thick and dark colored. The Garwin soils are the only typical Humic Gley soils mapped in Wabasha County. The Colo soils are classified in the Humic Gley great soil group, but they have some characteristics of Alluvial soils.

COLO SERIES

The Colo series consists of dark-colored, moderately fine textured Humic Gley soils that are integrading toward Alluvial soils. These soils are somewhat poorly drained to poorly drained. They are on first bottoms and developed in alluvium derived principally from loess and glacial drift. They are finer textured and less well drained than the Huntsville soils. Normally, they are slightly acid to mildly calcareous.

Representative profile of Colo silty clay loam (SW¼ SW¼ sec. 11, T. 110 N., R. 10 W.):

A11—0 to 26 inches, black (10YR 2/1) silty clay loam; moderate, coarse to fine, subangular blocky structure; friable to firm; neutral to mildly alkaline; clear, wavy boundary.

A12—26 to 34 inches, black (10YR 2/1) to very dark gray (10YR 3/1) silty clay loam; common, fine, faint, dark-brown (10YR 3/3) mottles; moderate, coarse to fine, subangular blocky structure; friable to firm; slightly acid to mildly alkaline; clear, wavy boundary.

A13—34 to 54 inches, dark-gray (5Y 4/1) silty clay loam; common, medium, prominent, dark-brown (10YR 3/3) mottles; weak, very fine, subangular blocky structure; friable to firm; neutral to mildly alkaline; abrupt, smooth boundary.

C—54 to 72 inches +, dark grayish-brown (10YR 4/2) fine sand; structureless; loose; mildly alkaline; water table below a depth of 50 inches.

Range in characteristics.—In areas where the soil material is less wet than that in the profile described, mottling is lacking in the lower part of the profile, and the hue below a depth of about 34 inches is 2.5Y or 10YR rather than 5Y.

GARWIN SERIES

The Garwin series consists of Humic Gley soils developed in deep, silty loess under grasses that tolerate water. These soils are poorly drained to very poorly drained. They occur in depressions within areas of somewhat poorly drained Muscatine soils and well-drained Port Byron, Downs, and Mt. Carroll soils. In places glacial till is present at a depth of 4 feet or more.

Representative profile of Garwin silt loam in a pasture where the slope is 1 percent (SE¼SW¼ sec. 30, T. 108 N., R. 12 W.):

A1—0 to 11 inches, black (10YR 2/1) to very dark brown (10YR 2/2) silt loam; weak to moderate, fine and medium, granular structure; very friable; slightly acid; clear, wavy boundary.

B21—11 to 18 inches, very dark gray (10YR 3/1) silty clay loam; weak, fine, granular structure; firm; medium to slightly acid; abrupt, wavy boundary.

B22g—18 to 28 inches, dark grayish-brown (2.5Y 4/2), light silty clay loam; moderate, very fine, subangular blocky structure; firm; medium to slightly acid; abrupt, wavy boundary.

B3g—28 to 34 inches, olive-gray (5Y 5/2) silt loam; moderate, thin and medium, platy structure, or moderate, very fine, subangular blocky structure; friable to firm; medium to slightly acid; abrupt, wavy boundary.

C—34 to 40 inches +, grayish-brown (2.5Y 5/2) silt loam; many, medium, distinct, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/4) mottles; massive; friable; slightly acid; water table below a depth of 34 inches.

Range in characteristics.—The thickness of the surface layer ranges from 10 to 20 inches. In places mottling in the subsoil is more prominent than that shown in the representative profile.

Planosols

The Planosols are intrazonal soils. They have an eluviated surface layer and a more strongly illuviated, cemented, or compacted B horizon than that in the associated soils that are not Planosols. The Planosols developed in areas of nearly flat topography under grass or forest. The climate was humid or subhumid.

In Wabasha County the only soils in the Planosol great soil group are the Zwingle.

ZWINGLE SERIES

The Zwingle series consists of poorly drained Planosols. These soils developed under forest vegetation in fine-textured alluvium. They are nearly level to gently sloping and are on high terraces along tributaries of the Mississippi River.

The Zwingle soils are associated with the Medary soils, which developed in similar material and under somewhat similar conditions. They are more poorly drained than the Medary soils.

Representative profile of a Zwingle silt loam in a nearly level pasture of bluegrass (NW¼SW¼SW¼ sec. 8, T. 111 N., R. 12 W.):

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam; common, fine, distinct mottles of dark yellowish brown (7.5YR 4/4) and a few spots of dark brown (10YR 3/3); weak, fine, granular structure and weak, very fine, subangular blocky structure; friable; slightly plastic when wet; strongly acid; abrupt, smooth boundary.

A21—6 to 8 inches, grayish-brown (2.5Y 5/2) silt loam; common, fine, distinct mottles of light olive brown (2.5Y 5/4) and streaks of dark grayish brown (10YR 4/2); weak, very fine, subangular blocky structure; friable when moist, slightly plastic when wet; very strongly acid; abrupt, smooth boundary.

A22—8 to 12 inches, grayish-brown (2.5Y 5/2) silty clay loam; common, fine, distinct mottles of dark yellowish brown (10YR 4/4); moderate to strong, medium, subangular blocky structure; friable to firm when moist, plastic when wet; very strongly acid; abrupt, smooth boundary.

B1—12 to 14 inches, dark grayish-brown (10YR 4/2) silty clay that has some darker stains; strong, very fine, angular blocky structure; firm when moist, plastic when wet; thin, continuous clay films on the surfaces of peds; very strongly acid; abrupt, smooth boundary.

B21—14 to 20 inches, dark grayish-brown (10YR 4/2) and grayish-brown (10YR 5/2) silty clay; a few, fine, distinct mottles of dark yellowish brown (10YR 4/4); strong, fine, angular blocky structure; firm when moist, plastic when wet; thin, continuous clay films on the surfaces of peds; a few darker root channels present; very strongly acid; clear, wavy boundary.

B22—20 to 32 inches, dark grayish-brown (10YR 4/2) clay; a few, fine, distinct mottles of dark yellowish brown (10YR 4/4); strong, fine and medium, angular blocky structure; very hard when dry, very firm when moist, very plastic when wet; thick, continuous clay films on the surfaces of peds; very strongly acid; clear, wavy boundary.

C1—32 to 41 inches, brown to dark-brown (10YR 4/3) clay; a few, medium, faint mottles of dark yellowish brown (10YR 4/4); massive (structureless); very hard when dry, very firm when moist, very plastic when wet; a few, patchy clay films present; very strongly acid; abrupt, wavy boundary.

C2—41 to 48 inches, dark grayish-brown (10YR 4/2) clay; many fine spots of very dark brown (10YR 2/2); massive (structureless); very hard when dry, very firm when moist, very plastic when wet; neutral; abrupt, wavy boundary.

C3—48 to 60 inches +, dark-gray (10YR 4/1) to dark grayish-brown (2.5Y 4/2) clay that has streaks of light brownish gray (10YR 6/2); common, medium, prominent mottles of yellowish red (5YR 4/6) and dark reddish brown (5YR 3/4); massive (structureless); very hard when dry, very firm when moist, very plastic when wet; moderately calcareous; mild to strong effervescence with dilute hydrochloric acid.

Range in characteristics.—In the upper part of the profile, the thickness of the silty material ranges from 8 to 14 inches. The thickness of the clayey material ranges from about 2 feet to more than 8 feet, but the greater thickness is more common. The underlying material is normally stratified silt and clay, but it is sand or gravel in the thinner variations. In places both the sand and gravel are present. In places the clay in the subsoil and underlying material is reddish, but it is normally dark grayish brown or dark gray. In some profiles the silty A horizons are prominently mottled.

Alluvial soils

Soils in the Alluvial great soil group developed in recent alluvium and colluvium on flood plains, on alluvial fans, and in waterways. Most of the soils are moderately well drained, but some of them are poorly drained. Because these soils are young, they do not have a well-developed profile. Frequent flooding leaves fresh deposits of sediment, which subjects the soils to continual change. In Wabasha County the Arenzville, Chaseburg, Genesee, Huntsville, Minneiska, Osseo, and Zumbro soils are in this group.

ARENZVILLE SERIES

The Arenzville series consists of light-colored, deep Alluvial soils that are well drained to moderately well drained. These soils are underlain by a dark-colored layer of soil. They formed in medium-textured, recent alluvial deposits washed from soils developed in loess under forest vegetation. Normally, they are neutral to mildly calcareous.

The Arenzville soils are similar to the Huntsville soils, but they are lighter colored than those soils. They are also similar to the Genesee soils, except that they overlie a buried soil.

Representative profile of Arenzville silt loam in a pasture (NW¼SE¼ sec. 31, T. 110 N., R. 12 W.):

A11—0 to 17 inches, very dark grayish-brown (10YR 3/2) and brown (10YR 5/3) silt loam; weak, very thin, thin, and medium, platy structure; very friable; abundant woody roots and grass roots in uppermost 6 inches, but the number of roots decreases with increasing depth; neutral to mildly calcareous; abrupt, smooth boundary.

A12—17 to 27 inches, very dark grayish-brown (10YR 3/2) and brown (10YR 5/3) silt loam; weak, medium and thick, platy and weak, medium, angular blocky structure; very friable; slightly more compact than overlying material; neutral; abrupt, smooth boundary.

A13—27 to 40 inches, dark-brown (10YR 3/3) and brown (10YR 5/3) silt loam; weak, medium and coarse, angular blocky structure; very friable; slightly more compact than overlying material; neutral; abrupt, smooth boundary.

IIC—40 to 42 inches, mixed dark yellowish-brown (10YR 4/4) and very dark brown (10YR 2/2) loamy sand; single grain; loose; a few small pebbles; slightly acid; abrupt, smooth boundary.

IIIA1b—42 to 72 inches, very dark brown (10YR 2/2) silt loam; weak, medium and coarse, subangular blocky structure; very friable; vertical cleavage is very distinct; neutral; abrupt, smooth boundary.

IIICb—72 to 84 inches +, dark-brown (10YR 3/3) to brown (10YR 4/3) silt loam; weak, medium, subangular blocky structure; very friable; vertical cleavage is very distinct; neutral.

Range in characteristics.—Depth to the buried soil ranges from 15 to 48 inches. In places the buried soil is black instead of very dark brown. The IIC horizon is lacking in many places. In some places there are alternate light- and dark-colored layers that range from one-fourth inch to 3 inches in thickness. The surface layer and the A12 and A13 horizons are dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) in some places, rather than very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3).

CHASEBURG SERIES

The Chaseburg series consists of light-colored, deep Alluvial soils that are well drained to moderately well drained. The soils formed in silty, alluvial and colluvial deposits, and they occupy small areas in draws and on foot slopes.

The Chaseburg soils are widely distributed throughout the county and are associated with the Fayette and similar soils. They are light colored, rather than dark colored like the Judson soils, but they occupy similar positions. They are better drained than the Osseo soils. Normally, they are slightly acid to neutral.

Representative profile of a Chaseburg silt loam on a slope of 4 percent (SE¼SE¼ sec. 3, T. 110 N., R. 12 W.):

A11—0 to 13 inches, very dark grayish-brown (10YR 3/2) silt loam that has streaks of dark grayish brown (10YR 4/2); weak to moderate, thin, platy structure; friable; slightly acid; clear, wavy boundary.

A12—13 to 48 inches, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) silt loam that has streaks of dark grayish brown (10YR 4/2); weak to moderate, fine and medium, granular structure that shows slight platiness; friable; medium to slightly acid; abrupt, wavy boundary.

A13—48 to 78 inches, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) silt loam that has faint streaks of dark grayish brown (10YR 4/2) and a few, fine, faint mottles of dark yellowish brown (10YR 3/4); weak, fine, granular structure; friable; medium to slightly acid; abrupt, wavy boundary.

C—78 to 100 inches +, dark grayish-brown (10YR 4/2) silt loam; structureless; friable; medium to slightly acid.

Range in characteristics.—In many places the Chaseburg soils overlie a buried Fayette, Downs, or Mt. Carroll soil. The color of the A horizons ranges from grayish brown (10YR 5/2) or light brownish gray (10YR 6/2) to very dark gray (10YR 3/1). Faint mottling is in the A11 or A12 horizons in places. In some places lenses of fine sand or thin layers of loam or very fine sandy loam are in the profile.

GENESEE SERIES

The Genesee series consists of well drained or moderately well drained Alluvial soils formed in material washed from uplands occupied by light-colored soils developed in loess. The natural vegetation was hardwoods, such as willow, cottonwood, soft maple, elm, and ash.

The Genesee soils are light colored like the Arenzville and Chaseburg soils, but they do not overlie a buried soil.

In many places the Genesee soils are associated with the Huntsville soils, but they are lighter colored than those soils. The Genesee soils are subject to occasional flooding, which occurs mostly in spring during snow melt. Normally, they are neutral to mildly calcareous.

Representative profile of Genesee silt loam (SW¼ SW¼ sec. 3, T. 109 N., R. 12 W.):

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, fine, granular structure; friable; abundant fibrous roots; neutral to mildly calcareous; clear, smooth boundary.

C1—9 to 18 inches, very dark grayish-brown (10YR 3/2) silt loam; weak to moderate, thin and medium, platy structure; friable; abundant fibrous roots; neutral to mildly calcareous; clear, smooth boundary.

C2—18 to 39 inches, very dark grayish-brown (10YR 3/2) silt loam; weak to moderate, medium, platy structure breaking to weak to moderate, very fine and fine, subangular blocky structure; friable; neutral to mildly calcareous; abrupt, smooth boundary.

C3—39 to 44 inches, very dark grayish-brown (10YR 3/2) loam with thin layers of very dark brown (10YR 2/2); weak to moderate, medium and coarse, subangular blocky structure; very friable; neutral to mildly calcareous; abrupt, smooth boundary.

C4—44 to 60 inches +, very dark grayish-brown (10YR 3/2) fine sandy loam; massive (structureless); very friable; calcareous.

Range in characteristics.—In some places the color of the profile is brown (10YR 4/3). In many places the profile contains thin layers or lenses of fine sand.

HUNTSVILLE SERIES

The Huntsville series consists of dark-colored, medium-textured Alluvial soils that are well drained or moderately well drained. The sediments from which these soils formed were derived principally from Brunizems developed in loess and in drift of Wisconsin age.

The Huntsville soils are associated with the Arenzville and Genesee soils, but they are darker colored than those soils. They are also associated with the Colo soils, but they are better drained than the Colo soils. The Huntsville soils are subject to occasional flooding.

Representative profile of Huntsville silt loam in a pasture (NE¼NE¼SE¼ sec. 27, T. 108 N., R. 12 W.):

A1—0 to 50 inches, black (10YR 2/1) to very dark brown (10YR 2/2) silt loam; moderate, fine and medium, granular structure and moderate, thin and medium, platy structure; very friable; a few, thin streaks of very dark grayish brown (10YR 3/2); abundant fibrous roots; neutral; clear, wavy boundary.

C—50 to 84 inches +, black (10YR 2/1) silt loam; moderate, very fine and fine, granular structure; very friable; mildly calcareous.

Range in characteristics.—In places the lower part of the profile, near the water table, is somewhat grayer than the lower part of the profile described as typical. In some places loam or very fine sandy loam is below a depth of 3 feet.

MINNEISKA SERIES

The Minneiska series consists of dark-colored Alluvial soils that are moderately well drained. These soils formed in stratified deposits, consisting of medium-textured sediments over moderately coarse textured or coarse textured sediments. The sediments washed from soils underlain by loess, glacial till, sandstone, and limestone.

The Minneiska soils are associated with the Arenzville, Genesee, and Huntsville soils. They are darker colored than the Arenzville and Genesee soils. Unlike the Huntsville soils, they have coarse-textured material within 30 inches of the surface.

Representative profile of Minneiska silt loam (120 feet west and 420 feet south of the northeast corner NW¼ NE¼ sec. 26, T. 110 N., R. 10 W.):

Ap—0 to 6 inches, very dark brown (10YR 2/2) silt loam; cloddy to very weak, medium, granular structure; friable; abundant fibrous roots; mildly calcareous; abrupt, smooth boundary.

A1—6 to 21 inches, very dark brown (10YR 2/2) silt loam; weak, fine and medium, granular structure; friable; abundant fibrous roots in upper part, decreasing to few in lower part; mildly calcareous; abrupt, wavy boundary.

C1—21 to 27 inches, very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) sandy loam to loamy sand; single grain (structureless); loose; slightly indurated; mildly calcareous; abrupt, wavy boundary.

C2—27 to 33 inches, dark grayish-brown (10YR 4/2) to grayish-brown (10YR 5/2) medium sand; single grain (structureless); loose; slightly indurated; slightly acid; abrupt, wavy boundary.

C3—33 to 60 inches +, dark grayish-brown (10YR 4/2) to grayish-brown (10YR 5/2) fine sand that contains a few coarser fragments; single grain (structureless); loose; neutral to mildly calcareous.

Range in characteristics.—The texture of the surface layer ranges from light silty clay loam to fine sandy loam, but it is normally loam or silt loam. The combined A horizons range from 15 to 30 inches in thickness, but they are generally about 20 inches thick. In some places the A horizons are black (10YR 2/1) or very dark gray (10YR 3/1). In places the underlying sand is coarse, and in some profiles there is fine gravel. Pockets of shells are common in the substratum.

OSSEO SERIES

The Osseo series consists of light-colored, somewhat poorly drained Alluvial soils within the Gray-Brown Podzolic region. The soils developed in silty colluvial and alluvial material from soils of loess-covered uplands. This material was deposited in draws, on alluvial fans, and on foot slopes by runoff water and surface creep.

The Osseo soils are similar to the Chaseburg soils. They are less well drained, however, than those soils.

Representative profile of Osseo silt loam, 0 to 2 percent slopes (NW¼NE¼ sec. 7, T. 110 N., R. 13 W.):

Ap—0 to 5 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, medium, granular structure; very friable; abundant fibrous roots; neutral to mildly calcareous; clear, wavy boundary.

A1—5 to 19 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, fine and medium, granular structure grading to weak to moderate, medium, subangular blocky structure; friable; common, fine, distinct mottles of dark grayish brown (10YR 4/2) and light gray (10YR 7/2); abundant fibrous roots; neutral to mildly calcareous; abrupt, wavy boundary.

A12—19 to 29 inches, very dark gray (10YR 3/1) silt loam; massive (structureless); friable; common, medium, prominent mottles of dark red (2.5YR 3/6); neutral; clear, wavy boundary.

C1—29 to 35 inches, black (10YR 2/1) silty clay loam; moderate, medium, angular blocky structure; firm; slightly acid; abrupt, smooth boundary.

C2—35 to 60 inches +, gray (5Y 5/1) silty clay loam that becomes more bluish with increasing depth; massive (structureless); firm, common, fine, prominent mottles of yellowish red (5YR 4/6); neutral.

Range in characteristics.—In places these soils are underlain by peat or muck at a depth of 2 to 3 feet. The peat is 2 to 3 feet thick and is underlain by blue (5G 4/1) clay. In some places the C1 horizon is missing, and the very dark gray A12 horizon directly overlies peat or clay. In some areas this soil is better drained than the typical soil of the series.

ZUMBRO SERIES

The Zumbro series consists of dark-colored, coarse-textured Alluvial soils of flood plains and low terraces along major streams. The soils are moderately well drained to somewhat poorly drained. They are coarse textured and have thick, dark A horizons. The underlying material is mainly clean, washed sand, but it contains a small amount of pink or red and black grains. Mottles occur below a depth of 10 to 16 inches.

The Zumbro soils are associated with the Minneiska, Arenzville, Genesee, and Huntsville soils. Their profile is coarser textured to a depth of 18 to 36 inches than that of the Minneiska soils. They are coarser textured throughout than the Arenzville, Genesee, and Huntsville soils.

Representative profile of Zumbro loamy fine sand in a cultivated field (SE¼SE¼SE¼ sec. 26, T. 110 N., R. 10 W.):

Ap—0 to 8 inches, very dark gray (10YR 3/1) loamy fine sand; weak, cloddy structure that breaks easily to single grains; loose; somewhat compacted; neutral; abrupt, smooth boundary.

A1—8 to 13 inches, very dark gray (10YR 3/1) loamy fine sand; very weak, medium, subangular blocky structure that breaks easily to single grain; loose; neutral; abrupt, wavy boundary.

C1—13 to 22 inches, very dark grayish-brown (10YR 3/2) fine sand; common, medium, prominent mottles of dark reddish brown (5YR 3/4); very weak, medium, subangular blocky structure that breaks easily to single grain; loose; slightly acid; clear, wavy boundary.

C2—22 to 30 inches, very dark grayish-brown (10YR 3/2) fine sand; common, fine, distinct mottles of brown

to dark brown (7.5YR 4/4); single grain (structureless); loose; slightly acid; clear, wavy boundary.

C3—30 to 34 inches, dark yellowish-brown (10YR 4/4) fine sand; single grain (structureless); loose; slightly acid; abrupt, wavy boundary.

C4—34 to 53 inches +, yellowish-brown (10YR 5/4) to light yellowish-brown (10YR 6/4) fine sand; single grain (structureless); loose; medium acid.

Range in characteristics.—The texture of the A horizons ranges from light fine sandy loam to fine sand. The thickness of the combined A horizons ranges from 9 to 20 inches. In places the texture of the C horizons is medium sand or loamy sand. In some places the C horizons contain fine gravel. The substratum in those areas is calcareous at a depth of about 40 inches.

Lithosols

Lithosols are a group of soils that have no clearly expressed soil morphology and consist of a freshly and imperfectly weathered mass of rock fragments. These soils have only an A and a C or R horizon, and they are generally steep. The only Lithosols mapped in Wabasha County are the Sogn soils.

SOGN SERIES

The Sogn series consists of dark-colored Lithosols that are very shallow over limestone. The soils are gently sloping to steep and are on the tops of old landforms. They formed under prairie grasses in material weathered from limestone of the Platteville and Galena formations.

The Sogn soils are associated with the Dodgeville soils. They developed entirely in material weathered from limestone, however, rather than partly in loess.

Representative profile of a Sogn silt loam in a pasture on a ridgetop where the slope is 3 percent (NE¼SW¼ sec. 34, T. 108 N., R. 12 W.):

A1—0 to 3 inches, black (10YR 2/1) to very dark brown (10YR 2/2) silt loam; moderate, medium, granular structure; friable; moderately calcareous; clear, wavy boundary.

A12—3 to 7 inches, very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) silt loam; moderate, medium, granular structure; friable; many fragments of light yellowish-brown (10YR 6/4) limestone; moderately calcareous; abrupt, wavy boundary.

R—7 inches +, light yellowish-brown (10YR 6/4), platy, fragmented limestone bedrock.

Range in characteristics.—The thickness of the combined A horizons ranges from 3 to 12 inches. Fragments of limestone are on the surface as well as in the profile.

Regosols

Regosols consist of deep deposits of loess, sand, or gravel in which little or no profile development has taken place. Their A horizon is thin, and their B horizon is either absent or is only slightly developed. The rest of the profile is the C horizon. The Bold, Boone, Plainfield, and Sparta soils are in this great soil group, but the Sparta soils are intergrading toward the Brunizem great soil group.

The Bold soils are deep, and they formed in calcareous loess. The Plainfield and Boone soils formed in sand or in material weathered from sandstone, but they differ in mode of origin and in position on the landscape. The Plainfield soils are on stream terraces, and their parent material is coarse sand containing fine gravel. The Boone soils developed in material from disintegrated sandstone.

BOLD SERIES

The Bold series consists of Regosols that formed under hardwoods in deep, coarse-textured, calcareous loess. These soils are on the uplands where the rolling to steep slopes are complex and irregular.

The Bold soils are associated with the Seaton soils. They are somewhat similar to those soils, but their profile shows less development.

Representative profile of a Bold silt loam, in a cultivated field where the slope is 17 percent (NW¼NW¼ sec. 24, T. 109 N., R. 14 W.):

Ap—0 to 6 inches, dark-brown (10YR 3/3) silt loam that has streaks of brown (10YR 5/3); weak, thin, platy structure; very friable; moderately calcareous; abrupt, smooth boundary.

C1—6 to 13 inches, brown (10YR 5/3) silt loam that has streaks of light gray (10YR 7/2) when dry; cloddy; very friable; moderately calcareous; abrupt, smooth boundary.

C2—13 to 50 inches, brown (10YR 5/3) silt loam that has streaks of light gray (10YR 7/2) when dry and a few, distinct mottles of strong brown (7.5YR 5/6) at a depth of 40 inches or more; single grain to massive (structureless); very friable; moderately calcareous; abrupt, smooth boundary.

IIC3—50 to 53 inches, dark yellowish-brown (10YR 4/4) clay loam; massive (structureless); firm; moderately calcareous; abrupt, smooth boundary.

IIR—53 inches +, limestone bedrock.

Range in characteristics.—The thickness of the surface layer ranges from 0 to 8 inches. Depth to bedrock ranges from 4 feet to more than 10 feet. The silt loam throughout the profile has a high proportion of coarse silt. In some areas the texture throughout the profile is very fine sandy loam.

BOONE SERIES

The Boone series consists of excessively drained Regosols developed under forest in fine and medium sands derived from sandstone. In most places sandstone is within 3 feet of the surface. In the western part of the county, the Boone soils are dominantly from the St. Peter formation. In the eastern part of the county, they are steep and occupy positions immediately below outcrops of Jordan sandstone on the bluffs. In other parts of the county, they occur wherever sandstone outcrops, but most of the areas are more gently sloping.

The Boone soils contain more sand than the Hixton soils, and they lack development of a textural B horizon. Unlike the Plainfield soils, which overlie loose or stratified sand, the Boone soils overlie sandstone. Normally, they are strongly acid.

Representative profile of a Boone loamy fine sand on a north-facing slope of 4 percent (center of SE¼SE¼ sec. 35, T. 108 N., R. 12 W.):

Ap—0 to 5 inches, dark-brown (10YR 3/3) loamy fine sand; single grain (structureless); loose; many grass roots; medium acid; abrupt, smooth boundary.

A2—5 to 9 inches, dark-brown (10YR 3/3) fine sand; single grain (structureless); loose; a few grass roots; medium acid; abrupt, smooth boundary.

B21—9 to 19 inches, dark-brown (7.5YR 4/4) fine sand; single grain (structureless); loose; strongly acid; clear, wavy boundary.

B22—19 to 28 inches, dark-brown (7.5YR 4/4) to yellowish-brown (10YR 5/4) fine sand; single grain (structureless); loose; strongly acid; clear, wavy boundary.
C—28 to 36 inches, light yellowish-brown (10YR 6/4) to brownish-yellow (10YR 6/6) fine sand splotched with dark brown (7.5YR 4/4) and brownish yellow (10YR 6/8); single grain (structureless); loose; strongly acid; abrupt, wavy boundary.
R—36 inches +, very strongly acid sandstone.

Range in characteristics.—The color of the surface layer ranges from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2), but it is dark brown (10YR 3/3) in a few places under grass. The color of the profile varies somewhat, as a result of differences in the color of the parent material. Depth to bedrock ranges from 12 to 42 inches or more. Outcrops of sandstone occur in a few places. Fragments of sandstone, intermingled with a few pebbles of mixed origin, are scattered on the surface.

PLAINFIELD SERIES

The Plainfield series consists of droughty, excessively drained Regosols on stream terraces. These soils developed under forest in alluvial sands that are deep and acid. The parent material is sand that is largely quartz but contains a small amount of other minerals.

The Plainfield soils are associated with the Sparta soils, but they have a thinner and lighter colored A horizon than those soils. The slopes range from nearly level to moderate.

Representative profile of a Plainfield fine sand in a cultivated field where the slope is 5 percent (SW¼SE¼ NE¼ sec. 2, T. 110 N., R. 10 W.):

Ap—0 to 7 inches, dark-brown (10YR 3/3) to dark yellowish-brown (10YR 3/4) fine sand to loamy fine sand; single grain (structureless); loose; medium acid; abrupt, smooth boundary.
B2—7 to 22 inches, dark-brown (7.5YR 3/4) fine and medium sand; single grain (structureless); loose; medium acid; abrupt, smooth boundary.
B3—22 to 26 inches, dark-brown (7.5YR 3/4) medium sand; single grain (structureless); loose; strongly acid to medium acid; abrupt, smooth boundary.
C—26 to 60 inches +, dark yellowish-brown (10YR 3/4) medium and coarse sand; single grain (structureless); loose; medium acid.

Range in characteristics.—The thickness of the surface layer ranges from 2 to 9 inches, and that of the subsoil, from 18 to 50 inches. In many places the profile is more strongly acid than the profile described as typical for the series. The color of the sand underlying the subsoil ranges from dark yellowish brown to brownish yellow or pale yellow. Throughout the profile, fine gravel is mixed with the sand in places.

SPARTA SERIES

The Sparta series consists of somewhat excessively drained Regosols that are intergrading toward Brunizems. The soils developed under sparse grasses in acid, sandy material that consists almost entirely of quartz sand. They are on stream terraces and are nearly level to gently sloping.

The Sparta soils are associated with the Plainfield soils. They have a thicker and darker A horizon than those soils.

Representative profile of Sparta loamy fine sand, 0 to 2 percent slopes, in a brushy pasture (southeast corner of sec. 2, T. 110 N., R. 10 W.):

A0—1 inch to 0, leaves, leaf duff, and grass.
A1—0 to 30 inches, very dark gray (10YR 3/1) loamy fine sand; weak, fine, granular structure to single grain (structureless); loose; medium acid; gradual, wavy boundary.
B1—30 to 40 inches, dark-brown (10YR 3/3) loamy fine sand; single grain (structureless); loose; strongly acid; abrupt, wavy boundary.
B3—40 to 44 inches, dark-brown (10YR 3/3) and yellowish-brown (10YR 5/4) sand; single grain (structureless); loose; strongly acid; abrupt, wavy boundary.
C—44 to 72 inches +, yellowish-brown (10YR 5/4) sand; single grain (structureless); loose; strongly acid.

Range in characteristics.—The thickness of the surface layer ranges from 6 to 30 inches, depending on the severity of wind erosion. In most places it is 12 to 20 inches thick. In areas that have been cultivated, the A0 horizon is absent.

Climate [4]

Wabasha County has a continental climate, typical of that in areas near the center of the great land mass that makes up the North American continent. Winters are cold. Summers are warm and are generally pleasant, but there are occasional periods when the days are hot and humid. The interaction between cold air from the north and warm, moist air from the south causes marked daily changes in temperature and precipitation. The greatest amount of precipitation falls during the warm season. The climate is uniform throughout the county because there are no pronounced differences in relief.

Until June 1, 1962, when an official substation for keeping records of temperature was established at Theilman, the county had no official temperature substation. Since 1894, however, records of temperature and precipitation have been kept at Zumbrota, in Goodhue County only a few miles from the county line of Wabasha County. The temperature and precipitation at Zumbrota are considered representative for most of Wabasha County, and therefore the data used in this report are based on those records. Table 9 gives temperature and precipitation data for Zumbrota. It shows the wide range of temperature to be expected, the probabilities of very high and of very low temperatures, and the greatest and smallest amount of precipitation to be expected 1 year in 10.

The mean (average) temperature for the months of December, January, and February is 17.8° F. In most winters the temperature drops to 20 to 25 degrees below zero, but the weather does not remain that cold for more than a day or two at a time. The average temperature for the months of June, July, and August is 70.3°. Days when the temperature reaches 100° or higher have occurred only 12 times in the past 30 years. Periods of hot, humid weather usually do not last long in summer, because cooler, drier air invades the region.

[4] By JOSEPH H. STRUB, JR., State climatologist, U.S. Weather Bureau.

TABLE 9.—*Temperature and precipitation for Wabasha County, Minn.*

[Data from Zumbrota, Goodhue County, Minn.]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average monthly total	One year in 10 will have—		Days with snow cover 1.0 inch or more	Average depth of snow on days with snow cover
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—		
	°F.	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Number*	*Inches*
January	25	5	42	−20	0.8	0.1	1.9	24	4
February	29	7	43	−15	.7	.1	1.6	23	5
March	39	19	61	− 6	1.5	.5	2.8	21	5
April	57	34	78	22	2.2	.7	4.0	2	1
May	71	46	86	31	3.5	1.2	6.7	(1)	
June	72	56	92	43	4.4	2.8	6.5	0	
July	85	60	95	48	3.7	1.2	8.1	0	
August	83	58	93	45	3.8	1.5	7.0	0	
September	74	49	90	33	3.4	.6	7.2	0	
October	62	38	81	23	1.8	.4	3.8	0	
November	42	24	61	3	1.4	.3	2.8	6	2
December	30	11	46	−11	.8	.3	1.5	18	3
Year	56	34	[2] 109	[3] −45	28.0	20.4	35.7	93	4

[1] Less than 0.5 day. [2] Highest maximum recorded. [3] Lowest minimum recorded.

The freeze-free period is long enough so that the crops commonly grown in the county reach maturity without much danger from damage by frost. The probability of certain temperatures occurring in spring and in fall is shown in table 10. In that table, for example, it is shown that 5 years out of 10, or 50 percent of the time, a temperature of 32° or lower can be expected to occur as late as May 12 in spring and as early as September 26 in fall. The latest date on which a temperature of 32° has occurred in spring is June 9, and the earliest date on which a temperature of 32° or lower has occurred in fall is August 30.

Table 11 shows figures for annual precipitation for the years 1952 through 1961 at Elgin, Lake City, Wabasha (Reads Landing), Theilman, and Zumbro Falls, as well as at Zumbrota. The normal amount of rainfall for

TABLE 10.—*Probabilities of last freezing temperatures in spring and first in fall, Wabasha County, Minn.*

[Data from records kept at Zumbrota, Goodhue County, Minn.]

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	36° F. or lower	40° F. or lower	50° F. or lower
Spring:								
1 year in 10, later than	April 9.	April 23.	May 2.	May 16.	May 28.	June 9.	June 22.	
2 years in 10, later than	April 3.	April 17.	April 26.	May 10.	May 22.	June 6.	June 16.	
5 years in 10, later than	March 24.	April 6.	April 16.	April 30.	May 12.	May 24.	June 5.	June 23.
Fall:								
1 year in 10, earlier than	October 21.	October 12.	October 3.	September 17.	September 11.	August 30.	August 10.	
2 years in 10, earlier than	October 27.	October 18.	October 8.	September 23.	September 17.	September 4.	August 17.	
5 years in 10, earlier than	November 9.	October 30.	October 19.	October 4.	September 26.	September 14.	August 31.	July 11.

TABLE 11.—*Annual precipitation at six locations for 1952 through 1961*

City	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Elgin [1]	28. 24	32. 24	35. 37	22. 27	31. 00	34. 34	20. 01	35. 98	24. 45	28. 29
Lake City [2]	24. 95	24. 03	37. 42	22. 53	26. 13	27. 23	20. 09	30. 29	23. 59	26. 69
Reads Landing near Wabasha	26. 32	28. 76	40. 33	26. 22	26. 00	27. 05	18. 17	29. 56	25. 28	27. 33
Theilman [3]	26. 67	29. 48	39. 67	26. 81	28. 11	31. 08	21. 99	35. 30	24. 01	29. 51
Zumbro Falls [4]	22. 04	29. 43	31. 42	21. 59	28. 15	31. 60	19. 52	40. 20	24. 36	24. 79
Zumbrota	20. 82	30. 03	33. 88	17. 46	24. 08	36. 16	23. 95	41. 17	25. 29	25. 44

[1] Records kept at this station since February 1, 1941.
[2] Records kept at this station since July 1, 1942.
[3] Records kept at this station since March 30, 1936.
[4] Records kept at this station since May 7, 1947.

Zumbrota for the period 1931 to 1960 is 28.02 inches, and the normal amount for Wabasha (Reads Landing) is 28.93 inches. The normal amount was not completed for the other stations shown in table 11.

In farming it is helpful if the farmer knows the probabilities of wet periods or dry periods so that he can plan his work. Table 12 gives the probabilities of receiving specified amounts of precipitation during the 1-week periods indicated, and table 13 gives the probabilities of receiving a specified amount of precipitation during the 3-week periods indicated. Precipitation is well distributed throughout the year, but almost 19 inches, or 67 percent of the annual precipitation, falls during the growing season of May through September.

Precipitation of 0.01 inch or more can be expected on an average of 100 days each year. Rainfall of an intensity of 1.10 inch per hour can be expected about once in 2 years. The total amount of rainfall for any 1 year ranges from as little as 17.46 inches, in 1955, to as much as 41.17 inches, in 1959. Rainfall is generally well distributed throughout the growing season, but there is too much precipitation in some years and too little in others. The heaviest rainfall occurs as a result of thunderstorms, and an average of about 38 of those storms occur annually. Some thunderstorms are accompanied by hail and damaging winds. Tornadoes are rare; only two tornadoes were reported in this county during the period 1916 to 1961.

The average amount of annual snowfall is nearly 45 inches. Measurable snowfall of 1 inch or more usually does not occur until mid-November or later. The last measurable snowfall in spring has occurred as early as the first 2 weeks in April. The greatest amount of snowfall in any 1 month was 31.2 inches, and the greatest amount in any 1 year was 66.8 inches, in 1936.

TABLE 12.—*Amounts and probability* [1] *of weekly precipitation (6)*

Date	Amount of precipitation in inches							
	None or a trace [2]	0.20	0.40	0.60	0.80	1.00	1.40	2.00
April 26 to May 2	11	77	63	49	38	28	14	4
May 3 to May 9	13	70	56	45	35	27	16	8
May 10 to May 16	8	69	50	35	25	19	8	3
May 17 to May 23	6	73	60	49	40	33	23	13
May 24 to May 30	15	72	59	51	42	35	26	15
May 31 to June 6	6	77	64	53	43	36	27	14
June 7 to June 13	2	88	76	64	53	44	30	16
June 14 to June 20	4	78	65	53	44	35	25	12
June 21 to June 27	6	79	68	58	50	43	32	19
June 28 to July 4	7	78	65	54	43	37	26	13
July 5 to July 11	9	72	58	47	36	29	19	9
July 12 to July 18	18	63	50	40	33	26	18	8
July 19 to July 25	9	64	49	35	27	21	13	5
July 26 to August 1	12	66	54	44	36	31	22	13
August 2 to August 8	13	67	58	49	42	36	27	17
August 9 to August 15	12	65	49	38	29	22	14	6
August 16 to August 22	11	71	57	46	37	29	23	9
August 23 to August 29	13	62	49	39	31	25	17	9
August 30 to September 5	12	70	56	45	36	27	16	8
September 6 to September 12	5	80	65	54	45	38	25	13
September 13 to September 19	10	72	57	45	36	29	19	8
September 20 to September 26	13	63	49	39	31	24	16	9
September 27 to October 3	30	51	38	28	22	16	10	4

[1] Probability expressed as a percentage, or number of times out of 100 that event can be expected to occur.
[2] A trace of precipitation is an amount too small to measure.

TABLE 13.—*Amount and probability* [1] *of precipitation for 3-week periods* (5)

Date	Amount of precipitation in inches							
	None or a trace [2]	0.20	0.40	0.60	0.80	1.00	1.40	2.00
March 1 to March 21	0	90	75	61	48	38	22	9
March 22 to April 11	2	95	87	77	66	56	36	19
April 12 to May 2	1	97	94	88	80	73	55	35
May 3 to May 23	0	99	97	94	89	83	69	48
May 24 to June 13	0	99	98	95	92	88	78	64
June 14 to July 4	0	100	99	98	95	92	84	69
July 5 to July 25	0	99	95	89	84	76	63	44
July 26 to August 15	0	95	88	80	75	70	60	47
August 16 to September 5	0	99	97	93	87	81	67	48
September 6 to September 26	0	100	98	93	88	83	71	53
September 27 to October 17	3	91	81	69	57	49	35	20
October 18 to November 7	5	84	72	58	48	39	26	15
November 8 to November 28	2	80	65	56	47	37	26	15
November 29 to December 19	2	75	55	40	26	21	10	4
December 20 to January 9	4	78	56	39	26	17	7	2
January 10 to January 30	3	81	56	35	21	12	4	1
January 31 to February 27	2	85	63	44	29	20	8	1

[1] Probability expressed as a percentage or number of times out of 100 that event can be expected to occur.
[2] A trace of precipitation is an amount too small to measure.

Dry spells occur occasionally in this county, although they are not frequent. The driest period from May through September in the years 1931 to 1960 occurred in 1949, when 9.82 inches of precipitation was recorded at Zumbrota and 10.93 inches was recorded at Wabasha (Reads Landing). Drought occurs whenever the supply of moisture for crops, either the supply from rainfall or that stored in the soil, becomes inadequate for plants. Each day there is inadequate moisture in the root zone is defined as a drought day. Table 14 gives the probabilities of drought days on soils of different moisture-storing capacities.

Wind speeds in this county range from an average of about 9 miles per hour in August to nearly 12 miles per hour in April. The prevailing direction of the wind is west northwest from November through April and southeasterly during the other months. The relative humidity at noon ranges from 51 percent in May to 72 percent in December. During a typical year, there are 92 days that are clear, 117 days that are partly cloudy, and 156 days that are cloudy. Heavy fog is not common, but it occurs on an average of 14 times each year.

TABLE 14.—*Probabilities of drought days on soils of different moisture-storing capacities at Zumbrota, Goodhue County, Minn.* (2)

Probability [1]	Minimum drought days if soil has total available moisture capacity of—			
	1 inch	3 inches	5 inches	7 inches
10	82	57	43	28
20	74	48	34	21
30	69	40	28	16
40	65	34	23	12
50	60	29	18	8
60	56	23	13	4
70	52	18	8	0
80	47	11	0	0
90	39	0	0	0

[1] Probability expressed as a percentage, or number of times out of 100 that event can be expected to occur.

Underlying Rocks (10)

The bedrock in Wabasha County has a monoclinal dip toward the southwest. As a result, the top of the Jordan sandstone is 1,050 feet above sea level in the most easterly township of the county, but it is at an elevation of only 850 feet in the southwestern corner of the county. This general monoclinal dip is interrupted by a series of faults that cut the formations in the region a few miles east of Mazeppa. Here, the rocks are displaced as much as 75 feet. The formations that underlie the county are shown in figure 18.

At Wabasha, granites of Precambrian age are at a depth of 440 feet, or about 260 feet above sea level. Red shales and sandstones that overlie the granite at Wabasha belong to the Eau Claire member of the Dresbach formation. It is assumed that the Hinckley sandstone and the red clastic series, which are more than 2,000 feet thick in adjoining Olmsted County, pinch out against the westward-sloping surface of the granite, somewhere between Rochester and Wabasha.

The St. Croixan series of the Cambrian system includes Dresbach sandstone, the Franconia formation, the St. Lawrence formation, and Jordan sandstone (fig. 19). The Dresbach sandstone, which is about 450 feet thick, is the deepest member of this series. Above the Dresbach sandstone lie the Franconia sandstones and shales, which are 100 to 165 feet thick. This formation is characterized

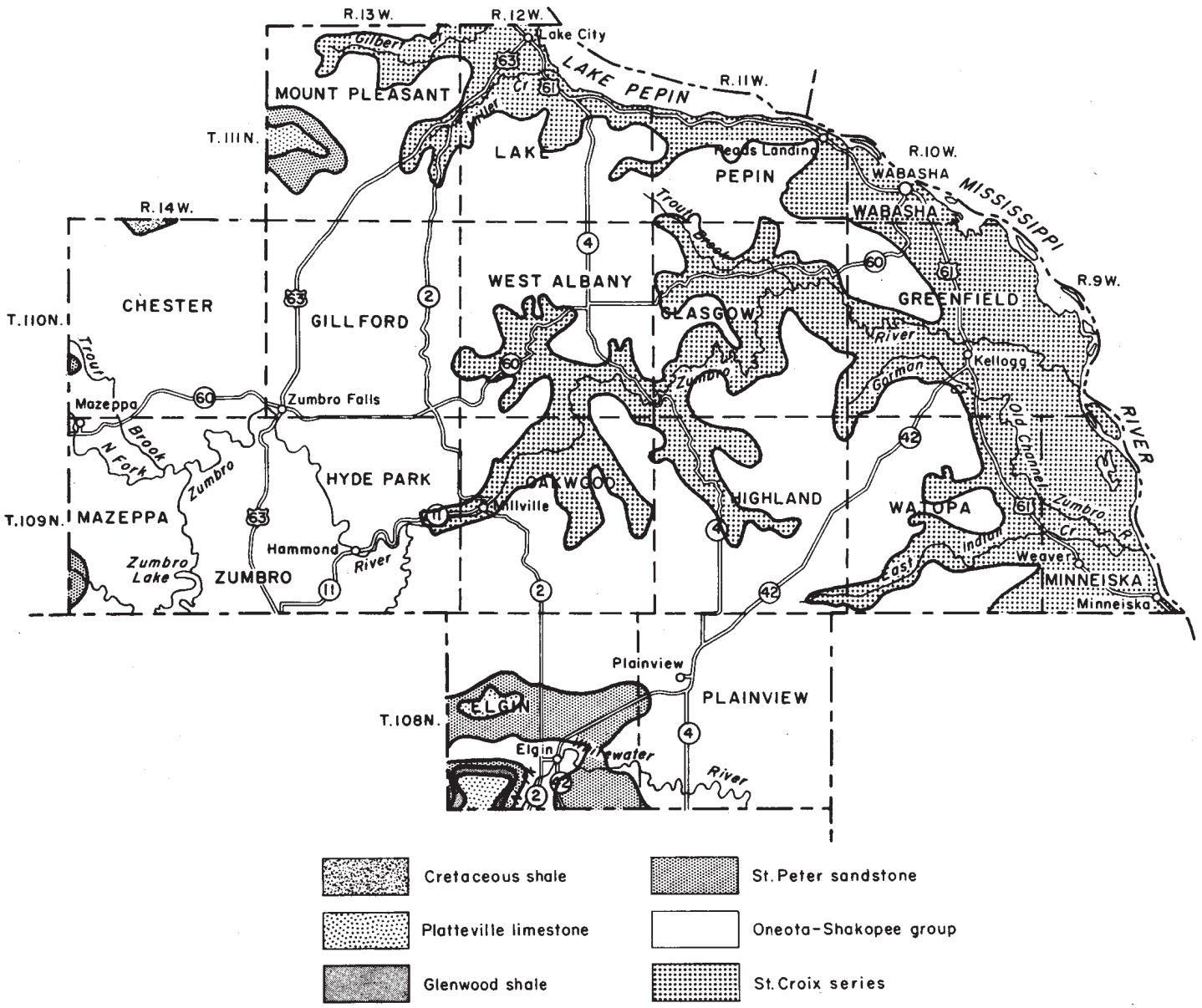

Figure 18.—**Geologic map of Wabasha County, showing the underlying rock formations.**

by the presence of glauconite, a greenish mineral. The St. Lawrence formation of dolomite, shale, and limestone overlies the Franconia. It is about 50 feet thick. Exposed above this formation, also in the bluff walls along the Mississippi River and its major tributaries, is the Jordan sandstone, which is 75 to 125 feet thick.

The next series of rocks, of which the Prairie Du Chien group is the basal member, were formed during Ordovician times. Oneota dolomitic limestone is the deepest member of this group, which also includes New Richmond sandstone and Shakopee limestone. The Oneota dolomite is thickly bedded and massive, and it contains a large amount of cherty material. It is about 145 feet thick. The New Richmond sandstone outcrops on the uplands several miles back from the bluffs of the Mississippi and Zumbro Rivers in the eastern part of the county. Its thickness varies, but in most places it is no more than 20 feet thick. The Shakopee limestone lies just below the glacial drift in a large area in the eastern and southern parts of the county. Its thickness ranges from 30 to 60 feet.

Around Elgin and Plainview, St. Peter sandstone overlies the Shakopee limestone. The St. Peter formation is almost pure quartz sandstone and has a characteristic white color. The extensive flats around Elgin are underlain by St. Peter sandstone, and the formation also outcrops in the west-central part of Mount Pleasant Township. Where the upper part of the St. Peter sandstone has not been removed by erosion, that formation is about 100 feet thick.

The hills south of Elgin are of St. Peter sandstone, capped by a thin formation of Glenwood shale and Platteville limestone. The limestone is not more than 15 feet thick, and the shale is less than 4 feet thick.

733-993—65——9

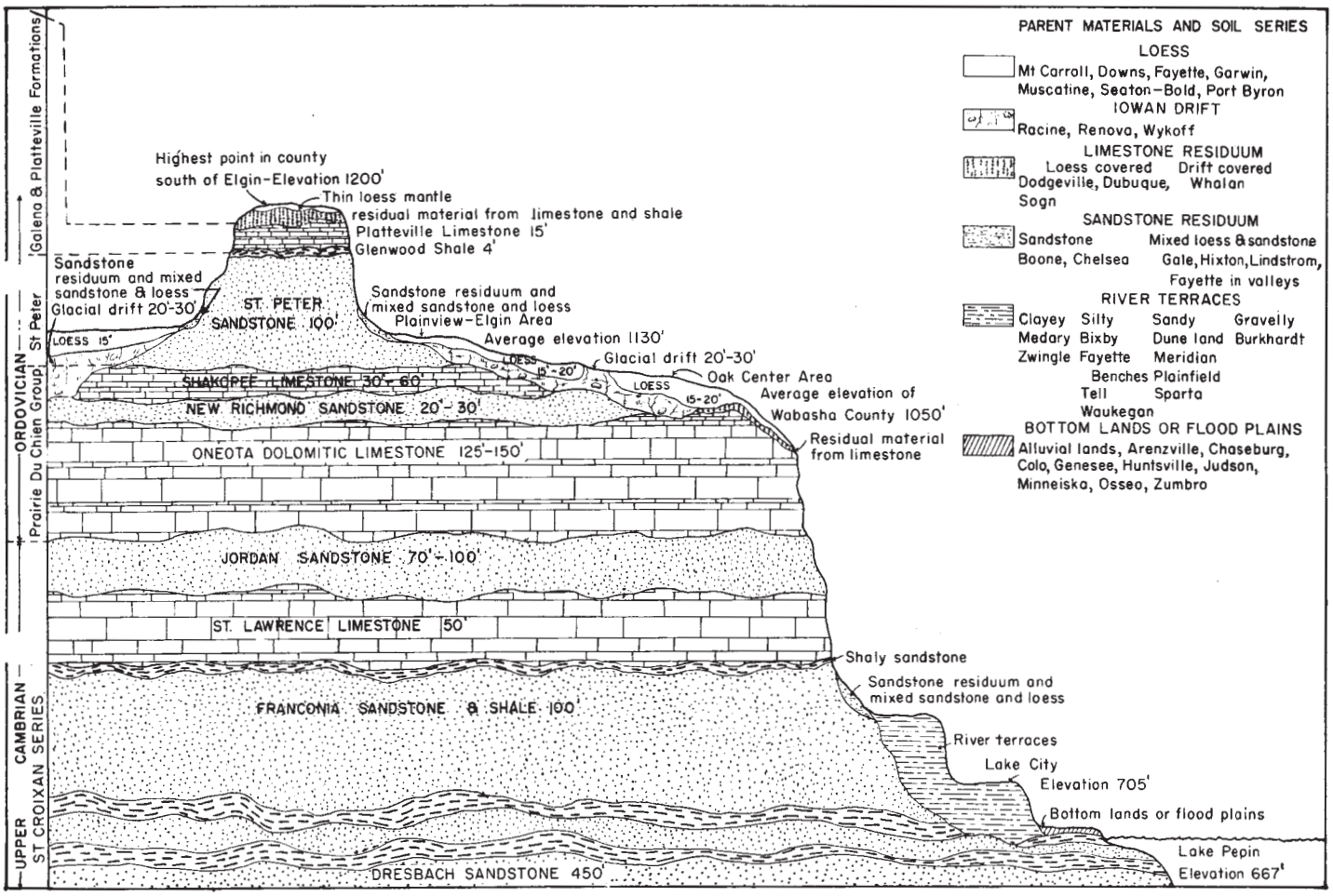

***Figure 19.*—Geologic cross section of Wabasha County.**

Additional Facts About the County

This section contains information about the agriculture of the county. It also describes the transportation, markets, industries, and recreational facilities.

Agriculture.—Wabasha County is largely agricultural. In 1959 there were 1,408 farms in the county, and the average-sized farm was 216.9 acres. About 14.3 percent of these farms was operated by tenants.

Wheat, corn, oats, barley, and potatoes were grown for sale as early as 1860. Wheat was the foremost crop early in the history of the county. Of a total of 98,858 acres of cropland in 1874, wheat was grown on 62,822 acres, corn on 8,081 acres, oats on 5,364 acres, barley on 3,220 acres, and potatoes on 686 acres. In 1880 wheat production reached its peak, however, and soon after that the production of wheat declined. Dairying and diversified farming gained in importance. In 1959 wheat was harvested for grain on only 2,415 acres.

A total of 57,823 acres of corn and 39,055 acres of oats was harvested for grain in 1959. In that year soybeans were grown for all purposes on 7,876 acres, and hay was cut from 43,749 acres.

Livestock are a major source of income in this county. In 1959 there were 61,305 cattle and calves, 750 horses and mules, 66,984 hogs and pigs, and 24,361 sheep and lambs in the county. There were also 213,703 chickens 4 months old and older. In addition 57,020 turkeys and turkey fryers were raised.

Modern tractors are the main source of power on the farms, and combines, cornpickers, and balers are common equipment. Threshing machines, formerly used for harvesting grain, are rarely seen, and grain is generally combined instead of shocked. Practically all of the farms have electricity. Telephones were reported on 1,267 farms in 1959.

Two large nurseries are located at Lake City. They produce many different kinds of nursery stock for retail and wholesale markets.

Transportation and markets.—This county has a good system of roads. U.S. Highways Nos. 61 and 63 cross the county and are suitable for carrying heavy loads. Minnesota State Highways Nos. 42 and 60 are blacktopped roads, and there are several important blacktopped county roads. Good gravelled roads that are maintained by the county or the township serve most of the farms.

Marketing facilities are good. Milk is usually marketed as whole milk, and there is daily pickup service by truck. Large processing plants where dairy products are processed are located at Rochester and Oak Center. Livestock are shipped by truck for marketing in South St. Paul.

Grain elevators are located at Lake City, Bellechester, and Elgin. There are facilities for shipping and processing soybeans and flax at Red Wing, and flourmills at Lake City and Wabasha. Several manufacturing plants are located in Lake City, and canning plants for peas and sweet corn are located at Plainview and Rochester.

Recreational facilities.—Recreational facilities in this county consist mainly of facilities for fishing, boating, water skiing, and huntng deer, squirrel, pheasant, and waterfowl. Lake Pepin, Lake Zumbro, and the Mississippi River are popular for fishing, boating, and water skiing, and they are among the more productive fishing waters in the State. Nearly all kinds of fish caught in Minnesota can be found in Wabasha County.

Marinas are located at Lake City and Wabasha, and additional ones could be developed profitably. Fishing barges and small boats for fishing can be rented at various resorts and fishing camps along Lake Zumbro, Lake Pepin, and the Mississippi River.

The areas suitable for hunting various kinds of game are shown in figures in the section "Management of Wildlife." Hunters have had greater success in shooting deer in this county than in counties farther north in Minnesota.

Opportunities for the development of recreational facilities are numerous in this county. For example, additional resorts for tourists who are vacationing could be developed along the Mississippi River. Overnight camping and picnic sites could also be developed in many areas of the county, which is entirely within the Minnesota Memorial Hardwood Forest. Many areas along the Mississippi and Zumbro Rivers and along Lake Pepin and Lake Zumbro would be suitable for these facilities. If sediment can be controlled, several small streams present good possibilities for development as trout streams.

Other possibilities include the development of facilities for winter skiing and development of golf courses and hiking or riding trails. Several sites along the bluffs bordering the stream valleys in the county have potential for winter skiing.

Golf courses and hiking or riding trails should be developed in cooperation with existing and future resorts and camping sites. Such facilities can be developed by individuals or by groups of individuals, each providing one or more facilities. Hiking or riding trails might extend over several farms, and the horses and stables could be provided on one farm. Facilities for picnicking and camping may be integrated with these, either on the same farms or within short driving distance. Resorts that provide facilities for hiking, riding, or golf, in addition to facilities for fishing, boating, and swimming are likely to be even more popular than they are at the present time. Sites for picnics or parks could be developed on the top of bluffs where scenic views of the valley along the Mississippi River may be seen and enjoyed.

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Glossary

Acidity, soil. The degree of acidity or alkalinity of a soil mass, expressed in either pH value or in words. A soil that tests to pH 7.0 is precisely neutral in reaction, because it is neither acid nor alkaline.

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline.	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Aggregate, soil. Many fine soil particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alluvium (alluvial deposits). Soil material, such as sand, silt, or clay that has been deposited on land by streams.

Bulk density. The mass or weight of ovendry soil per unit bulk volume, including air space. Formerly called apparent density, or volume weight.

Calcareous soil. An alkaline soil that contains enough calcium carbonate to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Catena. A sequence, or chain, of soils on a landscape, developed from one kind of parent material but having different characteristics because of differences in relief and drainage.

Chert. A structureless form of silica, closely related to flint, that breaks into angular fragments. Soils developed from impure limestone containing fragments of chert and having abundant quantities of these fragments in the soil mass are called cherty soils.

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. See also Texture, soil.

Colluvium. Mixed deposits of soil material and rock fragments at the base of rather steep slopes. The deposits have accumulated as the result of soil creep, slides, or local wash.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose. Noncoherent; will not hold together in a mass.

Friable. When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm. When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic. When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky. When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard. When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft. When dry, breaks into powder or individual grains under very slight pressure

Cemented. Hard and brittle; little affected by moistening.

Drainage, soil. The rapidity and extent of the removal of water from the soil by runoff, by flow through the soil to underground spaces, or by a combination of both processes.

Drift (geology). Material of any sort deposited by geological processes in one place after having been removed from another. *Glacial drift* consists of earth, sand, gravel, and boulders deposited by glaciers and by the streams and lakes associated with glaciers. It includes *glacial till*, which is not stratified, and *glacial outwash*, which is stratified.

Driftless Area. An area of about 15,000 square miles that was not covered by the continental ice cap, despite the fact that the ice several times advanced far south of it. This area covers part of Minnesota and extends into Wabasha County.

Duff. The matted, partly decomposed organic surface layer on forested soils.

Eluviation. The movement of material from one place to another within the soil, in either true solution or colloidal suspension. Soil horizons that have lost material through eluviation are said to be eluvial; those that have received material are illuvial. With an excess of rainfall over evaporation, eluviation may take place either downward or laterally, according to the direction of water movement. See also Illuviation.

First bottom. The normal flood plain of a stream, subject to flooding.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

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 that have yellow and gray mottling caused by intermittent waterlogging.

Granular structure. Soil structure in which the individual grains are grouped into spherical aggregates that have indistinct sides. Highly porous granules are commonly called crumbs. A well-granulated soil has the best structure for most ordinary crop plants. See also Structure, soil.

Great soil group. Any one of several broad groups of soils that have fundamental characteristics in common.

Horizon, soil. A layer of soil, approximately parallel to the soil surface, that has distinct characteristics produced by soil-forming processes.

Humus. The well-decomposed, more or less stable part of the organic matter in mineral soils.

Illuviation. The accumulation of material in a soil horizon through the deposition of suspended mineral and organic matter originating from horizons above. Since at least part of the fine clay in the B horizon of many soils has moved from the A horizon above, the B horizon is called an illuvial horizon. See also Eluviation.

Leaching. The removal of materials in solution by the passage of water through the soil.

Liquid limit. The moisture content at which the soil material passes from a plastic to a liquid state. See also Plastic limit.

Loam. The textural class name for soils that contain a moderate amount of sand, silt, and clay. Loam soils are 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. See also Texture, soil.

Loess. A geological deposit of relatively uniform, silty material that has been transported to its present position by wind.

Maximum density. The highest density obtained in the compaction test. See also Optimum moisture content.

Muck. Highly decomposed organic soil material developed from peat. Generally, muck has a higher content of minerals or ash than peat, and it is decomposed to such a degree that the original plant parts cannot be identified.

"Off-site" oak. Oak growing in an area that is better suited to other kinds of trees or other kinds of vegetation.

Optimum moisture content. The moisture content at which a soil material yields the highest density in the standard or modified test for optimum moisture and maximum density.

Parent material. The unconsolidated mass of material from which the soil develops.

Peat. Unconsolidated soil material, consisting largely of undecomposed or slightly decomposed organic matter, accumulated where there has been excessive moisture.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *Very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating acidity and alkalinity. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Plastic limit. The moisture content at which a soil material passes from a semisolid to a plastic state.

Plow planting. See Wheel-track planting.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction. See Acidity, soil.

Residuum. Unconsolidated, partly weathered mineral material that accumulates over disintegrating solid rock. Residuum is not soil but is frequently the material in which a soil has formed.

Sand. Individual rock or mineral fragments in soils having a diameter ranging from 0.05 millimeter 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 of sand and not more than 10 percent clay. See also Texture, soil.

Scalping. Removal of the sod or other vegetation, before or at the time of tree planting, to reduce competition with the tree.

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. See also Texture, soil.

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 soils includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying parent material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular) and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer beneath the solum, or true soil. It may refer to the parent material or to layers below the B horizon.

Surface layer. That part of the soil from the actual surface to the first change in color, texture, or structure; generally, the plow layer or its equivalent; normally about 5 to 8 inches in thickness, but may be as thick as 18 inches. See also Horizon, soil.

Terrace, agricultural. An embankment or ridge constructed across slopes, on the contour, or at a slight angle to the contour. The terrace intercepts and slows surface runoff so that it may soak into the soil or flow slowly and harmlessly to a prepared outlet. 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. A *broad-base* terrace is one built on slopes gentle enough to be farmed; it is used on permeable soils. A *level* terrace is one built across a slope on the contour, as contrasted to a *graded* terrace built at a slight angle to the contour. A *level* terrace is used only on soils that are permeable enough to permit all of the storm water to soak into the soil, so that none will break over the terrace to cause gullies.

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 loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Till, glacial. An unstratified deposit of earth, sand, gravel, and boulders transported by glaciers.

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.

Topsoil. A presumably fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Variant, soil. A soil that has properties sufficiently different from those of other known soils to justify a new series name, but whose geographic area is so limited that creation of a new series is not believed to be justified.

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.

Wheel-track planting. Planting a crop at the time the soil is plowed, or soon after, without additional tillage operations to prepare a seedbed. Sometimes called plow planting.

U.S. GOVERNMENT PRINTING OFFICE:1965

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GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND WOODLAND SUITABILITY GROUPS

[See table 1 , p. 6 , for the acreage and proportionate extent of the soils, and table 2 , p. 54 , for the estimated yields. To find the engineering properties of the soils, see the section beginning on p. 72]

Map symbol	Mapping unit	Page	Capability unit		Woodland suitability group	
			Symbol	Page	Number	Page
Ad	Alluvial land	8	VIw-1	53	14	70
Aw	Alluvial land, wet	8	VIIw-1	53	15	70
Az	Arenzville silt loam	8	IIw-3	42	14	70
BbA	Bixby loam, 0 to 2 percent slopes	9	IIs-1	42	16	70
BbB	Bixby loam, 2 to 6 percent slopes	9	IIe-5	40	1	64
BbB2	Bixby loam, 2 to 6 percent slopes, moderately eroded	9	IIe-5	40	1	64
BfE	Boone loamy fine sand, 18 to 35 percent slopes	9	VIIs-1	54	13	69
BhB	Boone and Chelsea loamy fine sands, 2 to 6 percent slopes	9	IVs-1	51	8	67
BhC	Boone and Chelsea loamy fine sands, 6 to 12 percent slopes	9	VIIs-1	54	13	69
BhD	Boone and Chelsea loamy fine sands, 12 to 18 percent slopes	10	VIIs-1	54	13	69
BkA	Burkhardt gravelly sandy loam, 0 to 2 percent slopes	10	IVs-2	51	9	68
BkB2	Burkhardt gravelly sandy loam, 2 to 6 percent slopes, moderately eroded	10	IVs-2	51	9	68
BrA	Burkhardt loam, 0 to 2 percent slopes	10	IIIs-1	47	6	67
BrB	Burkhardt loam, 2 to 6 percent slopes	10	IIIs-2	47	6	67
BtA	Burkhardt sandy loam, 0 to 2 percent slopes	10	IIIs-1	47	6	67
BtB	Burkhardt sandy loam, 2 to 6 percent slopes	10	IIIs-2	47	6	67
BtB2	Burkhardt sandy loam, 2 to 6 percent slopes, moderately eroded	10	IIIs-2	47	6	67
BtC2	Burkhardt sandy loam, 6 to 12 percent slopes, moderately eroded	10	IVe-6	51	10	68
CaB	Chaseburg fine sandy loam, 2 to 6 percent slopes	11	IIw-4	42	14	70
ChA	Chaseburg silt loam, 0 to 2 percent slopes	11	IIw-3	42	14	70
ChB	Chaseburg silt loam, 2 to 6 percent slopes	11	IIw-4	42	14	70
Co	Colo silty clay loam	11	IIw-3	42	14	70
DdC2	Dodgeville silt loam, 6 to 12 percent slopes, moderately eroded	12	IIIe-3	44	1	64
DdD2	Dodgeville silt loam, 12 to 18 percent slopes, moderately eroded	12	IVe-3	49	2	65
DgC2	Dodgeville silt loam, shallow, 6 to 12 percent slopes, moderately eroded	12	IVe-5	50	11	68
DgD	Dodgeville silt loam, shallow, 12 to 18 percent slopes	12	VIe-2	52	11	68
DgD2	Dodgeville silt loam, shallow, 12 to 18 percent slopes, moderately eroded	12	VIe-2	52	11	68
DgE2	Dodgeville silt loam, shallow, 18 to 35 percent slopes, moderately eroded	12	VIIe-1	53	5	66
DhA	Downs and Mt. Carroll silt loams, 0 to 2 percent slopes	13	I-1	36	16	70
DhB	Downs and Mt. Carroll silt loams, 2 to 6 percent slopes	13	IIe-1	37	16	70
DhB2	Downs and Mt. Carroll silt loams, 2 to 6 percent slopes, moderately eroded	13	IIe-1	37	16	70
DhC	Downs and Mt. Carroll silt loams, 6 to 12 percent slopes	13	IIIe-1	43	1	64
DhC2	Downs and Mt. Carroll silt loams, 6 to 12 percent slopes, moderately eroded	13	IIIe-1	43	1	64
DhD	Downs and Mt. Carroll silt loams, 12 to 18 percent slopes	13	IVe-1	48	3	65
DhD2	Downs and Mt. Carroll silt loams, 12 to 18 percent slopes, moderately eroded	13	IVe-1	48	3	65
DmA	Downs and Mt. Carroll silt loams, benches, 0 to 2 percent slopes	13	I-1	36	16	70
DmB	Downs and Mt. Carroll silt loams, benches, 2 to 6 percent slopes	13	IIe-1	37	16	70

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND WOODLAND SUITABILITY GROUPS

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Map symbol	Mapping unit	Page	Capability unit		Woodland suitability group	
			Symbol	Page	Number	Page
DnB	Dubuque silt loam, 2 to 6 percent slopes	14	IIe-3	39	1	64
DnB2	Dubuque silt loam, 2 to 6 percent slopes, moderately eroded	14	IIe-3	39	1	64
DnC	Dubuque silt loam, 6 to 12 percent slopes	14	IIIe-3	44	1	64
DnC2	Dubuque silt loam, 6 to 12 percent slopes, moderately eroded	14	IIIe-3	44	1	64
DnD	Dubuque silt loam, 12 to 18 percent slopes	14	IVe-3	49	2	65
DnD2	Dubuque silt loam, 12 to 18 percent slopes, moderately eroded	14	IVe-3	49	2	65
DnE	Dubuque silt loam, 18 to 25 percent slopes	14	VIe-1	52	4	66
DnF	Dubuque silt loam, 25 to 35 percent slopes	14	VIe-1	52	4	66
DrB	Dubuque silt loam, shallow, 2 to 6 percent slopes	15	IIIe-5	45	7	67
DrB2	Dubuque silt loam, shallow, 2 to 6 percent slopes, moderately eroded	15	IIIe-5	45	7	67
DrC2	Dubuque silt loam, shallow, 6 to 12 percent slopes, moderately eroded	15	IVe-5	50	11	68
DrD	Dubuque silt loam, shallow, 12 to 18 percent slopes	15	VIe-2	52	11	68
DrD2	Dubuque silt loam, shallow, 12 to 18 percent slopes, moderately eroded	15	VIe-2	52	11	68
DrE	Dubuque silt loam, shallow, 18 to 25 percent slopes	15	VIIe-1	53	5	66
DrF	Dubuque silt loam, shallow, 25 to 35 percent slopes	15	VIIe-1	53	5	66
DsD3	Dubuque soils, 12 to 18 percent slopes, severely eroded	16	VIe-1	52	2	65
DtD3	Dubuque soils, shallow, 12 to 18 percent slopes, severely eroded	16	VIIe-1	53	5	66
DtE3	Dubuque soils, shallow, 18 to 25 percent slopes, severely eroded	16	VIIe-1	53	5	66
Du	Dune land	16	VIIs-1	54	13	69
FaA	Fayette silt loam, uplands, 0 to 2 percent slopes	16	I-2	36	16	70
FaB	Fayette silt loam, uplands, 2 to 6 percent slopes	16	IIe-2	37	16	70
FaB2	Fayette silt loam, uplands, 2 to 6 percent slopes, moderately eroded	16	IIe-2	37	16	70
FaC	Fayette silt loam, uplands, 6 to 12 percent slopes	17	IIIe-2	43	1	64
FaC2	Fayette silt loam, uplands, 6 to 12 percent slopes, moderately eroded	17	IIIe-2	43	1	64
FaC3	Fayette silt loam, uplands, 6 to 12 percent slopes, severely eroded	17	IVe-2	48	1	64
FaD	Fayette silt loam, uplands, 12 to 18 percent slopes	17	IVe-2	48	3	65
FaD2	Fayette silt loam, uplands, 12 to 18 percent slopes, moderately eroded	17	IVe-2	48	3	65
FaD3	Fayette silt loam, uplands, 12 to 18 percent slopes, severely eroded	17	VIe-1	52	3	65
FaE2	Fayette silt loam, uplands, 18 to 25 percent slopes, moderately eroded	17	VIe-1	52	4	66
FaE3	Fayette silt loam, uplands, 18 to 25 percent slopes, severely eroded	17	VIe-1	52	4	66
FaF2	Fayette silt loam, uplands, 25 to 35 percent slopes, moderately eroded	17	VIe-1	52	4	66
FbA	Fayette silt loam, benches, 0 to 2 percent slopes	18	I-2	36	16	70
FbB	Fayette silt loam, benches, 2 to 6 percent slopes	18	IIe-2	37	16	70
FbB2	Fayette silt loam, benches, 2 to 6 percent slopes, moderately eroded	18	IIe-2	37	16	70
FbC	Fayette silt loam, benches, 6 to 12 percent slopes	18	IIIe-2	43	1	64

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND WOODLAND SUITABILITY GROUPS

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Map symbol	Mapping unit	Page	Capability unit		Woodland suitability group	
			Symbol	Page	Number	Page
FbC2	Fayette silt loam, benches, 6 to 12 percent slopes, moderately eroded	18	IIIe-2	43	1	64
FcB	Fayette silt loam, valleys, 2 to 6 percent slopes	18	IIe-2	37	16	70
FcB2	Fayette silt loam, valleys, 2 to 6 percent slopes, moderately eroded	18	IIe-2	37	16	70
FcC	Fayette silt loam, valleys, 6 to 12 percent slopes	18	IIIe-2	43	1	64
FcC2	Fayette silt loam, valleys, 6 to 12 percent slopes, moderately eroded	18	IIIe-2	43	1	64
FcD	Fayette silt loam, valleys, 12 to 18 percent slopes	18	IVe-2	48	3	65
FcD2	Fayette silt loam, valleys, 12 to 18 percent slopes, moderately eroded	19	IVe-2	48	3	65
FcE2	Fayette silt loam, valleys, 18 to 25 percent slopes, moderately eroded	19	VIe-1	52	4	66
FcF	Fayette silt loam, valleys, 25 to 35 percent slopes	19	VIe-1	52	4	66
FrB2	Fayette-Renova silt loams, 2 to 6 percent slopes, moderately eroded	19	IIe-2	37	16	70
FrC2	Fayette-Renova silt loams, 6 to 12 percent slopes, moderately eroded	19	IIIe-2	43	1	64
FrD2	Fayette-Renova silt loams, 12 to 18 percent slopes, moderately eroded	20	IVe-2	48	3	65
GaB2	Gale silt loam, 2 to 6 percent slopes, moderately eroded	20	IIe-5	40	1	64
GaC2	Gale silt loam, 6 to 12 percent slopes, moderately eroded	20	IIIe-4	45	2	65
GaD2	Gale silt loam, 12 to 18 percent slopes, moderately eroded	20	IVe-4	49	2	65
GhC2	Gale-Hixton complex, shallow, 6 to 12 percent slopes, moderately eroded	20	IVe-6	51	10	68
GhD2	Gale-Hixton complex, shallow, 12 to 18 percent slopes, moderately eroded	21	VIe-3	52	12	69
GhE2	Gale-Hixton complex, shallow, 18 to 25 percent slopes, moderately eroded	21	VIIe-1	53	12	69
Gm	Garwin silt loam	21	IIIw-3	46	17	71
Gn	Genesee sandy loam	21	IIw-3	42	14	70
Gs	Genesee silt loam	21	IIw-3	42	14	70
HfB	Hixton fine sandy loam, 2 to 6 percent slopes	22	IIIe-6	46	6	67
HfC	Hixton fine sandy loam, 6 to 12 percent slopes	22	IVe-6	51	10	68
HfD	Hixton fine sandy loam, 12 to 18 percent slopes	22	VIe-3	52	12	69
HfE	Hixton fine sandy loam, 18 to 35 percent slopes	22	VIIe-1	53	12	69
Hu	Huntsville silt loam	22	IIw-3	42	14	70
JuA	Judson silt loam, 0 to 2 percent slopes	22	IIw-3	42	14	70
JuB	Judson silt loam, 2 to 6 percent slopes	22	IIw-4	42	14	70
LnB	Lindstrom silt loam, 2 to 6 percent slopes	23	IIe-1	37	16	70
LnC	Lindstrom silt loam, 6 to 12 percent slopes	23	IIIe-1	43	1	64
LnC2	Lindstrom silt loam, 6 to 12 percent slopes, moderately eroded	23	IIIe-1	43	1	64
LnD	Lindstrom silt loam, 12 to 18 percent slopes	23	IVe-1	48	3	65
LnD2	Lindstrom silt loam, 12 to 18 percent slopes, moderately eroded	23	IVe-1	48	3	65
LnE2	Lindstrom silt loam, 18 to 25 percent slopes, moderately eroded	23	VIe-1	52	4	66
MbA	Medary silt loam, brown variant, 0 to 2 percent slopes	23	I-2	36	16	70
MbB	Medary silt loam, brown variant, 2 to 6 percent slopes	24	IIe-2	37	16	70
MdA	Meridian sandy loam, 0 to 2 percent slopes	24	IIIs-1	47	6	67
MdB	Meridian sandy loam, 2 to 6 percent slopes	24	IIIe-6	46	6	67
MdB2	Meridian sandy loam, 2 to 6 percent slopes, moderately eroded	24	IIIe-6	46	6	67

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND WOODLAND SUITABILITY GROUPS

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Map symbol	Mapping unit	Page	Capability unit		Woodland Suitability group	
			Symbol	Page	Number	Page
MdC	Meridian sandy loam, 6 to 12 percent slopes	24	IVe-6	51	10	68
MdC2	Meridian sandy loam, 6 to 12 percent slopes, moderately eroded	24	IVe-6	51	10	68
Mn	Minneiska silt loam	24	IIw-3	42	14	70
MuA	Muscatine silt loam, 0 to 2 percent slopes	25	IIw-1	41	17	71
MuB	Muscatine silt loam, 2 to 6 percent slopes	25	IIw-2	41	17	71
Os	Osseo silt loam	25	VIw-1	53	15	70
PaA	Plainfield fine sand, 0 to 2 percent slopes	25	VIIs-1	54	8	67
PaB	Plainfield fine sand, 2 to 6 percent slopes	25	VIIs-1	54	8	67
PaC	Plainfield fine sand, 6 to 12 percent slopes	26	VIIs-1	54	13	69
PbA	Port Byron silt loam, 0 to 2 percent slopes	26	I-1	36	16	70
PbB	Port Byron silt loam, 2 to 6 percent slopes	26	IIe-1	37	16	70
PbB2	Port Byron silt loam, 2 to 6 percent slopes, moderately eroded	26	IIe-1	37	16	70
PbC	Port Byron silt loam, 6 to 12 percent slopes	26	IIIe-1	43	16	70
PbC2	Port Byron silt loam, 6 to 12 percent slopes, moderately eroded	26	IIIe-1	43	16	70
PoA	Port Byron silt loam, benches, 0 to 2 percent slopes	26	I-1	36	16	70
PoB	Port Byron silt loam, benches, 2 to 6 percent slopes	26	IIe-1	37	16	70
RaA	Racine silt loam, 0 to 2 percent slopes	27	I-1	36	16	70
RaB	Racine silt loam, 2 to 6 percent slopes	27	IIe-1	37	16	70
RaB2	Racine silt loam, 2 to 6 percent slopes, moderately eroded	27	IIe-1	37	16	70
RaC2	Racine silt loam, 6 to 12 percent slopes, moderately eroded	27	IIIe-1	43	1	64
RaD2	Racine silt loam, 12 to 18 percent slopes, moderately eroded	27	IVe-1	48	3	65
ReB	Renova silt loam, 2 to 6 percent slopes	27	IIe-2	37	16	70
ReB2	Renova silt loam, 2 to 6 percent slopes, moderately eroded	27	IIe-2	37	16	70
ReC	Renova silt loam, 6 to 12 percent slopes	27	IIIe-2	43	1	64
ReC2	Renova silt loam, 6 to 12 percent slopes, moderately eroded	27	IIIe-2	43	1	64
ReD	Renova silt loam, 12 to 18 percent slopes	28	IVe-2	48	3	65
ReD2	Renova silt loam, 12 to 18 percent slopes, moderately eroded	28	IVe-2	48	3	65
ReE2	Renova silt loam, 18 to 25 percent slopes, moderately eroded	28	VIe-1	52	4	66
ReF2	Renova silt loam, 25 to 35 percent slopes, moderately eroded	28	VIe-1	52	4	66
RkB2	Renova-Wykoff loams, 2 to 6 percent slopes, moderately eroded	28	IIe-5	40	1	64
RkC2	Renova-Wykoff loams, 6 to 12 percent slopes, moderately eroded	28	IIIe-4	45	2	65
RkD2	Renova-Wykoff loams, 12 to 18 percent slopes, moderately eroded	28	IVe-4	49	2	65
Rv	Riverwash	28	VIIw-1	53	17	71
SbD2	Seaton-Bold soils, 12 to 18 percent slopes, moderately eroded	29	IVe-2	48	3	65
So	Sogn soils	29	VIIs-1	54	5	66
SpA	Sparta loamy fine sand, 0 to 2 percent slopes	29	IVs-1	51	8	67
SpB	Sparta loamy fine sand, 2 to 6 percent slopes	29	IVs-1	51	8	67
Sr	Steep, stony, and rocky land	29	VIIs-1	54	5	66
St	Stony colluvial land	30	VIIw-1	53	14	70

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Symbol	Mapping unit	Page	Capability unit		Woodland suitability group	
			Symbol	Page	Number	Page
ThA	Tell silt loam, 0 to 2 percent slopes	30	IIs-1	42	16	70
ThB	Tell silt loam, 2 to 6 percent slopes	30	IIe-5	40	16	70
ThB2	Tell silt loam, 2 to 6 percent slopes, moderately eroded	30	IIe-5	40	16	70
Tm	Terrace escarpments, loamy	30	VIIe-1	53	5	66
Ts	Terrace escarpments, sandy	30	VIIs-1	54	13	69
WaA	Waukegan silt loam, 0 to 2 percent slopes	31	IIs-1	42	16	70
WaB	Waukegan silt loam, 2 to 6 percent slopes	31	IIe-4	39	16	70
WaB2	Waukegan silt loam, 2 to 6 percent slopes, moderately eroded	31	IIe-4	39	16	70
WaC2	Waukegan silt loam, 6 to 12 percent slopes, moderately eroded	31	IIIe-4	45	16	70
WhB2	Whalan silt loam, 2 to 6 percent slopes, moderately eroded	31	IIe-3	39	1	64
WhC2	Whalan silt loam, 6 to 12 percent slopes, moderately eroded	31	IIIe-3	44	1	64
WhD2	Whalan silt loam, 12 to 18 percent slopes, moderately eroded	31	IVe-3	49	2	65
WsB2	Whalan silt loam, shallow, 2 to 6 percent slopes, moderately eroded	32	IIIe-5	45	7	67
WsC	Whalan silt loam, shallow, 6 to 12 percent slopes	32	IVe-5	50	11	68
WsC2	Whalan silt loam, shallow, 6 to 12 percent slopes, moderately eroded	32	IVe-5	50	11	68
WsD	Whalan silt loam, shallow, 12 to 18 percent slopes	32	VIe-2	52	11	68
WsD2	Whalan silt loam, shallow, 12 to 18 percent slopes, moderately eroded	32	VIe-2	52	11	68
WsE2	Whalan silt loam, shallow, 18 to 25 percent slopes, moderately eroded	32	VIIe-1	53	5	66
WsF2	Whalan silt loam, shallow, 25 to 35 percent slopes, moderately eroded	32	VIIe-1	53	5	66
WvB	Wykoff gravelly loam, 2 to 6 percent slopes	33	IIIe-6	46	6	67
WvC2	Wykoff gravelly loam, 6 to 12 percent slopes, moderately eroded	33	IVe-6	51	10	68
WvD2	Wykoff gravelly loam, 12 to 18 percent slopes, moderately eroded	33	VIe-3	52	12	69
WvE2	Wykoff gravelly loam, 18 to 35 percent slopes, moderately eroded	33	VIIe-1	53	12	69
Zb	Zumbro loamy fine sand	33	IIIw-4	47	14	70
ZgA	Zwingle silt loam, 0 to 2 percent slopes	34	IIIw-1	46	17	71
ZgB	Zwingle silt loam, 2 to 6 percent slopes	34	IIIw-2	46	17	71
ZgB2	Zwingle silt loam, 2 to 6 percent slopes, moderately eroded	34	IIIw-2	46	17	71

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