SOIL SURVEY

Osceola County Michigan

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
MICHIGAN AGRICULTURAL EXPERIMENT STATION
and
MICHIGAN DEPARTMENT OF CONSERVATION
Issued June 1969

Major fieldwork for this soil survey was done in the period 1952 to 1959. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1959. This survey was made cooperatively by the Soil Conservation Service, the Michigan Agricultural Experiment Station, and the Michigan Department of Conservation. It is part of the technical assistance furnished to the Osceola County Soil Conservation District.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

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

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

Farmers and those who work with farmers can learn about use and management of the soils in the section that describes the soils and in the section that discusses management of the soils for various kinds of crops.

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

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

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

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

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Contents

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SOIL SURVEY OF OSCEOLA COUNTY, MICHIGAN

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

OSCEOLA COUNTY lies in the north-central part of the Lower Peninsula of Michigan (fig. 1). The county is bordered on the north by Wexford and Missaukee Counties, on the west by Lake County, on the south

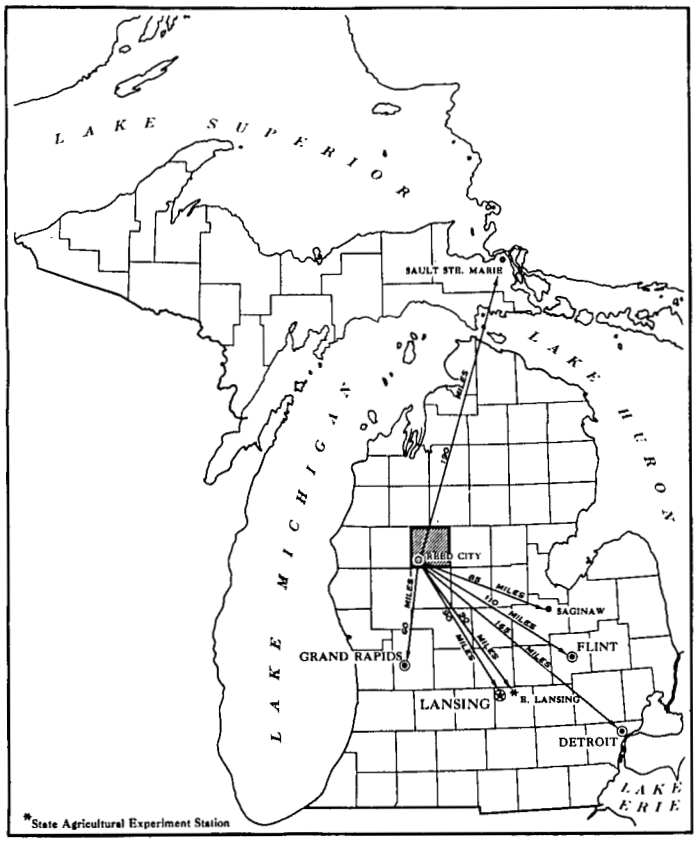

Figure 1.—Location of Osceola County in Michigan.

by Mecosta County, and on the east by Clare County. The county is about 24 miles wide and 24 miles long and has a land area of about 371,840 acres. At the last general Census, about 13,000 people lived in the county. Reed City, the county seat, is in the southwestern part of the county.

This is an agricultural county and had about 175,000 acres in farms in 1964. Dairying is the principal enterprise. Most of the acreage farmed is used to grow feed grains, hay, and pasture. The principal crops are corn, oats, wheat, and hay, the latter being mostly alfalfa, timothy, and clover hay. The chief cash crops are potatoes and wheat. About 134,000 acres is in trees. Numerous lakes and streams provide a source of recreation.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Osceola 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 other facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

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

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 described and mapped. McBride and Evart, 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.

Many soil series contain soils that are alike except for the texture of their surface layer. According to this difference in texture, separations known as soil types are made.

Within a series, all the soils having a surface layer of the same texture belong to one soil type. For example, Isabella loam and Isabella loamy sand are two of the soil types in the Isabella series. The difference in the 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 features that affect management. For example, Isabella loam, 2 to 6 percent slopes, is one of several phases of Isabella loam.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. They used aerial photos for their base map because they show woods, buildings, field borders, trees, and similar details that greatly help in drawing boundaries accurately. The soil map in the back of this soil survey was prepared from the aerial photographs.

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

Other mapping units are called undifferentiated units. They are named for the major series in them. Names of the series are joined by "and" such as Ensley and Tonkey loams. Individual areas within the mapping unit are either Ensley or Tonkey soil.

On some soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be called soils. These areas are shown on a soil map as are other mapping units, but they are given descriptive names, such as Gullied land, coarse textured, or Gravel and sand pits, and are called miscellaneous land types rather than soils.

Only a part of the soil survey was completed when the soil scientist had finished naming, describing, and mapping the soils. The mass of detailed information he had recorded then needed to be presented in different ways for different groups of users, among them farmers, managers of forests, and engineers.

To do this, he had to consult with persons in other fields of work and jointly prepare with them groupings of practical value to different users. Such groupings are the capability units, designed mainly for those interested in producing crops and tame pasture; woodland suitability groups, for those who need to manage wooded tracts; and the classifications used by engineers who build highways or structures to conserve soil and water.

General Soil Map

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

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

The ten soil associations that were mapped in Osceola County are discussed in the pages that follows.

1. Kalkaska-Rubicon association

Well-drained sandy soils on level plains and steep moraines

The soils of this association are on level outwash and till plains, valley floors, and sloping to steep moraines. They are mainly in the northwestern part of the county and are among the sandiest and droughtiest soils in the county.

The major soils, the Kalkaska and the Rubicon, formed in sandy material and have a sandy surface layer and subsoil layer. The subsoil layer of the Kalkaska soils is darker brown than that of the Rubicon soils.

These soils have low available moisture capacity and low natural fertility. Water moves rapidly or very rapidly through the soil layers. Kalkaska soils are slightly more fertile and are less droughty than Rubicon soils. Both soils are subject to wind erosion if cultivated. Kalkaska soils are locally called hardwood soils because they are better suited to northern hardwoods than are the Rubicon soils. Areas of Rubicon soils are locally called pine lands.

In most areas of this association, the soils are too steep, too sandy and droughty, or too subject to erosion to be used for crops. Their major uses are for woods, pasture, wildlife habitats, or recreation.

2. Chelsea-Rubicon-Montcalm association

Well-drained and moderately well drained sandy soils on rolling to steep moraines

The soils of this association are in the most hilly part of the county, where there are many lakes and deep depressions but only a few streams. The dominant soils are level to steep and have stones on their surface.

The dominant soils, the Chelsea, Rubicon, and Montcalm, are sandy and well drained or moderately well drained. The Rubicon soils are sandy throughout their profile. The Chelsea and Montcalm are also sandy, but they have a slightly finer textured subsoil than the Rubicon. All three soils lie close together in a complex pattern.

Small areas of loamy McBride soils and of gravelly and sandy Mancelona soils together occupy less than 10 percent of the association. Organic soils and somewhat poorly drained to poorly drained sandy soils are in the wet depressions and drainageways.

Soils of this association have low to moderately low available moisture capacity and low to moderately low fertility. Water moves through these soils rapidly, and therefore they are droughty during dry periods in summer. None of the dominant soils hold adequate moisture for crops during the dry summer. The Montcalm soils have slightly better available moisture capacity than either the Chelsea or Rubicon soils.

Farming is severely limited on this association because the soils are droughty and low to moderately low in fertility. Wind and water erosion are limitations in most of the association. Most of this association is used for wood crops or as habitats for wildlife.

3. *McBride-Montcalm-Kalkaska association*

Well-drained and moderately well drained sandy and loamy soils on undulating and rolling moraines

The soils of this association are on undulating to rolling moraines throughout many parts of the county. Slopes are complex and vary greatly in degree of steepness. There are numerous streams, lakes, and depressions throughout this association.

The dominant soils, the McBride, Montcalm, and Kalkaska, are well drained or moderately well drained. The McBride soils are finer textured throughout their profile than either the Montcalm or the Kalkaska soils. The McBride soils have a loamy surface layer and subsoil, but the Montcalm and Kalkaska soils have a sandy surface layer and subsoil.

Poorly drained and very poorly drained organic soils and the sandy Roscommon soils are in depressions and drainageways throughout the association. These soils remain wet longer in spring than other soils of the association. In some areas the soils of the association are underlain with stratified gravelly sand and sand.

The Montcalm and Kalkaska soils have low or moderately low available moisture capacity and moderately low natural fertility. The McBride soils have moderately high available moisture capacity and moderate fertility.

The soils of most areas of this association are severely limited for crop use because of an erosion hazard, droughtiness, or steepness. The gently sloping to sloping areas of McBride soils are suited to crops and pasture. A large part of this association is presently in woods, and most areas of the association are suited to woods, recreational uses, or wildlife habitats.

4. *Isabella-McBride-Montcalm association*

Well-drained and moderately well drained loamy and sandy soils on undulating to hilly uplands

Soils of this association are on undulating to hilly uplands where there are many small lakes, intermittent streams, deep depressions, and short, narrow valleys. Most of the slopes are complex and short.

The dominant soils, the Isabella, McBride, and Montcalm, all are well drained or moderately well drained. The Isabella soils have a loamy surface layer, a subsoil of sandy loam to heavy sandy clay loam, and underlying material that is sandy clay loam. Down through the subsoil, the McBride soils have the same kinds of material as the Isabella, but the surface layer and the material underlying the subsoil are sandy loam. Montcalm soils are coarser than either Isabella or McBride soils. They have a sandy surface layer, a sandy to loamy subsoil, and sandy underlying material.

Minor soils in this association are somewhat poorly drained or poorly drained loamy and sandy soils in low-lying drainageways and depressions. These soils dry slowly in spring. Organic soils occupy the shores of many of the small lakes.

Available moisture capacity ranges from moderately high to high for two of the dominant soils, the McBride and Isabella, and moderately low for the third, the Montcalm. Fertility ranges from moderate to moderately low for the Isabella and McBride soils and is moderately low for the Montcalm soils.

Nearly level to sloping areas of this association are suited to crops. Sheet and gully erosion severely limit use of the steep areas for crops, but these are suitable for pasture and woods and well suited to recreational use. Dairy and general farms are predominant in this association.

5. *Nester-Kawkawlin-Sims association*

Well-drained to very poorly drained loamy soils on level to undulating uplands

Some of the soils of this association are among the most fertile and productive in the county, but many are of limited use because of wetness. Wet depressions and drainageways are common throughout the association.

The dominant soils, the Nester, Kawkawlin, and Sims, all formed in clay loam or silty clay loam glacial till. They differ from each other mainly in their degree of natural drainage. The Nester soils are well drained or moderately well drained, and the Kawkawlin soils are somewhat poorly drained. The Sims soils are poorly drained or very poorly drained and occupy wet depressions and drainageways. The Nester soils are gently sloping and have better surface drainage than either the Kawkawlin or Sims soils.

Small areas of well drained and moderately well drained, loamy McBride soils are on the steepest parts of this association. These soils are coarser textured than the dominant soils.

The dominant soils of this association have high available moisture capacity and high to moderate fertility. Because of their moderately slow permeability, these soils dry and warm slowly in spring and remain soft for long periods after prolonged rainfall. The water table is near the surface in spring in areas of Sims and Kawkawlin soils, and the resulting wetness delays planting and tillage.

Severely eroded areas of steeper Nester soils are present throughout the association. These soils have poor tilth and are difficult to work. Cobblestones and gravel are scattered over their surface.

Excess wetness, erosion damage, and an erosion hazard are the major limitations to the use of the soils of this association for crops. Kawkawlin and Sims soils generally require installation of artificial drainage systems for producing good yields of crops. The Kawkawlin and Sims soils in low positions also are subject to damage from early frosts.

Soils in this association have moderate to severe limitations for recreational uses and, in general, are not suited to the production of desirable trees.

6. *Nester-Kalkaska-Menominee association*

Well-drained and moderately well drained loamy and sandy soils on undulating to hilly uplands

This soil association is similar to association 5 but has a higher proportion of sandy and steep soils. It is on undulating to hilly uplands that are dissected by drainage-

ways and depressions. It is one of the most extensive soil associations in the county.

The major soils, the Nester, Kalkaska, and Menominee, differ greatly from each other in texture and fertility. The Nester soils are the finest textured of the three. They formed in clay loam or silty clay loam material and are well drained or moderately well drained. Kalkaska soils are the coarsest textured of the three, are well drained, and formed in thick deposits of medium and coarse sands. Menominee soils have a layer of sand or loamy sand, 18 to 42 inches thick, over loamy material. The three soils occur together in a complex pattern.

Minor soils in the association include small areas of organic soils and poorly drained mineral soils occupying drainageways and depressions. A few areas of the well drained and moderately well drained, loamy McBride soils also are present on the steeper areas.

Available moisture capacity and natural fertility vary greatly between the major soils of this association. Available moisture capacity ranges from low for the Kalkaska soils to high for the Nester soils. Natural fertility ranges from low for the Kalkaska soils to moderate for the Nester soils. Permeability is rapid in the Kalkaska soils. It is moderately slow in the Nester and Menominee soils below a depth of 18 to 42 inches. Surface runoff is medium to rapid on the Nester soils and is more rapid than on the coarse textured and more gently sloping Menominee or Kalkaska soils.

Water erosion has been severe on some of the sloping and hilly soils, especially in areas of Nester soils. A few gullies have formed in some of the more steeply sloping areas in the association, and their control is difficult. Kalkaska soils are subject to wind erosion when large areas are exposed by cultivation. The Menominee and the Kalkaska soils dry quickly in spring and can be tilled easily. Cultivation of the Nester soils is more difficult because they are finer textured and because there are gravel and cobblestones on the surface of these soils in many areas.

Use of the soils of this association for crops is limited in many areas by a serious erosion hazard. The Nester and Menominee soils are mainly used for crops or pasture, which are grown as part of a general farming or dairy farming operation. The sandy and droughty Kalkaska soils were cleared in the past but are now idle and in brush and trees because of declining crop yields and erosion damage. A few areas of Kalkaska and Menominee soils have been planted to trees.

7. *Rubicon-Croswell-Au Gres association*

Well-drained to somewhat poorly drained sandy soils on level to undulating plains

The soils of this association are generally sandy and droughty but in many areas are wet in spring. There are few lakes and streams in this association.

All of the major soils of this association formed in thick deposits of medium and coarse sand. Sandy material is at least 5 feet deep throughout most areas of the association. The dominant soils, the Rubicon, Croswell, and Au Gres, differ mainly in degree of drainage. The Rubicon soils are well drained, the Croswell soils are moderately well drained, and the Au Gres soils are somewhat poorly drained. The Au Gres soils are slightly darker colored and occupy lower positions than either the Rubicon or the Croswell soils.

A few areas in this association are underlain by clay loam material at a depth ranging from 18 to about 42 inches. Iosco soils are present in these areas. Small drainageways and depressions are occupied by organic soils and by poorly drained or very poorly drained Roscommon soils.

The major soils of this association have low available moisture capacity and natural fertility. In the absence of a high water table, water moves very rapidly through the soil profile. A fluctuating water table is present in the Au Gres soils during spring but recedes quickly at the beginning of summer. Pronounced mottling in the lower part of the Au Gres soils indicates that these soils are saturated for extended periods. Once the water table lowers, these soils dry quickly. All soils in this association are droughty during summer. It is difficult to maintain organic matter in the major soils of this association because they are loose and sandy.

The major limitations to the use of the soils of this association for crops are excess wetness, low available moisture capacity and fertility, and a wind erosion hazard. Most areas in this association are in second-growth woods. A few areas have been cleared and farmed in the past, but these areas are now idle and in grass or have been planted to trees.

8. *Grayling association*

Well-drained, droughty, sandy soils on level to sloping plains

The soils of this association are the most droughty and sandy of those of any association in the county.

The Grayling soils are dominant in this association. They are medium and coarse sand in texture to a depth of 5 feet or more. In most areas they are level or nearly level.

Available moisture capacity and natural fertility of these soils are low. Water moves through the soil very rapidly, and there is little surface runoff. Organic-matter content is low and is difficult to maintain because of the sandiness and looseness of the soil. The soils are acid.

Most areas in this association are in woods or are idle. Only a small acreage is used for crops. In the past large areas were cut over. These now have a sparse cover of jack pine and of scrub red and white oak. Many wildlife habitats are present.

9. *Mancelona-Montcalm association*

Well-drained and moderately well drained sandy soils on plains along streams

The soils of this association are on level to undulating plains adjacent to or near the Muskegon River. The level areas generally are underlain by sand and gravel. The undulating areas, most of them at higher elevations, are underlain by sand and loamy sand.

The dominant soils of this association, the Mancelona and the Montcalm soils, are well drained or moderately well drained. Mancelona soils are on the level plains and are underlain by stratified sand and gravel. They have a finer textured subsoil and a higher gravel content than the Montcalm soils. The Montcalm soils are on the higher, undulating areas. They formed in loamy sand or sand and have thin layers of sandy loam material in the profile.

Dark-colored, poorly drained soils of variable texture are on the flood plains of the Muskegon River. These soils

are subject to flooding during spring and following prolonged rain.

Available moisture capacity and natural fertility of the dominant soils of this association are moderately low. Water moves through the soils moderately rapidly to rapidly, and surface runoff is slow. Normally, these soils are filled nearly to capacity with moisture at the start of the growing season, but they become droughty as the season progresses and tend to become extremely droughty in dry summers. The organic-matter content of these soils is low and is difficult to maintain because the soils are sandy and loose.

Wind erosion and droughtiness are the major limitations to the use of the dominant soils of this association for crops. Many areas have been cleared of trees, nevertheless, and planted to such crops as corn, small grains, hay, and potatoes. Some areas are in trees or pasture. The largest gravel pit in the county is in this association.

10. Lupton-Markey-Wheatley association

Poorly drained and very poorly drained muck and sand soils in stream valleys

The soils of this association are in level stream valleys, or bottom lands, adjacent to the Muskegon River and east of Evart. They are subject to periodic flooding during spring and after rains and are among the most poorly drained soils in the county.

The major soils of the association are the Lupton, Markey, and Wheatley. Lupton soils formed in organic deposits more than 42 inches thick. Markey soils formed in organic materials, 12 to 42 inches thick, that overlie sandy material. Wheatley soils formed in sand and gravel. All of these soils have a high water table.

Available moisture capacity ranges from high for the Markey and Lupton soils to low for the Wheatley soils. Natural fertility for all three soils is low. Surface runoff is slow to ponded.

A high water table, periodic flooding, low fertility, and a frost hazard severely limit the soils of this association for most uses. Many areas are inaccessible for farm use because of the meanders of the Muskegon River. Harvesting of wood products is difficult.

Most areas of this association are in forest or permanent pasture.

Descriptions of the Soils

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

The procedure is first to describe the soil series, and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs. As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Gullied lands, for example, are miscellaneous land types that do not belong to a soil series. They are listed, nevertheless, in alphabetic order along with the soil series and the mapping units.

In comparing a mapping unit with a soil series, many will prefer to read the short description in paragraph form. It precedes the technical description that identifies A, B, and C horizons in soils and gives the depth of these horizons. The technical profile descriptions are mainly for soil scientists and others who want detailed information about soils.

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Abscota sand	184	(1)	Carbondale loam, 0 to 2 percent slopes, overwash	420	0.1
Abscota loam	144	(1)	Carbondale muck, 0 to 2 percent slopes	293	.1
Adrian muck	793	0.2	Carbondale muck, 6 to 12 percent slopes	59	(1)
Algansee sand	280	.1	Carbondale peat, 0 to 2 percent slopes	729	.2
Algansee loam	625	.2	Chelsea sand, 0 to 6 percent slopes [2]	7,300	2.1
Allendale loamy sand, 2 to 6 percent slopes	111	(1)	Chelsea sand, 6 to 12 percent slopes [2]	5,570	1.5
Allendale sandy loam, 2 to 6 percent slopes	191	(1)	Chelsea sand, 12 to 18 percent slopes [2]	5,155	1.4
Au Gres sand, 0 to 6 percent slopes	3,634	1.0	Chelsea sand, 18 to 25 percent slopes [2]	2,589	.7
Au Gres sand, loamy substratum, 0 to 6 percent slopes [2]	624	.2	Chelsea sand, 25 to 55 percent slopes [2]	352	.1
Belding sandy loam, 0 to 2 percent slopes	269	.1	Chelsea stony sand, 0 to 6 percent slopes [2]	179	(1)
Belding sandy loam, 2 to 6 percent slopes	572	.2	Chelsea stony sand, 6 to 12 percent slopes [2]	179	(1)
Belding sandy loam, clay subsoil variant, 2 to 6 percent slopes	204	(1)	Chelsea stony sand, 12 to 18 percent slopes [2]	138	(1)
Bergland mucky silt loam	273	.1	Coral fine sandy loam, 0 to 2 percent slopes	78	(1)
Blue Lake loamy sand, 0 to 2 percent slopes	325	.1	Coral fine sandy loam, 2 to 6 percent slopes	811	.2
Blue Lake loamy sand, 2 to 6 percent slopes	1,799	.5	Croswell sand, 0 to 6 percent slopes	5,505	1.5
Blue Lake loamy sand, 6 to 12 percent slopes	2,352	.6	Croswell sand, 6 to 12 percent slopes	236	.1
Blue Lake loamy sand, 12 to 18 percent slopes	1,236	.3	Dawson peaty muck	176	(1)
Blue Lake loamy sand, 18 to 25 percent slopes	868	.2	Dighton sandy loam, 2 to 6 percent slopes	313	.1
Bohemian fine sandy loam, 2 to 6 percent slopes	320	.1	Dighton sandy loam, 6 to 12 percent slopes	359	.1
Bohemian fine sandy loam, 6 to 12 percent slopes	311	.1	Dighton sandy loam, 12 to 18 percent slopes, moderately eroded	98	(1)
Bohemian fine sandy loam, 12 to 18 percent slopes	107	(1)	East Lake loamy sand, 0 to 6 percent slopes	2,469	.7
Brevort fine sandy loam	688	.2	East Lake loamy sand, 6 to 12 percent slopes	162	(1)
Brevort loamy sand	333	.1	East Lake loamy sand, 12 to 18 percent slopes	164	(1)
Brevort loamy sand, overwash	92	(1)	East Lake sandy loam, 0 to 2 percent slopes	428	.1
Brimley fine sandy loam, 2 to 6 percent slopes	145	(1)	Edmore and Tonkey sandy loams	905	.2
			Edwards muck	671	.2
			Ensley and Tonkey loams	356	.1

See footnotes at end of table.

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

Soil	Area	Extent
	Acres	*Percent*
Ensley and Tonkey loams, overwash	131	(1)
Evart loam	649	0. 2
Evart sand	298	. 1
Gladwin loamy sand, 0 to 2 percent slopes	177	(1)
Gladwin loamy sand, 2 to 6 percent slopes	104	(1)
Gladwin sandy loam, 0 to 2 percent slopes	513	. 1
Gladwin sandy loam, 2 to 6 percent slopes	126	(1)
Gravel and sand pits	355	. 1
Grayling sand, 0 to 6 percent slopes	3, 038	. 8
Grayling sand, 6 to 12 percent slopes	158	(1)
Grayling sand, 18 to 25 percent slopes	168	(1)
Greenwood peat	1, 395	. 4
Gullied land, coarse textured	170	(1)
Gullied land, moderately fine textured	125	(1)
Houghton muck	2, 878	. 8
Iosco loamy sand, 0 to 2 percent slopes	591	. 2
Iosco loamy sand, 2 to 6 percent slopes	1, 669	. 4
Iosco sandy loam, 0 to 2 percent slopes	337	. 1
Iosco sandy loam, 2 to 6 percent slopes	1, 770	. 5
Isabella loam, 2 to 6 percent slopes	1, 016	. 3
Isabella loam, 6 to 12 percent slopes	873	. 2
Isabella loam, 6 to 12 percent slopes, moderately eroded	216	. 1
Isabella loam, 12 to 18 percent slopes	211	. 1
Isabella loam, 12 to 18 percent slopes, moderately eroded	357	. 1
Isabella loamy sand, 2 to 6 percent slopes	234	. 1
Isabella loamy sand, 6 to 12 percent slopes	461	. 1
Isabella loamy sand, 6 to 12 percent slopes, moderately eroded	143	(1)
Isabella loamy sand, 12 to 18 percent slopes	176	(1)
Isabella loamy sand, 12 to 18 percent slopes, moderately eroded	117	(1)
Isabella sandy clay loam, 12 to 18 percent slopes, severely eroded	160	(1)
Isabella sandy clay loam, 18 to 25 percent slopes, severely eroded	105	(1)
Isabella sandy loam, 2 to 6 percent slopes	3, 486	. 9
Isabella sandy loam, 2 to 6 percent slopes, moderately eroded	163	(1)
Isabella sandy loam, 6 to 12 percent slopes	3, 650	1. 0
Isabella sandy loam, 6 to 12 percent slopes, moderately eroded	1, 095	. 3
Isabella sandy loam, 12 to 18 percent slopes	922	. 2
Isabella sandy loam, 12 to 18 percent slopes, moderately eroded	976	. 3
Isabella sandy loam, 18 to 25 percent slopes	690	. 2
Kalkaska gravelly sand, 2 to 6 percent slopes	184	(1)
Kalkaska sand, 0 to 6 percent slopes	17, 499	4. 7
Kalkaska sand, 6 to 12 percent slopes	20, 006	5. 4
Kalkaska sand, 6 to 12 percent slopes, severely eroded	476	. 1
Kalkaska sand, 12 to 18 percent slopes	10, 459	2. 8
Kalkaska sand, 12 to 18 percent slopes, severely eroded	425	. 1
Kalkaska sand, 18 to 25 percent slopes	2, 505	. 7
Kalkaska sand, 18 to 25 percent slopes, severely eroded	291	. 1
Kalkaska sand, 25 to 55 percent slopes	519	. 1
Kalkaska stony sand, 0 to 6 percent slopes	566	. 2
Kalkaska stony sand, 6 to 12 percent slopes	620	. 2
Kalkaska stony sand, 12 to 25 percent slopes	672	. 2
Kawkawlin loam, 0 to 2 percent slopes	1, 398	. 4
Kawkawlin loam, 2 to 6 percent slopes	6, 583	1. 8
Kawkawlin loam, overwash, 0 to 2 percent slopes	100	(1)
Kawkawlin loam, overwash, 2 to 6 percent slopes	88	(1)
Kawkawlin sandy loam, 0 to 2 percent slopes	262	. 1
Kawkawlin sandy loam, 2 to 6 percent slopes	1, 802	. 5
Kawkawlin stony loam, 2 to 6 percent slopes	109	(1)
Kent loam, 2 to 6 percent slopes	708	0. 2
Kent loam, 6 to 12 percent slopes	437	. 1
Kent loam, 6 to 12 percent slopes, moderately eroded	412	. 1
Kent loam, 12 to 18 percent slopes	84	(1)
Kent loam, 12 to 18 percent slopes, moderately eroded	202	. 1
Kerston loam	258	. 1
Kerston muck	1, 344	. 4
Kinross sand	1, 344	. 4
Linwood muck	1, 019	. 3
Loxley muck	558	. 2
Lupton muck	7, 230	1. 9
Mancelona loamy sand, 0 to 2 percent slopes	992	. 3
Mancelona loamy sand, 2 to 6 percent slopes	1, 296	. 3
Mancelona loamy sand, 6 to 12 percent slopes	466	. 1
Mancelona loamy sand, 12 to 18 percent slopes	254	. 1
Mancelona loamy sand, 18 to 25 percent slopes	144	(1)
Mancelona sandy loam, 0 to 2 percent slopes	307	. 1
Manistee loamy sand, 2 to 6 percent slopes	377	. 1
Manistee loamy sand, 6 to 12 percent slopes	422	. 1
Manistee loamy sand, 12 to 18 percent slopes	71	(1)
Markey muck	2, 730	. 7
McBride gravelly sandy loam, 6 to 12 percent slopes	984	. 3
McBride loamy sand, 2 to 6 percent slopes	826	. 2
McBride loamy sand, 6 to 12 percent slopes	2, 452	. 7
McBride loamy sand, 6 to 12 percent slopes, moderately eroded	448	. 1
McBride loamy sand, 12 to 18 percent slopes	2, 039	. 5
McBride loamy sand, 12 to 18 percent slopes, moderately eroded	369	. 1
McBride loamy sand, 18 to 25 percent slopes	1, 110	. 3
McBride sandy loam, 0 to 2 percent slopes	138	(1)
McBride sandy loam, 2 to 6 percent slopes	3, 661	1. 0
McBride sandy loam, 2 to 6 percent slopes, moderately eroded	152	(1)
McBride sandy loam, 6 to 12 percent slopes	5; 853	1. 6
McBride sandy loam, 6 to 12 percent slopes, moderately eroded	1, 449	. 4
McBride sandy loam, 12 to 18 percent slopes	3, 089	. 8
McBride sandy loam, 12 to 18 percent slopes, moderately eroded	1, 327	. 4
McBride sandy loam, 12 to 18 percent slopes, severely eroded	158	(1)
McBride sandy loam, 18 to 25 percent slopes	1, 055	. 3
McBride sandy loam, 18 to 25 percent slopes, moderately eroded	334	. 1
McBride sandy loam, 18 to 25 percent slopes, severely eroded	194	. 1
McBride stony sandy loam, 2 to 6 percent slopes	135	(1)
McBride stony sandy loam, 6 to 12 percent slopes	196	. 1
McBride soils, 25 to 45 percent slopes	232	. 1
Menominee loamy sand, 0 to 2 percent slopes	170	(1)
Menominee loamy sand, 2 to 6 percent slopes	3, 354	. 9
Menominee loamy sand, 6 to 12 percent slopes	5, 506	1. 5
Menominee loamy sand, 6 to 12 percent slopes, moderately eroded	531	. 1
Menominee loamy sand, 12 to 18 percent slopes	857	. 2
Menominee loamy sand, 12 to 18 percent slopes, moderately eroded	185	(1)
Menominee loamy sand, 18 to 25 percent slopes	374	. 1
Montcalm gravelly loamy sand, 0 to 6 percent slopes	1, 150	. 3
Montcalm gravelly loamy sand, 6 to 12 percent slopes	849	. 2
Montcalm gravelly loamy sand, 12 to 18 percent slopes	384	. 1

See footnotes at end of table.

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

Soil	Area	Extent
	Acres	*Percent*
Montcalm gravelly loamy sand, 18 to 25 percent slopes	200	0. 1
Montcalm loamy sand, 0 to 6 percent slopes	14, 571	3. 9
Montcalm loamy sand, 6 to 12 percent slopes	18, 051	4. 9
Montcalm loamy sand, 6 to 12 percent slopes, moderately eroded	2, 749	. 7
Montcalm loamy sand, 6 to 12 percent slopes, severely eroded	141	(1)
Montcalm loamy sand, 12 to 18 percent slopes	12, 351	3. 3
Montcalm loamy sand, 12 to 18 percent slopes, moderately eroded	3, 217	. 9
Montcalm loamy sand, 12 to 18 percent slopes, severely eroded	418	. 1
Montcalm loamy sand, 18 to 25 percent slopes	8, 879	2. 4
Montcalm sandy loam, 0 to 6 percent slopes	833	. 2
Montcalm sandy loam, 6 to 12 percent slopes	641	. 2
Montcalm sandy loam, 12 to 18 percent slopes	293	. 1
Montcalm stony loamy sand, 2 to 6 percent slopes	877	. 2
Montcalm stony loamy sand, 6 to 12 percent slopes	872	. 2
Montcalm stony loamy sand, 12 to 18 percent slopes	1, 737	. 5
Montcalm stony loamy sand, 18 to 25 percent slopes	692	. 2
Montcalm soils, 25 to 45 percent slopes	813	. 2
Munuscong fine sandy loam	175	(1)
Nester clay loam, 6 to 12 percent slopes, severely eroded	182	(1)
Nester clay loam, 12 to 18 percent slopes, severely eroded	426	. 1
Nester clay loam, 18 to 25 percent slopes, severely eroded	225	. 1
Nester gravelly loam, 6 to 12 percent slopes	178	(1)
Nester loam, 0 to 2 percent slopes	139	(1)
Nester loam, 2 to 6 percent slopes	8, 969	2. 4
Nester loam, 2 to 6 percent slopes, moderately eroded	856	. 2
Nester loam, 6 to 12 percent slopes	8, 959	2. 4
Nester loam, 6 to 12 percent slopes, moderately eroded	3, 136	. 8
Nester loam, 12 to 18 percent slopes	2, 162	. 6
Nester loam, 12 to 18 percent slopes, moderately eroded	1, 934	. 5
Nester loamy sand, 2 to 6 percent slopes	433	. 1
Nester loamy sand, 6 to 12 percent slopes	452	. 1
Nester loamy sand, 12 to 18 percent slopes	161	(1)
Nester sandy loam, 0 to 2 percent slopes	144	(1)
Nester sandy loam, 2 to 6 percent slopes	5, 907	1. 6
Nester sandy loam, 2 to 6 percent slopes, moderately eroded	146	(1)
Nester sandy loam, 6 to 12 percent slopes	4, 886	1. 3
Nester sandy loam, 6 to 12 percent slopes, moderately eroded	912	. 2
Nester sandy loam, 12 to 18 percent slopes	1, 020	. 3
Nester sandy loam, 12 to 18 percent slopes, moderately eroded	931	. 3
Nester stony loam, 6 to 12 percent slopes	131	(1)
Nester stony sandy loam, 2 to 6 percent slopes	149	(1)
Nester soils, 18 to 25 percent slopes	1, 202	. 3
Nester soils, 18 to 25 percent slopes, moderately eroded	465	. 1
Nester soils, 25 to 45 percent slopes	330	. 1
Newaygo sandy loam, 2 to 6 percent slopes	332	. 1
Newaygo sandy loam, 6 to 18 percent slopes	142	(1)
Ogemaw loamy sand, 0 to 2 percent slopes	106	(1)
Otisco loamy sand, 0 to 2 percent slopes	224	0. 1
Otisco loamy sand, 2 to 6 percent slopes	868	. 2
Otisco sandy loam, 0 to 2 percent slopes	243	. 1
Otisco sandy loam, 2 to 6 percent slopes	511	. 1
Pickford fine sandy loam	173	(1)
Pickford silty clay loam	72	(1)
Pinconning loamy sand	92	(1)
Richter sandy loam, 2 to 6 percent slopes	92	(1)
Rifle loam, overwash	117	(1)
Rifle muck	289	. 1
Rifle peat	2, 112	. 6
Roscommon mucky sand and sand	3, 558	1. 0
Rousseau fine sand, 2 to 6 percent slopes	233	. 1
Rousseau fine sand, 6 to 12 percent slopes	93	(1)
Rousseau fine sand, 12 to 18 percent slopes	77	(1)
Rubicon sand, 0 to 6 percent slopes	8, 543	2. 3
Rubicon sand, 6 to 12 percent slopes	4, 594	1. 2
Rubicon sand, 12 to 18 percent slopes	4, 567	1. 2
Rubicon sand, 18 to 25 percent slopes	2, 136	. 6
Rubicon sand, 25 to 55 percent slopes	431	. 1
Rubicon sand, loamy substratum, 0 to 6 percent slopes [2]	1, 411	. 4
Rubicon sand, loamy substratum, 6 to 12 percent slopes [2]	1, 193	. 3
Rubicon sand, loamy substratum, 12 to 18 percent slopes [2]	510	. 1
Rubicon sand, loamy substratum, 18 to 25 percent slopes [2]	97	(1)
Saranac loam	559	. 2
Saugatuck sand, 0 to 6 percent slopes	389	. 1
Selkirk loam, 0 to 2 percent slopes	89	(1)
Selkirk loam, 2 to 6 percent slopes	497	. 1
Shoals loam [2]	1, 202	. 3
Shoals loamy sand [2]	156	(1)
Sims clay loam	405	. 1
Sims loam	2, 385	. 6
Sims loam, overwash	229	. 1
Sims sandy loam	289	. 1
Sloan loam [2]	1, 909	. 5
Tawas loam, overwash	87	(1)
Tawas muck	3, 563	1. 0
Tawas peat	199	. 1
Traverse loam	220	. 1
Twining sandy loam, 0 to 2 percent slopes	128	(1)
Twining sandy loam, 2 to 6 percent slopes	759	. 2
Ubly sandy loam, 2 to 6 percent slopes	1, 255	. 3
Ubly sandy loam, 6 to 12 percent slopes	662	. 2
Ubly sandy loam, 12 to 18 percent slopes	146	(1)
Ubly sandy loam, clay subsoil variant, 2 to 6 percent slopes	245	. 1
Ubly sandy loam, clay subsoil variant, 6 to 12 percent slopes	70	(1)
Wallace sand, 0 to 6 percent slopes	337	. 1
Wallace sand, 6 to 18 percent slopes	216	. 1
Warners muck and Marl	120	(1)
Wheatley mucky loamy sand	430	. 1
Wheatley mucky sandy loam	582	. 2
Willette muck	319	. 1
Wind eroded land, sloping	672	. 2
Wind eroded land, steep	663	. 2
Cities, rivers, and built-up areas	1, 640	. 4
Total	[3]371,840	100. 0

[1] Less than 0.05 percent; total extent of all soils in this category is 1.2 percent of county.

[2] The Michigan Agricultural Experiment Station continues use of the name Arenac instead of Au Gres loamy substratum. The Chelsea soils in this county were formerly called Graycalm in Michigan. They have many characteristics of soils of the Chelsea series but differ from the Chelsea soils of southern Michigan because the climate is colder and crop responses therefore are different. The Michigan Agricultural Experiment Station continues use of the name Melita instead of Rubicon, loamy substratum; Pennock instead of Shoals; and Pinora instead of Sloan.

[3] Total acreage does not include lakes or ponds.

Following the name of each mapping unit, there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of the description of each mapping unit are the capability unit and woodland group in which the mapping unit has been placed. The page on which each capability group and woodland group is described can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Abscota Series

Soils of the Abscota series are well drained and moderately well drained, nearly level soils on bottom lands along streams. They formed in sandy material that was deposited as floodwaters receded.

The surface layer is very dark grayish-brown sand about 6 inches thick. It has very weak granular structure and is very friable.

The material below the surface layer is stratified, and texture of the individual layers varies. It is predominantly sand, but thin layers of loamy sand and sandy loam also are present in many areas. The material is loose and lacks structure. Color is brown or dark grayish brown in most areas.

Available moisture capacity and fertility of Abscota soils are low, and permeability is very rapid. Runoff is slow, and water ponds during periods when the water level is high.

These soils are used for recreational areas and cottage sites.

Typical profile of Abscota sand:

A1—0 to 6 inches, very dark grayish-brown (10YR 3/2) sand; very weak, fine, granular structure; very friable; mildly alkaline; abrupt, smooth boundary.
C1—6 to 11 inches, brown (10YR 5/3) sand; single grain; loose; calcareous; gradual, smooth boundary.
C2—11 to 60 inches, dark grayish-brown (10YR 4/2) sand; single grain; loose; calcareous.

The surface layer ranges to dark grayish brown in some areas. Texture ranges from sand to loam. A very dark brown former surface layer is present at a depth of about 2 feet in some places and is 2 to 12 inches thick.

In the moderately well drained soils, the material below a depth of 2 feet is mottled yellowish brown. Reaction of the profile is neutral to calcareous.

Abscota sand (Ab).—This is a nearly level soil on bottom lands or flood plains along rivers and streams. Slope ranges from 0 to about 3 percent.

The surface layer is sand or loamy sand. The lower layers are predominantly sand, but there are thin layers of sandy loam and loamy sand in many areas. Included in the mapping of this soil were some sand and gravel bars in a few areas.

Abscota sand is subject to annual spring flooding, is low in fertility and available moisture capacity, and is subject to frost.

Most of this soil is in woods or is used for recreation. Many summer cabins have been built along the streams. (Capability unit Vw-3 (L-4a); woodland suitability group O)

Abscota loam (Ac).—This soil is nearly level and is on bottom lands or flood plains and on some natural levees of rivers. Slopes range from 0 to about 3 percent.

The texture of the surface layer is sandy loam or loam. The lower layers are predominantly sand and loamy sand. Included in the mapping of this soil were some sand and gravel bars. Abscota loam is subject to annual spring flooding, is doughty and low in fertility, and is subject to frost.

Most areas of this soil are in woods or are used for recreation. Many summer cabins have been built. (Capability unit Vw-3 (L-4a); woodland suitability group O)

Adrian Series

The soils of this series are dark-colored organic soils formed mainly from reeds, sedges, and grasses. They are level and are on lake plains and drainageways. These soils are very poorly drained and are underlain by sand at depths ranging from 12 to 42 inches.

The surface layer of these soils is black muck about 14 inches thick. This layer contains woody material and has moderate granular structure. Below the surface layer is very dark grayish-brown mucky peat about 6 inches thick. It is moderately decomposed and is fibrous.

A light-gray sand is at a depth of about 26 inches. It is loose and lacks structure.

Available moisture capacity of Adrian soils is high, and natural fertility is low. Permeability is rapid, but runoff is very slow or ponded. The water table is at or near the surface unless these soils are artificially drained. The soils are low in content of phosphorus, potassium, and micronutrients. Excess wetness, a frost hazard, and a wind erosion hazard limit the use of these soils.

The soils are used mostly for recreation and wildlife habitats. The native vegetation is sedges, grasses, reeds, and shrubs. Common shrubs are dogwood, willow, and alder. Elm, cedar, and soft maple trees are in wooded areas.

Typical profile of Adrian muck:

1—0 to 14 inches, black (10YR 2/1) muck; contains woody materials; moderate, fine, granular structure; friable; medium acid; gradual, smooth boundary.
2—14 to 20 inches, very dark grayish-brown (10YR 3/2) mucky peat; fibrous; moderately decomposed; nonsticky when wet; medium acid; gradual, wavy boundary.
3—20 to 26 inches, dark grayish-brown (10YR 4/2) peat; massive; slightly sticky when wet; medium acid; abrupt, wavy boundary.
IIC—26 to 60 inches, light-gray (2.5Y 7/2) sand; single grain; loose; slightly acid.

Thickness of the muck surface layer ranges from 8 to 30 inches. In some areas the underlying layer is loamy sand and is mixed with a small amount of gravel. The reaction of the muck and peat layers is medium acid in most areas but ranges from strongly acid to neutral.

The Adrian soils are more fibrous than the Tawas soils and have a thinner layer of organic material than either the Greenwood or Houghton soils. They have a coarser textured underlying material than either the Linwood or Willette soils.

Adrian muck (Ad).—This shallow organic soil is in nearly level and depressed areas. Included in the mapping were pockets and small areas of Houghton muck and small areas of Roscommon and Brevort soils. The Houghton muck appears in pockets and also in areas where the organic layers of Adrian muck are more than 42 inches thick. The Roscommon and Brevort soils are on the borders of Adrian muck where the organic layers are less than 12 inches thick.

Excess wetness, low fertility, a frost hazard, and a wind erosion hazard limit the use of Adrian muck.

Most areas of Adrian muck support sedges, grasses, and shrubs. Elm, cedar, and soft maple trees are in wooded areas. (Capability unit Vwc-1 (M/4c); woodland suitability group J)

Algansee Series

The soils of this series are somewhat poorly drained, level soils on river flood plains. They formed in stratified sand and loamy sand material deposited by floodwaters.

The surface layer is very dark gray loamy sand or sand. It has weak granular structure and is very friable.

Below the surface layer, to a depth of 60 inches or more, is pale-brown sand. This material is single grain and loose and is mottled with brown.

Available moisture capacity and natural fertility of these soils are low. Permeability is very rapid, but runoff is slow. There is a fluctuating high water table. These soils are subject to flooding during spring and after rains. Excess wetness, low fertility, and a flood hazard severely limit use for crops.

Most areas of these soils are forested or in permanent pasture.

Typical profile of Algansee sand:

A1—0 to 7 inches, very dark gray (10YR 3/1) sand; very weak, fine; granular structure; very friable; neutral; abrupt, smooth boundary.

C—7 to 60 inches, pale-brown (10YR 6/3) sand; common, medium, distinct, dark-brown (7.75YR 4/4) mottles; single grain; loose; mildly alkaline.

The surface layer ranges from 4 to 14 inches in thickness, from very dark gray to dark grayish brown or black in color, and from sand to loam in texture. The underlying material is mainly sand or loamy sand and sand but includes thin layers of sandy loam or loam, Reaction of the material below the surface layer is neutral to moderately alkaline.

The Algansee soils are more poorly drained than the Abscota soils and are more intensely mottled. They are not so gray nor so dark colored as the Evart soils.

Algansee sand (Ae).—This soil is nearly level and is on narrow, low areas along rivers and streams. Texture of the surface layer is sand or loamy sand. Small areas of Abscota and Shoals soils are common in most areas and were included in mapping this soil. Narrow bars of well-drained sand or gravel, and small areas of shallow organic soils, also were included in mapping. Flooding, excess wetness, low available moisture capacity when drained, and low fertility are major limitations to the use of this soil.

Some areas of this soil are in pasture, but most are in trees, recreation areas, and wildlife habitats. (Capability unit Vw-3 (L-4c); woodland suitability group O)

Algansee loam (Ag).—This soil is nearly level and is on narrow, low areas along rivers and streams. The surface layer is sandy loam or loam, 6 to 14 inches thick. Below this depth the texture is predominantly sand or loamy sand. Small areas of shallow organic soils and narrow bars of well-drained sand or gravel were included in mapping this soil. Flooding, excess wetness, low available moisture capacity, and low natural fertility are major limitations to the use of this soil.

Some areas of this soil are in pasture, but most are in trees, recreation areas, and wildlife habitats. (Capability unit Vw-3 (L-4c); woodland suitability group O)

Allendale Series

Soils of this series are somewhat poorly drained and sandy and are on lake plains. They are level to gently sloping or undulating in most areas. These soils are underlain by silty clay or clay at a depth of 18 to 42 inches.

The surface layer is very dark grayish-brown sand about 7 inches thick. It has weak granular structure and is very friable. The subsurface layer is light brownish-gray loamy sand about 3 inches thick. It is single grain and loose.

The upper part of the subsoil is dark-brown or yellowish-brown sand about 18 inches thick. This layer is mottled light brownish gray and brownish yellow. It is single grain and loose. The lower part of the subsoil is dark-brown clay about 5 inches thick. It has pinkish-gray mottles, has moderate blocky structure, and is very firm.

Below the subsoil, at a depth of about 35 inches, is brown clay mottled with pinkish gray and yellowish brown. This material is high in lime content, has weak blocky structure and is very firm.

Available moisture capacity of these soils is moderately low, and natural fertility is low. The permeability of the upper sandy layers is rapid, and that of the lower clayey layers is slow. Runoff is slow

Excess wetness and slight droughtiness during dry periods are the major limitations to the use of these soils for crops. Low fertility and an erosion hazard also are limitations.

Most areas of these soils have been drained and are in crops. Some areas are in woods or in pasture. The native vegetation was elm, ash, swamp white oak, and white pine.

Typical profile of Allendale loamy sand:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, medium, granular structure; very friable; slightly acid; abrupt, smooth boundary.

A2—7 to 10 inches, light brownish-gray (10YR 6/2) loamy sand; single grain; loose; medium acid; abrupt, wavy boundary.

B21ir—10 to 17 inches, dark-brown (7.5YR 4/4) sand; weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—17 to 28 inches, yellowish-brown (10YR 5/4) sand; common, medium, distinct, light brownish-gray (10YR 6/2) and brownish-yellow (10YR 6/8) mottles; single grain; loose; slightly acid; abrupt, smooth boundary.

A'2—28 to 30 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; slightly acid; abrupt, irregular boundary.

IIB't—30 to 35 inches, dark-brown (7.5YR 4/4) clay; common, medium, distinct, pinkish-gray (7.5YR 6/2) mottles; moderate, medium, angular blocky structure; very firm; mildly alkaline; abrupt, irregular boundary.

IIC—35 to 60 inches, brown (7.5YR 5/4) clay; common, medium, distinct, pinkish-gray (7.5YR 6/2) and yellowish-brown (10YR 5/6) mottles; weak, coarse, angular blocky structure; very firm; calcareous.

Texture of the surface layer is sandy loam in some areas. In undisturbed areas the surface layer is very dark gray or black, is 1 to 3 inches thick, and is underlain by a light brownish-gray or grayish-brown subsurface layer 2 to 12 inches thick. Texture of the lower part of the subsoil and the underlying material is silty clay in some places. The reaction of the surface layer and subsoil layers ranges from slightly acid to mildly alkaline.

Allendale soils are more poorly drained than Manistee soils. They are better drained than the Pinconning soils. The texture of the upper layers of the Allendale soils is similar to that of the Au Gres soils, but the lower layers are finer textured.

Allendale loamy sand, 2 to 6 percent slopes (AlB).—This gently sloping soil is in areas between deep sandy soils and finer textured till soils and also occupies narrow low parts of side slopes of moraines. It is near the well-drained and sandy Kalkaska and Rubicon soils, which are in higher positions, and near the Selkirk, Pickford, and Pinconning soils, which are in lower positions. Small areas of Rubicon sand, loamy substratum, and of Au Gres sand, loamy substratum, were included in the mapping. They

are in high positions. Color of the surface layer is black in forested areas and very dark grayish-brown in cultivated areas. Some areas have a sandy surface layer.

This soil is droughty during dry periods, and erosion is a moderate hazard when it is cultivated. Wetness limits its use for crops. In some areas drainage of small, wet depressions is difficult.

Most areas of this soil are in pasture and woods. Elm, ash, swamp white oak, white pine, and second-growth aspen are the dominant trees in wooded areas. Areas that are drained are in crops. The principal crops are corn, wheat, and legume-grass meadows. (Capability unit IIIw–9 (4/lb) ; woodland suitability group G)

Allendale sandy loam, 2 to 6 percent slopes (AmB).—This gently sloping soil is on the broad knolls and narrow ridges of low plains. It is near the somewhat poorly drained Selkirk soils and the poorly drained or very poorly drained Pickford and Bergland soils. The surface layer is black in wooded areas and is very dark grayish brown in cultivated areas. In a few areas the surface layer is loamy sand, is lighter colored, and is eroded. Included in the mapping of this soil were small areas of Au Gres soils, loamy substratum.

Wetness, a moderate erosion hazard, droughtiness, and low fertility limit the use of this soil for crops. It is less droughty and less subject to erosion than Allendale loamy sands. In some areas drainage of small, wet depressions is difficult.

Most areas of Allendale sandy loam, 2 to 6 percent slopes, have been drained and are used for crops or pasture. Corn, wheat, and legume-grass meadows are the crops commonly grown. Undrained areas are in woods. White pine, elm, and ash are the dominant trees. (Capability unit IIIw–9 (4/lb) ; woodland suitability group G)

Au Gres Series

Soils of the Au Gres series are somewhat poorly drained, are nearly level or gently sloping and undulating, and are on lake and outwash plains. They formed in sandy material more than 66 inches thick. The Au Gres, loamy substratum, soils are underlain by loamy to clayey material at a depth ranging from 42 to 66 inches.

The surface layer of Au Gres soils is an organic mat over very dark gray sand about 1 inch thick. It has weak granular structure and is very friable. The subsurface layer is pinkish-gray sand that is single grain and loose.

The subsoil is dark reddish-brown or dark-brown sand about 22 inches thick. It is single grain and loose. The lower part of this layer has very pale brown or strong-brown mottles.

Below the subsoil is brown sand mottled with pale brown and yellowish brown. It is single grain and loose.

Available moisture capacity and fertility of these soils are low. Permeability is very rapid, and runoff is slow. The level of the water table fluctuates but is near the surface during spring months and in wet periods. Excess wetness, low available moisture capacity, and low fertility are major limitations to the use of these soils for crops. Wind erosion also is a hazard if the soils are cropped intensively.

Most areas of these soils are in trees, but a few areas are in crops or pasture. The native vegetation consisted of white-cedar, balsam fir, hemlock, aspen, and some hardwoods.

Typical profile of Au Gres sand:

O1—2 inches to 0, organic mat; leaves and other plant remains in various stages of decomposition; strongly acid; abrupt, smooth boundary.

A1—0 to 1 inch, very dark gray (10YR 3/1) sand; moderately high organic-matter content; weak, fine, granular structure; very friable; very strongly acid; abrupt, smooth boundary.

A2—1 to 5 inches, pinkish-gray (7.5YR 7/2) sand; single grain; loose; strongly acid; abrupt, irregular boundary.

B21hir—5 to 8 inches, dark reddish-brown (5YR 3/4) sand; weak, coarse, subangular blocky structure; very friable; medium acid; gradual, irregular boundary.

B22hir—8 to 14 inches, dark-brown (7.5YR 4/2) sand; very weak, coarse, subangular blocky structure; very friable; medium acid; gradual, irregular boundary.

B3—14 to 30 inches, reddish-yellow (7.5YR 6/6) sand; many, medium, distinct, strong-brown (7.5YR 5/6) and very pale brown (10YR 7/3) mottles; single grain; loose; medium acid; gradual, irregular boundary.

C—30 to 60 inches, brown (10YR 5/3) sand; many, medium, distinct, pale-brown (10YR 6/3) and yellowish-brown (10YR 5/6) mottles; single grain; loose; slightly acid.

In cultivated areas the surface layer is a very dark grayish-brown or very dark gray sand 6 to 10 inches thick, and the subsurface layer is very thin or is absent. Depth to mottling ranges from 10 to about 18 inches. Reaction of the surface soil and subsoil ranges from slightly acid to very strongly acid but is mostly medium acid to strongly acid.

The Au Gres soils are better drained and not so gray as the Roscommon soils. They are more poorly drained than the Croswell and the Rubicon soils. They lack the clayey underlying material of the Allendale soils and the underlying loamy material of the Iosco soils.

Au Gres sand, 0 to 6 percent slopes (ArB).—This soil is nearly level or gently sloping and is on broad plains near areas of moderately well drained Croswell soils and poorly drained or very poorly drained Roscommon soils. The surface layer is very dark gray in forested areas and very dark grayish brown to very dark gray in cultivated areas. When cultivated for the first time, the surface layer is a mixed pattern of black, yellowish brown, and gray. The surface layer is sand in most areas but is loamy sand in a few areas. This soil has hummocky relief in most areas because of tree windthrows, which are commonly called cradle knolls. Included in mapping this soil were Roscommon soils on some of the cradles and Croswell soils on the knolls.

Excess wetness, low fertility, low available moisture capacity when drained, and a slight wind erosion hazard are limitations to the use of this soil. This soil is very droughty during dry periods.

Most of this soil is in trees. Second-growth aspen predominates. Other trees are white-cedar, hemlock, balsam fir, and northern hardwoods. A few areas of this soil are in corn and small grains. Some small areas are idle. (Capability unit IVw–2 (5b) ; woodland suitability group F)

Au Gres sand, loamy substratum, 0 to 6 percent slopes (AuB).[1]—This soil is nearly level or gently sloping. It is near the well-drained Kalkaska, Rubicon, and Grayling soils; the somewhat poorly drained Iosco, Allendale, and Kawkawlin soils; and the poorly to very poorly drained Sims, Brevort, and Roscommon soils. The surface layer is black in forested areas and very dark grayish brown in cultivated areas. The surface layer is sand in most areas but is loamy sand in some.

[1] The Michigan Agricultural Experiment Station will continue to name this soil Arenac.

Excess wetness, low fertility, and low available moisture capacity if drained are the major limitations to the use of this soil. Wind erosion also is a hazard if this soil is cultivated.

Most areas of this soil are in woods or wildlife habitats. Corn, wheat, and hay are grown in a few areas. (Capability unit IVw–2 (5/2b) ; woodland suitability group F)

Belding Series

Soils of this series are somewhat poorly drained, are level or gently sloping, and are on till plains and moraines. They formed in loamy sand or sand, 18 to 42 inches thick, that overlies loam, silt loam, clay loam, or silty clay loam.

The surface layer is very dark gray sandy loam about 8 inches thick. It has weak granular structure and is friable.

The upper part of the subsoil is dark-brown and strong-brown sandy loam about 22 inches thick. It has distinct dark yellowish-brown and yellowish-brown mottles and has moderate blocky structure. The lower part of the subsoil is brown clay loam mottled with yellowish brown. This layer is about 6 inches thick and has moderate blocky structure.

Beneath the subsoil is brown clay loam mottled with yellowish brown. This layer lacks structure, is firm, and is high in lime content.

Available moisture capacity is moderately high, and fertility is moderate. Water moves moderately rapidly through the upper part of the soil and moderately slowly through the finer textured lower part. Runoff is slow, and water ponds in depressions and level areas. The water table is near the surface during spring months and wet periods. Excess wetness is a hazard to use of these soils in some years, especially in low areas. Frost is a hazard to crops in some low areas.

Most areas of Belding soils are used for crops. The principal crops are corn, wheat, oats, and mixed hay. Some areas are in permanent pasture or in woods. The native vegetation consisted of such northern hardwoods as elm, basswood, ash, hickory, and some white pine.

Typical profile of Belding sandy loam :

Ap—0 to 8 inches, very dark gray (10YR 3/1) sandy loam; weak, fine, granular structure; friable; moderately high organic-matter content; slightly acid; abrupt, smooth boundary.

B21hir—8 to 12 inches, dark-brown (7.5YR 4/4) sandy loam; weak, fine, granular structure; friable; medium acid; clear, wavy boundary.

B22hir—12 to 18 inches, strong-brown (7.5YR 5/6) sandy loam; common, medium, distinct, pale-brown (10YR 6/3) and dark-brown (7.5YR 3/2) mottles; weak, medium, subangular blocky structure; friable; medium acid; clear, wavy boundary.

B'21t—18 to 30 inches, pale-brown (10YR 6/3) sandy clay loam; common, medium, distinct, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; firm; slightly acid; abrupt, wavy boundary.

IIB'22t—30 to 36 inches, brown (7.5YR 5/4) clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; firm; mildly alkaline; abrupt, wavy boundary.

IIC—36 to 60 inches, brown (7.5YR 5/4) clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; firm; calcareous.

In undisturbed areas the surface layer is very dark gray, is 2 to 4 inches thick, and overlies a light-gray or light brownish-gray subsurface layer 2 to 8 inches thick. Depth to mottling ranges from 6 to about 16 inches. In some areas a brownish-gray layer 1 to 3 inches thick is between the upper and the lower part of the subsoil. Thickness of the lower part of the subsoil ranges from 2 to 10 inches. Reaction of the upper part of the subsoil ranges from slightly acid to medium acid, and that of the lower part of the subsoil from neutral to mildly alkaline.

The Belding soils are more poorly drained than the Ubly soils, are coarser textured in the upper solum than the Kawkawlin soils, and are finer textured in the subsoil than the Iosco or Allendale soils.

Belding sandy loam, 0 to 2 percent slopes (BdA).—This soil is nearly level and is on low moraines and till plains. It is near the Ubly, McBride, Nester, and Isabella soils, which are at higher elevations, and near the Kawkawlin and Sims soils, which are at lower elevations. Color of the surface layer is black in wooded areas and very dark gray or very dark grayish brown in cultivated areas. Small areas of Ubly and Kawkawlin soils were included in mapping this soil.

Excess wetness is the major limitation to use of this soil for crops, but frost also is a hazard in the lowest areas. During wet years water ponds on the surface in depressions and delays planting and harvesting.

Most areas of this soil are in woods. Northern hardwoods predominate. Some areas are used for pasture and crops. Crops grown are corn, small grains, and hay. (Capability unit IIw–8 (3/2b) ; woodland suitability group G)

Belding sandy loam, 2 to 6 percent slopes (BdB).—This soil is undulating and gently sloping and is on moraines and till plains. It is near Ubly, McBride, Nester, and Isabella soils, which are at higher elevations, and is near Sims and Kawkawlin soils, which are at lower elevations. The surface layer is very dark gray in most areas but is dark brown in a few areas. Included in mapping were small areas of Kawkawlin and Sims soils in the natural waterways and small depressions. These soils are finer textured than the Belding soil and dry more slowly in spring and after rains. Small areas of Ubly soils also were included in the areas mapped. These are on slight elevations.

Excess wetness limits use of this Belding soil for crops unless it is drained. The soil is subject to erosion when it is cultivated.

Most areas of this soil are used for crops. Corn, wheat, and oats are grown, and also grass-legume mixtures for hay and pasture. A few areas are in forest or permanent pasture. (Capability unit IIw–8 (3/2b); woodland suitability group G)

Belding Series, Clay Subsoil Variant

Soils of this variant of the Belding series are somewhat poorly drained, are gently sloping, and are on lake plains and deltas. They formed in sandy loam material, 18 to 42 inches thick, over clay or silty clay.

The surface layer is very dark grayish-brown sandy loam about 9 inches thick. It has weak granular structure and is very friable. There is a subsurface layer of grayish-brown sandy loam in many areas. It has weak platy structure and is very friable.

The upper part of the subsoil is dark-brown sandy loam about 7 inches thick. It is mottled with yellowish red, has weak blocky structure, and is very friable. The lower part of the subsoil is dark yellowish-brown sandy clay loam mottled with yellowish brown. It has weak blocky structure and is firm.

At a depth of about 30 inches is yellowish-brown clay. It is mottled with gray and brownish yellow, has moderate blocky structure, and is very firm.

Available moisture capacity and natural fertility of these soils are moderate. Water moves moderately through the upper coarser textured part of the solum, and very slowly through the lower part. Runoff is slow, and water erosion is not a hazard in most places.

Most areas of these soils are in forest or permanent pasture. A few areas are cropped and are in corn, small grains, and hay.

Typical profile of Belding sandy loam, clay subsoil variant:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) sandy loam; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—9 to 11 inches, grayish-brown (10YR 5/2) sandy loam; weak, thin, platy structure; very friable; medium acid; abrupt, irregular boundary.

Bhir—11 to 18 inches, dark-brown (10YR 4/3) sandy loam; few, fine, distinct, yellowish-red (5YR 5/6) mottles; weak, medium, subangular blocky structure; very friable; medium acid; abrupt, irregular boundary.

A'2—18 to 22 inches, grayish-brown (10YR 5/2) sandy loam; weak, fine, granular structure; very friable; medium acid; abrupt, irregular boundary.

B't—22 to 30 inches, dark yellowish-brown (10YR 4/4) sandy clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; firm; slightly acid; abrupt, wavy boundary.

IIC—30 to 60 inches, yellowish-brown (10YR 5/6) clay; many, medium, distinct, gray (10YR 6/1) and brownish-yellow (10YR 6/6) mottles; moderate, fine, angular blocky structure; very firm; calcareous.

In undisturbed areas the surface layer is very dark gray and is 2 to 4 inches thick. In some areas the grayish-brown subsurface layer is absent. The lower part of the subsoil is clay loam in some areas. Reaction of the surface layer and of the upper part of the subsoil ranges from medium acid to strongly acid. Reaction of the lower part of the subsoil ranges from slightly acid to medium acid.

The clay subsoil variants of the Belding series are not so gray and are better drained than Munuscong soils. They are finer textured in the upper layers than Allendale soils. Their drainage is similar to that of Coral soils, but they are finer textured in the lower layers.

Belding sandy loam, clay subsoil variant, 2 to 6 percent slopes (BeB).—This soil is gently sloping and undulating. The surface layer is very dark grayish brown in most areas. Included in mapping this soil were small areas of Munuscong soil occupying the slight depressions and temporary drainageways. The included Munuscong soil is more poorly drained than the Belding soil and dries slowly. During wet periods the wet areas in the depressions and drainageways delay planting and harvesting. Also included in mapping were small areas of clay subsoil variants of the Ubly series on slight rises or low knolls.

Excess wetness is the major limitation to the use of this Belding soil for crops.

Most areas of this soil are in pasture or forest. Some areas are in corn, small grains, and hay crops. (Capability unit IIw–8 (3/2b); woodland suitability group G)

Bergland Series

Soils of the Bergland series are very poorly drained, are nearly level, and are on lake or till plains. They formed in clay.

The surface layer is black silt loam about 9 inches thick. It has weak granular structure and is friable.

The subsoil is light brownish-gray silty clay mottled with yellowish brown. It has moderate blocky structure and is very firm.

Below the subsoil, at a depth of about 22 inches, is pinkish-gray clay mottled with strong brown and gray. It has weak blocky structure, is very firm, and is high in lime content.

Available moisture capacity of these soils is high, and natural fertility is moderately high. Permeability is very slow, and runoff is very slow to ponded. Unless these soils are artificially drained, the water table is at or near the surface. During wet periods in spring and sometimes in other periods, water stands in depressions and level areas.

Excess wetness and very slow permeability are the major limitations to the use of Bergland soils for crops. Frost damage to crops also is a hazard in low areas.

Only a few areas of these soils have been cleared, and these are used mainly for pasture and hay. The native vegetation was swamp forest that consisted of spruce, cedar, willow, hemlock, elm, ash, aspen, and maple.

Typical profile of Bergland silt loam:

A1—0 to 9 inches, black (10YR 2/1) silt loam; weak, coarse, granular structure; friable; high organic-matter content; slightly acid; abrupt, smooth boundary.

B2g—9 to 22 inches, light brownish-gray (10YR 6/2) silty clay; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, angular blocky structure; very firm, slightly acid; clear, wavy boundary.

C—22 to 60 inches, pinkish-gray (7.5YR 6/2) clay; common, coarse, distinct, strong-brown (7.5YR 5/6) and gray (10YR 5/1) mottles; weak, very coarse, angular blocky structure; very firm; calcareous.

In undisturbed areas a 1- to 12-inch layer of muck, peat, or moderately dark colored mineral material is at the surface. In other areas thickness of the surface layer ranges from 7 to 12 inches. Thickness of the subsoil ranges from 10 to 30 inches. Depth to the underlying layer of limy clay ranges from 17 to about 42 inches. Reaction of the surface layer and subsoil ranges from slightly acid to mildly alkaline.

The Bergland soils have a thicker and darker colored surface layer than the nearby Pickford soils. They are more poorly drained and grayer than the Selkirk soils, which are also nearby. Bergland soils have a finer textured surface layer and subsoil than the Sims soils.

Bergland mucky silt loam (Bg).—This soil occupies low areas and drainageways near the Selkirk, Pickford, Munuscong, and Allendale soils. The surface layer is black, and the texture is muck, mucky silt loam, or silt loam. Thickness of the surface layer ranges from 7 to 12 inches.

Excess wetness and the clayey texture of the subsoil are the major limitations to the use of this soil for crops. Wet depressions are common and remain wet for long periods during spring and after rains. Most areas are in swamp forest, but a few areas are used for hay and pasture. (Capability unit IIIw–2 (1c); woodland suitability group P)

Blue Lake Series

The soils of this series are well drained and moderately well drained and are nearly level to steep. They are on moraines and till and outwash plains. They formed in loamy sand or sandy material deposited by glaciers.

The surface layer is very dark gray loamy sand about 6 inches thick. It has weak granular structure and is very friable.

The upper part of the subsoil is dark reddish-brown or dark-brown loamy sand and sand about 30 inches thick. It is single grain and is very friable or loose. The lower part of the subsoil consists of alternate layers of sand and light sandy loam. The sand layers are brownish yellow and are single grain. The light sandy loam layers are dark brown, have weak blocky structure, and are friable.

Below the subsoil, at a depth of about 75 inches, is yellowish-brown sand that is single grain, loose, and high in lime content.

Available moisture capacity and natural fertility of these soils are moderately low. Permeability is moderately rapid, and runoff ranges from slow on mild slopes to rapid on steep slopes.

The Blue Lake soils are easy to till but are subject to erosion if the sloping areas are cropped intensively. Most of these soils have been cleared and are used for such crops as oats, rye, buckwheat, corn, potatoes, and beans. Some areas are in permanent pasture, some are idle, and some are planted to trees. The native vegetation consisted of northern hardwoods and pines.

Typical profile of Blue Lake loamy sand:

Ap—0 to 6 inches, very dark gray (10YR 3/1) loamy sand; weak, fine, granular structure; very friable; high in organic matter; strongly acid; abrupt, smooth boundary.

B21hir—6 to 18 inches, dark reddish-brown (5YR 3/2) loamy sand; weak, medium, subangular blocky structure; very friable; strongly acid; clear, wavy boundary.

B22hir—18 to 36 inches, dark-brown (7.5YR 4/4) sand; single grain; loose; strongly acid; clear, wavy boundary.

A'2—36 to 40 inches, brownish-yellow (10YR 6/6) sand; single grain; loose; medium acid; abrupt, wavy boundary.

A'2B't—40 to 75 inches; brownish-yellow (10YR 6/6) sand (A'2 horizon); single grain; loose; dark-brown (7.5YR 4/4) light sandy loam (B't horizon); weak, medium, subangular blocky structure; friable; medium acid; abrupt, wavy boundary between A'2 and B't horizons and with C horizon.

C—75 inches +, yellowish-brown (10YR 5/4) sand; single grain; loose; calcareous.

In undisturbed areas the surface layer is very dark gray and is 2 to 4 inches thick; it overlies a pinkish-gray subsurface layer 4 to 8 inches thick. Depth to the first light sandy loam layer (B't horizon) ranges from 28 to 50 inches. The texture of the B't layer is heavy loamy sand in some areas. Below a depth of 30 inches, the soil is mottled with gray and pale brown in some areas. Reaction of the surface layer and subsoil ranges from slightly acid to very strongly acid. Reaction of the material below the subsoil ranges from slightly acid to mildly alkaline.

The Blue Lake soils and the Otisco and Edmore soils all formed in similar material, but the Blue Lake soils are better drained than either of the other two soils. Blue Lake soils have darker colored subsoil layers than either the Montcalm or Chelsea soils.

Blue Lake loamy sand, 0 to 2 percent slopes (BlA).—This soil is nearly level and is on till plains and low moraines. It is near the Montcalm, Kalkaska, and Chelsea soils. The surface layer is very dark gray and is thin in wooded or idle areas. In a few areas the surface texture is sand. Small areas of Kalkaska and Montcalm soils were included in mapping this soil.

This soil has good tilth and is well drained. Moderately low fertility and available moisture capacity and the need to maintain organic-matter content are major limitations to its use for crops. Wind erosion is a hazard in cultivated areas. Some areas of this soil are used for crops, but most have been planted to red and white pine or are idle. (Capability unit IIIs–3 (4a); woodland suitability group C)

Blue Lake loamy sand, 2 to 6 percent slopes (BlB).—This soil is indulating or gently sloping. In wooded areas the surface layer is black or very dark gray. In cultivated areas it is dark gray to very dark gray and has some dark-brown spots. Small areas of Kalkaska, Montcalm, and Menominee soils were included in mapping this soil. Some moderately eroded Blue Lake soils also were included. The eroded soils are lower in organic-matter content and fertility and erode more readily than the uneroded soil.

This Blue Lake soil has good tilth. Moderately low fertility and available moisture capacity, the need to maintain organic-matter content, and an erosion hazard are the major limitations to its use for crops.

Most areas of this Blue Lake soil have been cultivated in the past. At present most are idle or have been planted to red and white pines. Some areas are still in corn, potatoes, wheat, rye, oats, buckwheat, beans for canning, and hay crops. (Capability unit IIIs–4 (4a); woodland suitability group C)

Blue Lake loamy sand, 6 to 12 percent slopes (BlC).—This soil is sloping and is on till plains and moraines. In cultivated areas the surface layer is mainly dark grayish brown, but some dark-brown and pale-brown spots occur on the upper slopes. In wooded areas the surface layer is black or very dark gray. Small areas of Kalkaska, Montcalm, and Menominee soils were included in mapping many areas of this soil.

This soil is easy to till. Some areas do not have continuous slopes. Runoff is medium in intensively cropped areas. Major limitations to use of this soil for crops are moderately low fertility and available moisture capacity, the need to maintain organic-matter content, and an erosion hazard.

Most areas of this soil are in crops. The major crops are corn, wheat, and hay. Wooded areas are in stands of northern hardwoods. (Capability unit IIIe–9 (4a); woodland suitability group C)

Blue Lake loamy sand, 12 to 18 percent slopes (BlD).—This soil is moderately steep and is on moraines and till plains. The surface layer is very dark grayish brown or very dark gray in most areas but is dark brown and pale brown in spots on the upper part of the slopes in cultivated areas. Small areas of Montcalm and Kalkaska soils were included in mapping many areas of this soil. Also included were some areas of Blue Lake loamy sand having slopes of less than 12 percent and some having slopes of more than 18 percent. Moderately eroded areas also were mapped. These eroded soils are lighter colored and lower in fertility and organic-matter content than uneroded soils and tend to be more droughty.

Moderately low fertility and available moisture capacity, the need to maintain organic matter, and an erosion hazard limit use of this soil for crops. Soil moisture is inadequate for crops during dry years and is further limited if runoff is not controlled. Slopes are not continuous in many areas. Most areas of this soil are in woods or pasture. The dominant trees are sugar maple, white ash, and hemlock. (Capability unit IVe–9 (4a); woodland suitability group C)

Blue Lake loamy sand, 18 to 25 percent slopes (BlE).—This soil is steep and is adjacent to drainageways and on moraines. In wooded areas the surface layer is black or very dark gray. In pastured or cultivated areas, it is very dark grayish brown, with many spots of dark brown or pale brown on the upper slopes and many very dark gray spots on the lower slopes. In some areas the texture of the surface layer is sand, and in other areas it is sandy loam. Gravel is present on the surface in many areas but does not interfere with operation of machinery. Included in mapping this soil were some moderately eroded areas. Soils in these eroded areas are lighter colored, are lower in organic-matter content and fertility, and are subject to greater runoff than in uneroded areas. Small areas of Kalkaska and East Lake soils also were included in mapping many of the areas. Other inclusions are small areas of Blue Lake soils having slopes of more than 25 percent.

Droughtiness, a severe erosion hazard, moderately low available moisture capacity and fertility, the need to maintain organic matter, and the difficulty of operating farm machinery on the steep slopes are the major limitations to the use of this soil for crops.

Most areas of this soil are forested. The dominant trees are hard maple, white oak, hemlock, and some aspen. (Capability unit VIe–2 (4a) ; woodland suitability group C)

Bohemian Series

Soils of this series are well drained and moderately well drained, are undulating to moderately steep, and are on lake outwash plains and deltas. They formed in layers of silt and very fine sand.

The surface layer is very dark grayish-brown fine sandy loam about 6 inches thick. It has weak granular structure and is friable. The subsurface layer is pinkish-gray sandy loam about 2 inches thick. It has weak platy structure and is friable.

The upper part of the subsoil is reddish-brown or yellowish-red, stratified very fine sandy loam and silt loam about 7 inches thick. It has weak blocky structure and is friable. The thickness and sequence of the layers in the lower part of the subsoil are variable. Some layers are reddish-brown, yellowish-red, or reddish-gray light silty clay loam. These layers have weak blocky structure and are firm. Other layers are light reddish-brown very fine sandy loam about 3 inches thick. These layers lack structure and are friable.

Below the subsoil, at a depth of about 33 inches, is light yellowish-brown stratified silt and very fine sand, with thin lenses of silty clay loam or clay. These layers lack structure, are friable, and are high in lime content.

The available moisture capacity of these soils is high, and natural fertility is moderate. Permeability is moderate to slow. Runoff is slow on the gently sloping soils and medium on the more steeply sloping soils. The sloping and moderately steep soils are more droughty than the less steeply sloping soils because the amount of runoff is greater. An erosion hazard is the major limitation to the use of these soils for crops.

Most areas of these soils have been cleared and are used for hay, small grains, and pasture. Some areas are in trees.

Typical profile of Bohemian fine sandy loam:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2—6 to 8 inches, pinkish-gray (5YR 6/2) sandy loam; weak, thin, platy structure; friable; strongly acid; clear, wavy boundary.

B21hir—8 to 10 inches, reddish-brown (5YR 4/4) fine sandy loam; weak, medium, subangular blocky structure; friable; strongly acid; gradual, smooth boundary.

B22hir—10 to 15 inches, yellowish-red (5YR 4/6), stratified very fine sandy loam and silt loam; weak, medium, subangular blocky structure; friable; medium acid; clear, wavy boundary.

IIA'2B'21t—15 to 23 inches, reddish-brown (5YR 4/4) light silty clay loam (B'21t horizon); reddish-gray (5YR 5/2) light silt loam (IIA'2 horizon); IIA'2 horizon occurs as thick coatings on peds and as lenses and tongues; peds of 2B'21t are surrounded by IIA'2 material in upper part; weak, medium, subangular blocky structure; A'2 is friable; B'21t is firm, is medium acid, and has gradual, irregular boundary.

IIB'22t—23 to 30 inches, reddish-brown (5YR 4/4) light silty clay loam; moderate, medium, subangular blocky structure; firm; thin lenses of clay; slightly acid; clear, smooth boundary.

IIIB'3—30 to 33 inches, light reddish-brown (5YR 6/4) very fine sandy loam; massive; friable; neutral; abrupt, wavy boundary.

IIC—33 to 60 inches, light yellowish-brown (10YR 6/4), stratified silt and very fine sand, with thin lenses of silty clay loam and clay; massive; friable; calcareous.

In undisturbed areas the surface layer is very dark gray and is 2 to 4 inches thick. The texture, sequence, and thickness of the layers in the subsoil vary greatly over short distances. Texture of the subsoil ranges from light silty clay loam to heavy fine sandy loam or heavy silt loam. Combined thickness of the surface layer and subsoil ranges from 18 to about 40 inches. The material below the subsoil ranges from stratified silt and very fine sand to predominantly silt or predominantly very fine sand. It has lenses and layers of fine sandy loam, fine sand, loam, silty clay loam, and clay, ¼ inch to 2 inches thick. Reaction of the surface and subsoil layers ranges from slightly acid to strongly acid.

Bohemian soils and Brimley soils formed in similar material, but Bohemian soils are better drained. They have a higher content of silt and very fine sand than the Rousseau soils. Bohemian soils are more stratified and have a higher content of silt and fine sand than McBride soils.

Bohemian fine sandy loam, 2 to 6 percent slopes (BoB).—This soil is gently sloping or undulating and is adjacent to more steeply sloping Bohemian soils. In cultivated areas the surface layer is very dark grayish brown, with a few spots and streaks of dark brown. In wooded areas the surface layer is very dark gray. In some areas texture of the surface layer is silt loam. Small areas of Brimley soils in nearly level areas and in depressions were included in mapping this soil.

When used for cultivated crops, this soil is subject to a moderate hazard of erosion. Available moisture capacity is high, and soil moisture generally is adequate for plant growth. Small seep spots and wet depressions are present in a few areas and hinder tillage during wet years.

Most areas of this soil are in crops or pasture. The crops commonly grown are corn, oats, wheat, and legume-grass mixtures. Some areas are in forest. (Capability unit IIe–2 (2.5a) ; woodland suitability group A)

Bohemian fine sandy loam, 6 to 12 percent slopes (BoC).—This soil is sloping and is adjacent to drainageways. The surface layer in cultivated areas is very dark grayish brown with a few spots and streaks of brown on the upper side slopes. In wooded areas the surface color is very dark gray. In a few areas the texture of the surface layer is sandy loam or silt loam. Small areas of this soil

with slopes of less than 6 percent or more than 12 percent were included in mapping. In cultivated areas runoff is medium to rapid and erosion is a moderate hazard. Soils in uneroded areas have good tilth and are easy to work.

Most areas of this soil are in crops or pasture. Crops commonly grown are corn, oats, wheat, and legume-grass mixtures. (Capability unit IIIe–5 (2.5a); woodland suitability group A)

Bohemian fine sandy loam, 12 to 18 percent slopes (BoD).—This soil is strongly sloping and rolling and is adjacent to drainageways in most areas. In cultivated areas the surface layer is very dark grayish brown, with a few areas of brown on the upper side slopes. In wooded areas the color of the surface layer is very dark gray. In some places the texture of the surface layer is sandy loam or silt loam. Slopes exceeding 18 percent were included in mapping some areas.

The degree of slope and a serious erosion hazard limit the use of this soil for crops.

Most areas of this soil are in crops or pasture, but some areas are in forest. Crops commonly grown are corn, wheat, oats, and legume-grass mixtures. Northern hardwoods predominate in forested areas. (Capability unit IVe–4 (2.5a); woodland suitability group A)

Brevort Series

These soils are poorly drained or very poorly drained and are nearly level or in depressed areas on lake, till, and outwash plains. They formed in sand or loamy sand over loam, silt loam, clay loam, or silty clay loam material. Depth to the finer textured material ranges from 18 to 42 inches.

The surface layer is very dark gray fine sandy loam about 10 inches thick. It has weak granular structure and is friable.

Below the surface layer, to a depth of about 28 inches, is brown or grayish-brown sand mottled with yellowish brown and strong brown. This material is single grain and loose.

Below the sandy material is light brownish-gray silty clay loam mottled with distinct brown. This material lacks structure, is firm, and is high in lime content.

Available moisture capacity and natural fertility of these soils are moderately low. Water moves rapidly through the sandy upper layers and moderately slowly through the lower finer textured layers. Runoff is very slow or ponded. These soils are in positions that receive runoff from adjacent higher soils.

Brevort soils dry slowly in spring or after prolonged rains. In undrained areas the water table is at or near the surface during spring and the soils are excessively wet for long periods. In low areas frost also is a hazard to crops.

Most areas of these soils are idle or are in trees. Aspen and conifers are the dominant trees in forested areas. Some areas of these soils have been drained and are in crops or pasture.

Typical profile of Brevort fine sandy loam:

Ap—0 to 10 inches, very dark gray (10YR 3/1) fine sandy loam; weak, fine, granular structure; friable; high content of organic matter; neutral; abrupt, smooth boundary.

C1—10 to 17 inches, brown (10YR 5/3) sand; many, medium, distinct, yellowish-brown (10YR 5/8) mottles; single grain; loose; neutral; abrupt, smooth boundary.

C2—17 to 28 inches, grayish-brown (10YR 5/2) sand; many, medium, distinct, strong-brown (7.5YR 5/8) mottles; single grain; loose; neutral; abrupt, smooth boundary.

IIC3—28 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam; many, coarse, distinct, brown (10YR 4/3) mottles; massive; firm; calcareous.

In some undisturbed areas a layer of muck or peat 1 to 12 inches thick is at the surface. In some places the surface layer is very dark brown and is 5 to 11 inches thick. The finer textured layer underlying the sandy layers ranges from loam to silt loam, clay loam, or silty clay loam. Reaction of the upper layers of the solum ranges from slightly acid to mildly alkaline.

Brevort soils and Iosco soils formed in similar material, but Brevort soils are more poorly drained. They have a coarser textured surface layer and subsoil than Ubly soils.

Brevort fine sandy loam (Br).—This soil is nearly level or is in irregularly shaped depressions. Slopes exceed 2 percent over short distances. This soil is near Kalkaska and Menominee soils, which are in higher positions, and near Iosco soils, which are gently sloping to nearly level. The surface layer is fine sandy loam 8 to 14 inches thick. In a few areas this layer is loam. Thickness of the coarse-textured material beneath the surface layer is variable. Loam or silty clay loam underlies the coarse-textured material at a depth of about 30 inches. Small areas of Roscommon loamy sand and Sims sandy loam were included in mapping this soil. Stones cover the surface in a few areas and hinder the use of farm machinery.

A high water table restricts the root zone and hinders use of farm machinery. Frost is a hazard to crops. Most areas of this soil are used for woods or pasture or are idle. (Capability unit IIIw–10 (4/2c); woodland suitability group W)

Brevort loamy sand (Bt).—This soil is nearly level and is in depressed areas and in shallow temporary drainageways. The surface layer is very dark gray loamy sand. Sand underlies the surface layer at a depth of 6 to 10 inches. Small areas of Roscommon soils were included in mapping most areas of this soil.

The water table is at or near the surface in undrained areas, and the soil is saturated. Wetness and a frost hazard limit the use of this soil for crops.

Most areas of this soil are in trees or pasture or are idle. (Capability unit IIIw–10 (4/2c); woodland suitability group W)

Brevort loamy sand, overwash (Bv).—This soil is nearly level and is in depressed areas and natural drainageways. A layer of dark-brown loamy sand, 4 to 18 inches thick, has been washed over the original very dark gray surface layer. Small areas of Roscommon soils were included in mapping this soil. Also included were areas with slopes exceeding 2 percent. Excess wetness resulting from a high water table and very slow runoff is the main limitation to the use of this soil for crops.

Most areas of this soil are in forest, but a few areas are in permanent pasture. (Capability unit IIIw–10 (4/2c); woodland suitability group W)

Brimley Series

The soils of this series are somewhat poorly drained, are undulating, and are on lake and outwash plains and deltas. They formed in material that was deposited by water and

is stratified. The stratified layers are predominantly silt and very fine sand, with thin layers of fine sandy loam, silty clay loam, or clay.

The surface layer is very dark grayish-brown fine sandy loam about 6 inches thick. This layer has weak granular structure and is friable. The subsurface layer is grayish-brown fine sandy loam about 2 inches thick. This layer has weak granular structure and is friable.

The upper part of the subsoil is dark-brown fine sandy loam and is about 5 inches thick. It has distinct dark yellowish-brown mottles in the lower part, has weak blocky structure, and is friable. The lower part of the subsoil is stratified fine sandy loam, heavy silt loam, light silty clay loam, and silt loam. It is mottled with yellowish brown and dark brown. It has weak blocky structure and is friable or firm.

The material underlying the subsoil is grayish-brown stratified silt, very fine sand, and thin layers of fine sandy loam, fine sand, and clay. This material has distinct yellowish-brown mottles and is massive, very friable, and limy.

Available moisture capacity of these soils is high, and natural fertility is moderate. Water moves through the soils at a moderate to moderately slow rate. Runoff is slow and ponds in some depressed areas. The pronounced mottles indicate that these soils are saturated with water for extended periods. Excess wetness limits depth of the root zone, hinders operation of farm machinery, and delays planting of crops during years when spring rainfall is excessive. These soils dry slowly.

The Brimley soils are used for crops in areas where there is adequate artificial drainage. Undrained areas are in pasture or woods.

Typical profile of Brimley fine sandy loam:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; weak, fine, granular structure; friable; moderately high organic-matter content; medium acid; abrupt, smooth boundary.

A2—6 to 8 inches, grayish-brown (10YR 5/2) fine sandy loam; weak, fine, granular structure; friable; medium acid; abrupt, wavy boundary.

Bhir—8 to 13 inches, dark-brown (10YR 4/3) fine sandy loam; few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles in lower part; weak, medium, subangular blocky structure; friable; medium acid; abrupt, wavy boundary.

A'2—13 to 15 inches, brown (10YR 5/3), stratified fine sandy loam, silt, and fine sand; common, fine, distinct, dark grayish-brown (10YR 4/2) and yellowish-brown (10YR 5/6) mottles; weak, fine, granular structure; very friable; strongly acid; abrupt, irregular boundary.

A'2B'21t—15 to 23 inches, brown (10YR 5/3) fine sandy loam (A'2 horizon); dark yellowish-brown (10YR 4/4) heavy silt loam (B'21t horizon); A'2 horizon occurs as thick coatings on peds and as fillings in root and worm channels; few, fine, faint, yellowish-brown (10YR 5/6) mottles in B'21t horizon; very weak, medium, subangular blocky structure; friable; strongly acid; gradual, irregular boundary.

B22tg—23 to 36 inches, grayish-brown (10YR 5/2), stratified fine sandy loam, silt loam, and light silty clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) and dark-brown (7.5YR 4/4) mottles; weak, fine, subangular blocky structure; firm; slightly acid; abrupt, smooth boundary.

C—36 to 60 inches, grayish-brown (10YR 5/2), stratified silt and very fine sand; also thin strata of fine sandy loam, fine sand, and clay; common, medium, distinct, light yellowish-brown (10YR 6/4) mottles; massive; very friable; calcareous.

In undisturbed areas the surface layer is very dark gray and is 2 to 4 inches thick. In some cultivated areas the surface layer is very dark gray and is 6 to 10 inches thick. The upper part of the subsoil ranges from dark yellowish brown to dark brown and is 3 to 8 inches thick. Texture of the various layers of the subsoil ranges from silt loam to silt, fine sandy loam, or very fine sand. Thin layers of silty clay loam, fine sand, or clay are present and range in thickness from ¼ inch to 3 inches. Texture of the material below the subsoil ranges from stratified silt and very fine sand to predominantly silt or predominantly very fine sand. Depth to limy material ranges from 18 to about 40 inches. Reaction of the surface layer and subsoil ranges from strongly acid to slightly acid.

The Brimley soils are more poorly drained than the Bohemian soils. The various layers of the Brimley soils are more variable in texture and thickness than are the various layers of Twining and Coral soils.

Brimley fine sandy loam, 2 to 6 percent slopes (ByB).—This soil is gently sloping or undulating. It is adjacent to Montcalm and Isabella soils. The surface layer is very dark grayish brown in cultivated areas and very dark gray in wooded areas. In some areas the surface texture is loamy fine sand or loam. Some poorly drained depressions and waterways are present. These wet areas dry slowly and hinder tillage during wet years. Included in mapping this soil were some level areas.

Excess wetness limits use of this soil for crops unless drainage is provided.

Most areas of this soil are in crops. Corn, wheat, and clover-grass mixtures are the crops commonly grown. Undrained areas are in trees or permanent pasture. (Capability unit IIw–7 (2.5b); woodland suitability group G)

Carbondale Series

Soils of this series are very poorly drained organic soils and occupy depressed areas and seep slopes on till, lake, and outwash plains. They are level in most areas but are gently sloping or sloping in a few areas. They formed in materials derived from coniferous and deciduous trees mixed with some fibrous plant remains. Thickness of the organic material is 42 inches to many feet.

The surface layer of these soils is black muck about 12 inches thick. It has moderate granular structure and is friable.

Below the surface layer, to a depth of 24 inches, is very dark brown mucky peat. It has moderate platy structure and is friable.

Below the mucky peat is a dark-brown peat to a depth of 60 inches or more. It is fibrous, has weak platy structure, and is friable. Small chunks of wood and partly decomposed woody material are present in this layer.

Available moisture capacity of these organic soils is high, and natural fertility is moderate. Movement of water through the soils is variable but is generally rapid. Runoff is very slow, and water ponds in the lowest areas, especially in spring and after rains. These soils are low in content of phosphorus, potassium, and many micronutrients. A high water table and wind erosion and frost hazards are the major limitations to the use of these soils for crops.

Most areas of Carbondale soils are in trees or brush. The native vegetation consisted of white-cedar, black spruce, balsam fir, tamarack, alder, willow, and dogwood.

Typical profile of Carbondale muck:

1—0 to 12 inches, black (10YR 2/1) muck; moderate, fine, granular structure; friable; slightly acid; gradual, smooth boundary.
2—12 to 24 inches, very dark brown (10YR 2/2) mucky peat; moderate, thick, platy structure; friable; slightly acid; gradual, wavy boundary.
3—24 to 60 inches, dark-brown (10YR 4/3) peat; fibrous; weak; thick, platy structure; friable; many chunks of wood and partly decomposed woody material; neutral.

Thickness of the muck surface layer ranges from 10 to 18 inches. The first and second layers are peat in some areas. The amount of woody material in the underlying layer ranges from a few pieces to many logs and branches. Thickness of the organic material is as much as 30 feet or more in some areas. Reaction of the material ranges from medium acid to neutral.

Carbondale soils are less acid than Loxley or Houghton soils but are more acid than Lupton soils. Carbondale soils contain more woody fragments than Houghton soils.

Carbondale loam, 0 to 2 percent slopes, overwash (CaA).—This soil is in low areas that receive runoff from soils in higher areas. The surface layer is recently accumulated mineral material 4 to 15 inches thick. This layer is very dark gray, and its texture ranges from loam to sandy loam or silt loam. This soil has moderate fertility but is wet most of the time. A wind erosion hazard and a severe frost hazard also limit its use for crops.

In most areas this soil is in dense stands of white-cedar, black spruce, willow, elm, and some sedges. (Capability unit Vwc–1 (Mc); woodland suitability group J)

Carbondale muck, 0 to 2 percent slopes (CbA).—This soil is nearly level or is in depressed areas. The surface layer is black. As much as 2 inches of dark loam is on the surface in some areas. Small areas of Adrian, Linwood, and Tawas muck were included in mapping many areas of this soil.

Use of this soil for crops is severely limited by a high water table, a wind erosion hazard, and a frost hazard. The soil remains cold in spring and dries slowly, even when drained.

Most of this soil is in dense stands of swamp forest that include such species as white-cedar, black spruce, balsam fir, tamarack, elm, and willow. A few small areas are in vegetable crops. (Capability unit Vwc–1 (Mc); woodland suitability group J)

Carbondale muck, 6 to 12 percent slopes (CbC).—This soil is sloping and is below sloping mineral soils in higher areas. Seep water from the mineral soils keeps entire areas of the mineral soils and this muck soil wet continually. The surface layer of this Carbondale muck is black in most areas. Some mineral soils were included in mapping.

Most areas of this soil are in swamp forest and in dense stands of northern hardwoods. (Capability unit Vwc–1 (Mc); woodland suitability group J)

Carbondale peat, 0 to 2 percent slopes (CdA).—This soil is nearly level or is in depressed areas. It is similar to the Carbondale mucks, except that the surface layer is very dark brown or dark yellowish-brown peat. This surface layer is underlain by dark-brown or yellowish-brown peat at a depth of 6 to 12 inches. Reaction of the profile is medium to slightly acid. This soil is continually wet except in extremely dry seasons. It remains cold in spring and dries slowly, even after it has been drained. A severe frost hazard also limits its use for crops.

Most areas of this soil are in swamp forest consisting of balsam fir, elm, willow, and tamarack. (Capability unit Vwc–1 (Mc); woodland suitability group J)

Chelsea Series[2]

The soils of this series are well drained and moderately well drained and are sandy. They range from nearly level to moderately steep and are on moraines, till plains, and outwash plains. They formed in medium and coarse sands.

The surface layer is very dark grayish-brown sand about 10 inches thick. It has very weak granular structure and is friable. The upper part of the subsoil is dark yellowish-brown sand about 18 inches thick. It has very weak granular structure and is very friable. The lower part of the subsoil consists of alternate layers of light yellowish-brown sand and brown heavy loamy sand. The sand layers are single grain and loose. The heavy loamy sand layers are ⅛ inch to 8 inches thick and are massive and friable. Below the subsoil, at a depth of about 70 inches, is pale-brown sand. This sand is single grain and loose.

Available moisture capacity and natural fertility of these soils are low. Water moves through the soils rapidly. Runoff ranges from slow to medium, depending on the degree of slope. The organic-matter content of these soils is low, and they are droughty during dry periods in summer. Droughtiness is the major limitation to the use of these soils for crops, but low fertility and low organic-matter content also limit their use.

Most areas of these soils are in woods. A few areas have been cleared and are in crops or pasture. The native vegetation consisted of red pine, white pine, and some oak, hickory, red maple, and aspen.

Typical profile of Chelsea sand:

Ap—0 to 10 inches, very dark grayish-brown (10YR 3/2) sand; very weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.
Bir—10 to 28 inches, dark yellowish-brown (10YR 4/4) sand; very weak, fine, granular structure; very friable; strongly acid; clear, wavy boundary.
A'2—28 to 45 inches, light yellowish-brown (10YR 6/4) sand; single grain; loose; medium acid; abrupt, wavy boundary.
A2–B't—45 to 70 inches, light yellowish-brown (10YR 6/4) sand (A'2 horizon) abruptly separated by brown (7.5YR 4/4) heavy loamy sand (B't horizon); B't horizon occurs as ⅛-inch to 8-inch layers, in many places discontinuous and wavy. A'2 horizon is single grain, loose; B't horizon is massive, friable; medium acid; abrupt, wavy boundary between last B't horizon and C horizon.
C—70 inches +, pale-brown (10YR 6/3) sand; single grain; loose; neutral.

Thickness of the surface layer in cultivated areas ranges from 6 to 10 inches, and the color ranges from very dark grayish brown to grayish brown. In undisturbed areas the surface layer is very dark gray, 1 to 3 inches thick, and the subsurface layer is a light gray or pinkish gray and is 1 to 5 inches thick. The finer textured layers in the lower part of the subsoil are heavy loamy sand. Depth to the lowest sandy layer ranges from 50 to 80 inches or more. Reaction of the surface layer and subsoil ranges from medium acid to strongly acid.

Chelsea soils have a slightly coarser textured profile than Montcalm soils. They are finer textured than either the Grayling or Rubicon soils.

Chelsea sand, 0 to 6 percent slopes (ChB).—This soil is nearly level or gently sloping and undulating. The surface layer is sand in most areas, but in a few areas it is loamy

[2] These soils were formerly called Graycalm in Michigan. They differ from the Chelsea soils of southern Michigan and Indiana by occurring in a colder climate in Osceola County. Response of crops on these soils differs from that in southern Michigan and Indiana.

sand. Gravel covers the surface in some places and increases wear on tillage implements but does not hinder tillage. Included in mapping this soil were a few areas where slope exceeds 6 percent. Moderately eroded areas also were included. Color of the surface soil in the eroded areas is brown or dark grayish brown. The eroded soil has lower fertility and organic-matter content than the uneroded soil and is slightly more droughty. Also included in mapping were small areas of Rubicon, Mancelona, East Lake, and Kalkaska soils. These four soils are sandy and well drained or moderately well drained and are similar to Chelsea soils in their use and limitations.

Water erosion is seldom a hazard. Low fertility, low available moisture capacity, and a wind erosion hazard are the major limitations to the use of this soil for crops.

Most areas of this soil are in trees. A few areas are cleared and are in crops or pasture. (Capability unit IVs–4 (5a); woodland suitability group E)

Chelsea sand, 6 to 12 percent slopes (ChC).—This soil is sloping and is on plains and uplands. Texture of the surface layer is sand in most areas, but in some areas it is loamy sand. Most areas of this soil are uneroded or are slightly eroded, but some moderately eroded and severely eroded areas were included in mapping. In these eroded areas the surface layer is lighter colored than in uneroded areas and is lower in organic-matter content and fertility. Also included in mapping were small areas of Montcalm, Rubicon, and East Lake soils. These three soils are sandy and well drained or moderately well drained and are similar to the Chelsea soil in their use and limitations. Slopes range outside the specified limits in some areas that were included in mapping this soil.

Water and wind erosion are hazards when this soil is cultivated. Use of this soil for crops is severely limited by low fertility and low available moisture capacity.

Most areas of this soil are in trees. Some areas are idle or are in pasture. (Capability unit VIs–1 (5a); woodland suitability group E)

Chelsea sand, 12 to 18 percent slopes (ChD).—This soil is moderately steep and is hilly. The surface layer is sand in most areas but is loamy sand in some areas. In most places this soil is uneroded or slightly eroded, but there are moderately and severely eroded spots in many cultivated areas. The eroded soils are lighter colored than uneroded soils and are lower in fertility and content of organic matter. Use of this soil for crops is severely limited by an erosion hazard, by low fertility and low available moisture, and by the hilly relief.

Most areas of this soil are in trees. Some areas that have been cleared in the past are now idle or are replanted to trees. (Capability unit VIIs–1 (5a); woodland suitability group E)

Chelsea sand, 18 to 25 percent slopes (ChE).—This soil is steep but is uneroded or only slightly eroded in most areas. Texture of the surface layer is sand in most areas but is loamy sand in some areas. Slope exceeds 25 percent in a few areas included in mapping. Some areas of moderately eroded and severely eroded soils also were included in mapping. The eroded areas are lower in organic-matter content and natural fertility than those not eroded.

Use of this soil for crops is severely limited by low fertility and low available moisture. Steep slopes and the hazards of water and wind erosion also limit use for crops.

Most areas of this soil are in trees. (Capability unit VIIs–1 (5a); woodland suitability group E)

Chelsea sand, 25 to 55 percent slopes (ChF).—This soil is very steep and is adjacent to drainageways. Texture of the surface layer is sand in most areas. Small spots of this soil have a brown surface color rather than the very dark grayish brown typical of Chelsea soils. Small areas of the Rubicon, Grayling, Montcalm, and East Lake soils were included in mapping this soil in most places. Also included were small areas having slopes of less than 25 percent.

It is unsafe to operate wheel tractors and equipment on this very steep soil. A very severe erosion hazard, low available moisture capacity, and low fertility are other major limitations to its use for crops.

Most areas of this soil are in trees or pasture. (Capability unit VIIs–1 (5a); woodland suitability group E)

Chelsea stony sand, 0 to 6 percent slopes (ClB).—This soil is nearly level or is gently sloping or undulating and is uneroded or only slightly eroded. The surface layer is sand or loamy sand. Stones are present on the surface. They range from 10 inches to 6 feet in diameter and are 3 to 100 feet apart. In many places stones occur throughout the soil profile.

Use of this soil for cultivated crops is limited unless the stones are removed. Low available moisture and fertility and an erosion hazard are other major limitations to its use.

This soil is mainly in pasture or forest. (Capability unit VIIs–1 (5a); woodland suitability group E)

Chelsea stony sand, 6 to 12 percent slopes (ClC).—This soil is sloping and is uneroded or only slightly eroded. The surface layer is sand or loamy sand. Stones lie on the surface. They range from 10 inches to 6 feet in diameter and are 3 to 100 feet apart. In many places the stones are present throughout the soil profile. In some areas the color of the surface layer is brown. Small areas of Rubicon, Grayling, and Montcalm soils were included in mapping most areas of this soil.

Use of this soil for cultivated crops is limited unless the stones are removed. An erosion hazard and low available moisture capacity and fertility are the other major limitations to its use for crops.

This soil is mainly in pasture or forest. (Capability unit VIIs–1 (5a); woodland suitability group E)

Chelsea stony sand, 12 to 18 percent slopes (ClD).—This soil is moderately steep and hilly. The surface layer is sand or loamy sand. In some areas the surface soil is brown or pale brown. Stones lie on the surface. They range from 10 inches to 6 feet in diameter and are 3 to 100 feet apart. In many places stones are present throughout the soil profile. Included in mapping this soil in most places were small areas of Rubicon, Grayling, and Montcalm soils. Also included were small areas where slopes exceeded 18 percent.

Use of this soil for cultivated crops is limited unless the stones are removed. An erosion hazard and low available moisture capacity and fertility are other major limitations to its use.

Most areas of this soil are in pasture or remain in forest. (Capability unit VIIs–1 (5a); woodland suitability group E)

Coral Series

The soils of this series are somewhat poorly drained and are on till plains and low moraines. They are level or gently sloping in most areas and formed in sandy loam glacial material.

The surface layer is very dark grayish-brown fine sandy loam about 8 inches thick. It has weak granular structure and is friable. The subsurface layer is pale-brown sandy loam about 4 inches thick. This layer has weak granular structure and is friable.

The upper part of the subsoil is dark-brown sandy loam about 15 inches thick. It has yellowish-brown mottles and granular structure, and it is friable. The lower part of the subsoil is brown sandy clay loam about 21 inches thick. This layer has yellowish-brown and light brownish-gray mottles and moderate blocky structure. It is firm and slightly hard.

Below the subsoil, at a depth of about 48 inches, is grayish-brown sandy loam mottled with yellowish brown and brownish yellow. This material lacks structure and is friable.

Available moisture capacity of these soils is moderately high, and natural fertility is moderate. Water moves through the soil at a moderate rate unless there is a high water table. Because these soils are level to gently sloping and sandy, runoff is slow. The gray color of these soils indicates that they are wet for extended periods. During spring and other wet periods, the water table is usually within 12 inches of the surface. This high water table restricts the root zone. Excess wetness, especially in spring, is the major limitation to the use of these soils for crops.

The Coral soils are used mainly for crops, but a few areas remain in woods or are in pasture. Some areas that have been cleared are now idle and are covered with grass, willows, or tag alder. Crops commonly grown are corn, wheat, oats, and legume-grass mixtures. The native vegetation consisted of mixed hardwoods, principally maple, elm, beech, oak, basswood, ash, and some white pine.

Typical profile of Coral fine sandy loam:

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

A2—8 to 12 inches, pale-brown (10YR 6/3) sandy loam; weak, medium, granular structure; friable; medium acid; abrupt, irregular boundary.

Bhir—12 to 22 inches, dark-brown (7.5YR 4/4) sandy loam; common, medium, distinct yellowish-brown (10YR 5/6) mottles; weak, coarse, granular structure; friable; medium acid; clear, wavy boundary.

A'2—22 to 27 inches, pale-brown (10YR 6/3) sandy loam; common, medium, distinct yellowish-brown (10YR 5/6) mottles; weak, coarse, granular structure; slightly brittle when dry, friable when moist; medium acid; abrupt, irregular boundary.

B't—27 to 48 inches, brown (10YR 5/3) sandy clay loam; common, medium, distinct, light yellowish-brown (10YR 6/4) and light brownish-gray (10YR 6/2) mottles; moderate, coarse, subangular blocky structure; firm; medium acid in upper part, grading to slightly acid in the lower 2 or 3 inches; abrupt, irregular boundary.

C—48 to 60 inches, grayish-brown (10YR 5/2) sandy loam; common, medium, distinct yellowish-brown (10YR 5/6) and brownish-yellow (10YR 6/8) mottles; massive; friable; mildly alkaline.

Undisturbed areas have a very dark gray surface layer, 2 to 4 inches thick, over a gray subsurface layer of sandy loam. In some areas the subsurface layer is absent. Depth to mottling ranges from 8 to about 18 inches. In some areas texture of the lower part of the subsoil is heavy sandy loam rather than the sandy clay loam typical of the Coral soils. The material below the subsoil contains lenses or pockets of loamy sand in some areas. Depth to the material below the subsoil ranges from 36 to 55 inches or more. Reaction of the surface and subsoil layers ranges from strongly acid to slightly acid. Reaction below the subsoil is neutral to very strongly alkaline.

The Coral, McBride, and Ensley soils formed in similar material, but Coral soils are more poorly drained than McBride soils and are better drained than Ensley soils. They have a slightly coarser textured subsoil than Twining soils and are not so much stratified as Richter soils.

Coral fine sandy loam, 0 to 2 percent slopes (CoA).—This soil is nearly level or is in shallow depressions and drainageways. It is near the well drained and moderately well drained McBride and Montcalm soils, which are in higher positions, and is also near the poorly drained and very poorly drained Ensley soils, which are in lower positions. In wooded areas the surface layer is black or very dark gray. In a few areas it is loamy sand instead of the more typical fine sandy loam. Small areas of Ensley soils occupying depressions were included in mapping some of the areas. The Ensley soils dry more slowly in spring than the Coral soil, and this delays planting of crops.

The water table is close to the surface of this Coral soil during spring and other wet periods, and wetness limits the use of this soil for crops.

Most areas of this soil are in corn, wheat, oats, or legume-grass mixtures. Some areas are in forest or pasture. (Capability unit IIw–7 (2.5b); woodland suitability group G)

Coral fine sandy loam, 2 to 6 percent slopes (CoB).—This soil is gently sloping or undulating. Shallow depressions and drainageways are common and remain wet for long periods in spring. Texture of the surface layer is fine sandy loam in most areas but is sandy loam or loamy sand in some areas. The surface layer is very dark gray in wooded areas but is brown in a few moderately eroded areas. Slopes of less than 2 percent and more than 6 percent were included in mapping some areas of this soil. Excess wetness resulting from a fluctuating high water table limits use of this soil for crops.

Most areas of this soil remain in woods, but a few areas are in pasture and in crops. (Capability unit IIw–7 (2.5b); woodland suitability group G)

Croswell Series

Soils of this series are moderately well drained and sandy, are level to gently sloping, and are on till plains, low moraines, and outwash plains. They formed in thick deposits of medium and coarse sands.

The surface layer is dark grayish-brown sand about 8 inches thick. It has weak granular structure and is very friable. Under it is a subsurface layer of pinkish-gray sand about 4 inches thick. This layer is single grain and loose.

The subsoil is dark-brown or brown sand about 18 inches thick. The upper part has weak blocky structure and is very friable. The lower part of the subsoil is single grain and loose. The material underlying the subsoil at a depth of about 30 inches is loose, single grain sand. It has distinct

yellow, strong-brown, and reddish-yellow mottles and is slightly acid.

The available moisture capacity and natural fertility of Croswell soils are low. Water moves very rapidly through the soil. Runoff is slow to very slow because of the sandiness of the soil and the level to gentle slopes in most areas. During spring the water table is within 2 to 3 feet of the surface, but it recedes quickly at the beginning of summer. The pronounced mottling in the lower part of these soils indicates that this part is saturated for extended periods. Once the water table lowers, these soils dry quickly, and available moisture is seldom adequate for good crop growth.

Droughtiness and low fertility limit the use of these soils for crops.

Most areas of Croswell soils are in second-growth woods. A few areas have been cleared and farmed in the past but are now idle or have been planted to trees (fig. 2). The native vegetation consisted of mixed conifers and hardwoods. The most common trees were red and white pine and aspen.

Typical profile of Croswell sand:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) sand; weak, medium, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—8 to 12 inches, pinkish-gray (7.5YR 7/2) sand; single grain; loose; very strongly acid; abrupt, irregular boundary.

B21hir—12 to 20 inches, dark-brown (7.5YR 4/4) sand; weak, medium, subangular blocky structure; very friable; strongly acid; gradual, wavy boundary.

B22ir—20 to 30 inches, brown (7.5YR 5/4) sand; single grain; loose; strongly acid; gradual, wavy boundary.

C—30 to 60 inches, light yellowish-brown (10YR 6/4) sand; common, medium, distinct, yellow (10YR 7/8), strong-brown (7.5YR 5/8), and reddish-yellow (7.5YR 6/8) mottles; single grain; loose; slightly acid.

The surface layer is very dark gray in undisturbed areas and is ½ inch to 3 inches thick. The subsurface layer is light brownish-gray in some areas and is 2 to 10 inches thick. The subsurface layer is absent in some cultivated areas. Color of the subsoil is dark yellowish brown or reddish brown in a few areas. Combined thickness of the surface layer and subsoil ranges from 24 to about 36 inches. Depth to mottling ranges from 18 to about 40 inches. Reaction of the surface layer and the subsoil layer ranges from very strongly acid to slightly acid and is predominantly strongly acid to medium acid.

The Croswell soils are not so well drained as the Rubicon soils. They are better drained and less mottled than the Au Gres soils.

Figure 2.—**New plantation of red pine on Croswell sand, 0 to 6 percent slopes; Au Gres soils are in the lower area in the background.**

Croswell sand, 0 to 6 percent slopes (CrB).—This soil is nearly level to gently sloping. It is adjacent to well-drained sandy soils in slightly higher positions and to somewhat poorly drained sandy soils in lower positions. The surface layer is very dark gray in undisturbed areas and is dark grayish brown in cultivated areas.

Low natural fertility, low available moisture capacity, and a wind erosion hazard are major limitations to use of this soil. Soil moisture is seldom adequate for good crop growth. During spring the water table is within 2 to 3 feet of the surface, but it recedes quickly early in summer.

Most areas of this soil are in second-growth forest and brush consisting of aspen, brambles, and grass. A few small areas are cultivated. (Capability unit IVs–4 (5a); woodland suitability group E)

Croswell sand, 6 to 12 percent slopes (CrC).—This soil is sloping and is on ridges adjacent to poorly drained sandy soils and organic soils. The surface layer is very dark gray in wooded areas and dark gray in cultivated or idle areas. The layer underlying the subsoil contains chunks of cemented material in some places. Included in mapping this soil were many areas where well-drained Kalkaska soils are on narrow ridgetops and Au Gres soils are on the narrow lower side slopes.

This soil is subject to wind erosion if it is cultivated or its vegetative cover is burned. Very rapid permeability, low natural fertility, and low available moisture are the major limitations to its use for crops. Most areas of this soil have been in crops in the past but are now idle or under a cover of aspen, brambles, and grass. A small acreage is in forest. (Capability unit VIs–1 (5a); woodland suitability group E)

Dawson Series

Soils of this series are very poorly drained organic soils. They are nearly level or are in depressed areas and are on till and outwash plains. They formed in strongly to extremely strongly acid organic materials that are 12 to 42 inches thick and overlie sand or loamy sand.

The top 7 inches of these soils is very dark grayish-brown or black peaty muck. It has moderate granular structure and is friable. Below this layer to a depth of about 22 inches is dark reddish-brown peat. It is fibrous and friable.

Dark reddish-brown and reddish-brown loamy sand or sand lies at a depth of about 22 inches. It is single grain or massive and is loose.

The available moisture capacity of these soils is high, and the natural fertility is low. Movement of water through these soils is variable but commonly is rapid. Runoff is very slow because these soils are level or nearly level and are in low positions. Water often ponds in the lowest areas, especially in spring and after rains. In most places these soils are low in content of phosphorus, potassium, and many micronutrients.

A high water table, low fertility, and an extremely acid reaction severely limit the use of these soils for crops. Wind erosion and damage from frost also are major hazards if these soils are cultivated.

Present vegetative cover of these soils is leatherleaf, sphagnum moss, spruce, and tamarack.

Typical profile of Dawson peaty muck:

1—0 to 2 inches, very dark grayish-brown (10YR 3/2) peaty muck; moderate, medium, granular structure; friable; extremely acid; clear, wavy boundary.

2—2 to 7 inches, black (10YR 2/1) peaty muck; many, living, fine roots; moderate, medium, granular structure; friable; very strongly acid; gradual, smooth boundary.

3—7 to 22 inches, dark reddish-brown (5YR 3/4) peat; fine, fibrous structure; friable; extremely acid; abrupt, smooth boundary.

IIC1—22 to 29 inches, dark reddish-brown (5YR 3/4) loamy sand; massive; slightly firm; very strongly acid; clear, wavy boundary.

IIC2—29 to 60 inches, reddish-brown (5YR 4/3) sand; single grain; loose; very strongly acid.

The surface layer is dark grayish brown in some areas and consists of sphagnum or hypnum moss. The texture of the underlying mineral material is sand or loamy sand. Reaction of the organic material ranges from very strongly acid to extremely acid, and reaction of the sandy material ranges from very strongly acid to medium acid.

The layer of organic material is thinner in Dawson soils than in Houghton or Loxley soils. Dawson soils are more acid than Tawas and Adrian soils.

Dawson peaty muck (Da).—This organic soil is in nearly level or depressed areas on uplands and plains. In most areas the surface layer is partly decomposed mosses, but in some areas the second layer is muck. In a few areas the underlying mineral material is sandy loam instead of the more typical sand or loamy sand. In other areas the typical sand or loamy sand underlying material is only 8 to 12 inches thick and is itself underlain by silty clay loam to clay. Small areas of Greenwood and Loxley soils having organic materials more than 42 inches thick were included in mapping this soil.

Use of this soil for crops is very severely limited by excess wetness, a frost hazard, and strong to extremely acid reaction in the profile. Dawson peaty muck is not used for crops. It is in mosses, leatherleaf, some black spruce and tamarack, and a few wild huckleberries. A stunted and thin scattering of white pine, spruce, and aspen grows in some areas. (Capability unit VIIIw–1 (Mc–a); woodland suitability group L)

Dighton Series

Soils of this series are well drained and moderately well drained, are on till plains and moraines, and are gently sloping to moderately steep. They formed in silty clay loam, sandy clay loam, or clay loam glacial material. Loamy sand or sand underlies these soils at a depth ranging from 18 to about 42 inches.

The surface layer is very dark brown sandy loam about 8 inches thick. It has weak granular structure and is very friable. The subsurface layer is pale-brown sandy loam about 3 inches thick. It has weak blocky structure and is friable.

The subsoil is a brown or dark-brown clay loam about 21 inches thick. It has moderate or strong blocky structure and is firm.

Below the subsoil is yellowish-brown, stratified loamy sand and sand. This layer has single grain structure and is loose. In many areas a small amount of gravel is present.

Available moisture capacity of these soils is high, and natural fertility is moderately high. Water moves moderately slowly through the subsoil and rapidly through the material below the subsoil. Runoff varies according to steepness of the soil. It is medium in gently sloping areas and rapid in moderately steep areas. Erosion is the major hazard if these soils are used for crops.

Most areas of these soils have been cleared of trees and are in crops. Large acreages of the moderately steep areas are in forest or permanent pasture. Crops commonly grown are corn, small grains, and hay. The native vegetation consisted mainly of northern hardwoods, including sugar maple, beech, elm, birch, and some white pine, hemlock, and aspen.

Typical profile of Dighton sandy loam:

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

A21—8 to 11 inches, pale-brown (10YR 6/3) sandy loam; weak, fine, subangular blocky structure; friable; strongly acid; abrupt, irregular boundary.

B21t&A22—11 to 18 inches, brown (7.5YR 5/4) clay loam; moderate, medium, subangular blocky structure; firm (B21t horizon). Pale-brown (10YR 6/3) loam; massive; friable (A22 horizon). The A22 horizon occurs as thick coatings on peds and in root and worm channels; chunks and peds of the Bt horizon are partly or wholly surrounded by A22 material; strongly acid; clear, irregular boundary.

B22t—18 to 32 inches, dark-brown (7.5YR 4/4) clay loam; strong, medium, angular blocky structure; firm; strongly acid; abrupt, wavy boundary.

IIC—32 to 60 inches, yellowish-brown (10YR 5/4), stratified loamy sand and sand; small amount of gravel; single grain; loose; medium acid.

Color of the surface layer is dark grayish brown in some areas, and thickness ranges from 6 to 10 inches. Undisturbed areas have a very dark gray surface layer 1 to 4 inches thick. The typical subsurface layer is absent in a few areas. Texture of the subsoil ranges from silty loam to sandy clay loam or light clay. Reaction of the surface layer and subsoil ranges from slightly acid to strongly acid.

Dighton soils have a coarser textured underlying material and are more deeply leached than the Nester soils. They are finer textured and contain less gravel than the Newaygo soils.

Dighton sandy loam, 2 to 6 percent slopes (DgB).—This soil is gently sloping and is on undulating ridge and knoll tops, between Nester soils that are in higher positions and Montcalm soils that are in lower positions. The surface layer is very dark gray in undisturbed areas and very dark brown in cultivated areas. Texture of the surface layer is light loam in some areas, particularly in the northern part of Richmond Township. The lower few inches of the clay loam lower subsoil layer is limy in a few areas. Small areas of Nester soils were included in mapping some areas of this soil. Slopes range outside the specified limits over short distances.

If cultivated, this soil is subject to moderate water erosion. During long dry periods the soil becomes somewhat droughty. The few wet depressions and drainageways dry slowly in spring, and planting is delayed during wet years.

Most areas of this soil are in crops. Corn, wheat, oats, and hay are grown. Wooded areas are in northern hardwoods. (Capability unit IIe–2 (2.5a); woodland suitability group B)

Dighton sandy loam, 6 to 12 percent slopes (DgC).—This soil is on sloping ridgetops and knolls. It is near Nester and Isabella soils, which are in slightly higher positions. The surface layer is very dark gray in undisturbed areas and very dark brown or dark grayish brown in culti-

vated areas. Texture of the surface layer is loam or fine sandy loam in some areas. Some areas are moderately eroded, and the surface layer is grayish brown. In eroded areas the surface layer is a mixture of the original surface soil and the upper part of the subsoil. The present surface layer is lighter colored and lower in fertility and organic matter than that of an uneroded soil. Included in mapping this soil were some areas of Nester and Isabella soils. Also included were areas where slopes range from 2 to 6 percent, and other areas where slopes range from 12 to 18 percent.

Erosion and a moderate droughtiness during long dry periods are the major limitations to use of this soil for crops.

Most areas of this soil are in crops and pasture. Hay is the major crop. Northern hardwoods are dominant in the wooded areas. (Capability unit IIIe–5 (2.5a); woodland suitability group B)

Dighton sandy loam, 12 to 18 percent slopes, moderately eroded (DgD2).—This soil is on the tops of moderately steep ridges and knolls and is adjacent to drainageways. Color of the surface layer is very dark gray in undisturbed areas. It is very dark brown or dark grayish brown, with some spots of grayish brown, in cultivated areas. In a few areas, color of the surface layer is grayish brown with spots of brown. Included in mapping this soil were small areas with slopes of 6 to 12 percent. Also included were small areas of Nester, Isabella, and Montcalm soils.

An erosion hazard and droughtiness during extended dry periods are the major limitations to the use of this soil for crops.

Most areas of this soil are in crops or have been cultivated in the past. Corn, wheat, oats, and hay are the major crops. Northern hardwoods predominate in the wooded areas. (Capability unit IVe–4 (2.5a); woodland suitability group B)

East Lake Series

The soils of this series are well drained and moderately well drained and are on outwash and lake plains, deltas, and beach ridges. Slopes are nearly level to moderately steep. The soils formed in sand or loamy sand glacial material, 12 to 42 inches thick, that overlies stratified calcareous sand and gravel. Content of gravel varies considerably from one area to another.

The surface layer is very dark grayish-brown loamy sand about 7 inches thick. It has weak granular structure and is very friable. The subsurface layer is grayish-brown sand about 3 inches thick. It has very weak granular structure and is very friable.

The subsoil in most areas is dark-brown or brown sand about 26 inches thick. It has very weak blocky or single grain structure and is very friable or loose.

At a depth of about 36 inches is pale-brown, stratified gravelly sand and sand. This part is single grain, loose, and high in lime content.

Available moisture capacity and natural fertility of these soils are low. Water moves through them very rapidly. There is very little runoff from these soils because they are sandy. Their moisture content is seldom adequate for optimum crop growth, and crops show the effects of drought on these soils more quickly than on most soils in the county.

Major limitations to use of these soils for crops are low available soil moisture and low fertility. Large areas of East Lake soils are in aspen, wild cherry, and white birch. Other areas have been cleared in the past but are now idle or are used for pasture. A few areas are in hay, oats, or potatoes. The native vegetation consisted of mixed hardwoods and some white pine.

Typical profile of East Lake loamy sand:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, fine, granular structure; very friable; strongly acid; abrupt, smooth boundary.

A2—7 to 10 inches, grayish-brown (10YR 5/2) sand; very weak, fine, granular structure; very friable; medium acid; abrupt, wavy boundary.

B21hir—10 to 15 inches, dark-brown (7.5YR 4/4) sand; weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—15 to 22 inches, brown (10YR 5/3) sand; very weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B3—22 to 36 inches, yellowish-brown (10YR 5/6) sand; single grain; loose; neutral; abrupt, wavy boundary.

IIC—36 to 60 inches, pale-brown (10YR 6/3), stratified gravel, gravelly sand, and sand; limestone material prevalent; small amount of granitic and acidic rock material; single grain; loose; calcareous.

The surface layer is very dark gray or dark grayish brown in some areas and is 6 to 10 inches thick. In undisturbed areas the surface layer is very dark gray and is 1 to 3 inches thick. The subsurface layer is absent in some cultivated areas. Texture of the upper part of the subsoil is loamy sand in a few areas. A few to many cobblestones are in the subsoil in many areas. Reaction of the surface layer and subsoil ranges from strongly acid to mildly alkaline.

The subsoil of East Lake soils is brighter and darker colored than that of Rubicon soils and is less acid. The surface and subsoil layers of East Lake soils are coarser textured than those of Mancelona soils.

East Lake loamy sand, 0 to 6 percent slopes (EaB).—This soil is nearly level in most areas but in some areas is gently sloping. It is near Kalkaska soils. The surface layer is very dark gray in undisturbed areas and is gravelly in some areas. A few, fine, faint, pale-brown mottles are in the subsoil and underlying sand in some areas. Small areas of Gladwin and Kalkaska soils were included in mapping this soil. The East Lake loamy sand is slightly more droughty than the East Lake sandy loam but is less subject to erosion.

Low available moisture capacity and low fertility, the difficulty of maintaining organic-matter content, and a wind erosion hazard limit use of this soil for crops. Soil moisture is seldom adequate for good crop growth, especially during dry summer months. During extremely dry growing seasons, shallow-rooted crops, such as corn, will not mature.

Most areas of East Lake loamy sand are in crops, some are in pasture, and some are in trees. Hay, oats, and potatoes are the major crops. (Capability unit IVs–4 (5a); woodland suitability group E)

East Lake loamy sand, 6 to 12 percent slopes (EaC).—This soil occurs in rolling areas, near areas of Kalkaska, Montcalm, and Mancelona soils. Color of the surface soil is generally very dark grayish brown in cultivated areas and very dark gray in undisturbed areas. It is brown or dark brown in small eroded areas. In some areas the surface layer is gravelly.

This soil is easy to till, but erosion is a hazard when it is cropped intensively. The major limitations to its use for crops and pasture are low fertility and low available moisture. Yields of shallow-rooted crops are low, and in extremely dry years such crops do not mature. Pasture and hay do well early in the growing season but suffer from drought as available soil moisture is depleted during dry summer months.

Most areas of this soil are in crops, but some areas are in pasture or trees. Hay, oats, and potatoes are the principal crops. (Capability unit VIs–1 (5a); woodland suitability group E)

East Lake loamy sand, 12 to 18 percent slopes (EaD).—This soil is moderately steep and is in hilly areas near Kalkaska, Montcalm, and Chelsea soils. The surface layer is generally very dark grayish brown in cultivated areas and very dark gray in wooded areas. In small eroded areas the surface layer is brown. In many areas the surface layer is gravelly loamy sand. Small areas of Kalkaska and Chelsea soils were included in mapping this soil. Also included were a few areas where slopes exceed 18 percent.

Low available moisture, low fertility, and an erosion hazard severely limit use of this soil for crops. Pasture yields are low during hot summer months.

Most areas of this soil are idle or are in pasture. Some areas are in trees. (Capability unit VIIs–1 (5a); woodland suitability group E)

East Lake sandy loam, 0 to 2 percent slopes (ElA).—This soil is nearly level in most areas and sloping in a few areas. The surface layer is very dark grayish brown in cultivated areas and very dark gray in forested areas. In a few small spots, it is brown. A few streaks and spots of gravel are at the surface in some areas. Texture of the second and third layers of the profile is predominantly loamy sand. A few pale-brown mottles are in the lower part of the soil profile in some areas, and in these areas the water table is within 2 to 3 feet of the surface during wet seasons. Cobblestones are present in the soil in some areas. Small areas of Gladwin, Mancelona, and Kalkaska soils were included in mapping this soil.

Low fertility and low available moisture content, the need to maintain organic-matter content, and an erosion hazard limit the use of this soil for crops.

Most areas of this soil are in crops or pasture. Corn, potatoes, wheat, oats, and hay are the principal crops. Some areas are in trees. (Capability unit IVs–4 (5a); woodland suitability group E)

Edmore Series

Soils of this series are poorly drained or very poorly drained and are in nearly level or depressed areas on till plains and moraines. They formed in loamy sand glacial material. This series is not mapped alone but with the Tonkey soils as Edmore and Tonkey sandy loams.

The surface layer of Edmore soils is a black sandy loam about 9 inches thick. It has weak granular structure and is very friable.

The subsoil is grayish-brown and gray sandy loam about 23 inches thick. It is highly mottled with various colors, has weak blocky structure, and is friable.

Below the subsoil, at a depth of about 32 inches, is gray loamy sand, highly mottled with grayish brown. It has single grain structure, is loose, and is high in lime content.

Available moisture capacity of the Edmore soils is moderately low, and natural fertility is moderate. Water moves through the soil at a moderately rapid rate in the absence of a high water table. Because these soils are nearly level, runoff is very slow and water often ponds in low depressions. The gray color of these soils indicates that they are wet for extended periods. The water table is usually within 12 inches of the surface during spring and during other wet periods.

Wetness is the major limitation of these soils for crop use. Edmore soils are used mainly for pasture. A few areas are in trees. The native vegetation was predominantly elm, ash, spruce, white-cedar, tag alder, reeds, sedges, and cattails.

Typical profile of Edmore sandy loam:

Ap—0 to 9 inches, black (10YR 2/1) sandy loam; weak, medium, granular structure; very friable; high organic-matter content; slightly acid; abrupt, smooth boundary.

B1g—9 to 18 inches, grayish-brown (10YR 5/2) sandy loam; many, medium, distinct, brownish-yellow (10YR 6/6) and strong-brown (7.5YR 5/8) mottles; weak, fine, subangular blocky structure; very friable; slightly acid; gradual, wavy boundary.

B2g—18 to 32 inches, gray (10YR 5/1) sandy loam; many, medium, distinct, brownish-yellow (10YR 6/6), yellowish-red (5YR 4/8), and pale-brown (10YR 6/3) mottles; weak, medium, subangular blocky structure; friable; neutral; abrupt, wavy boundary.

Cg—32 to 60 inches, gray (10YR 5/1) loamy sand; many, medium, distinct, dark grayish-brown (10YR 4/2) mottles; single grain; loose; calcareous.

In some undisturbed areas the surface layer is muck or peat 1 to 12 inches thick. The surface layer in some areas is very dark gray and is 6 to 10 inches thick. Texture of the lower part of the subsoil is heavy loamy sand in some areas. Combined thickness of the surface layer and subsoil ranges from 25 to about 45 inches. Reaction of the surface layer and subsoil ranges from slightly acid to mildly alkaline. Texture of the underlying material is predominantly loamy sand, with lenses of sand to stratified loamy sand, fine sand, and light sandy loam.

These soils and the Montcalm and Otisco soils formed in similar material, but the Edmore soils are more poorly drained and grayer than either the Montcalm or Otisco soils. Their profile is coarser textured than that of the Ensley soils but is finer textured than that of the Roscommon soils.

Edmore and Tonkey sandy loams (Em).—The two soils in this mapping unit are in nearly level drainageways and depressed areas near the well-drained Montcalm soils and the somewhat poorly drained Otisco soils. In some areas mapped, the Edmore soils are dominant; in other areas, the Tonkey soils. A few areas contain both soils. The Tonkey soil is described in this soil survey in its alphabetical order. Edmore and Tonkey soils are similar. In areas of Tonkey soils, there are strata of sand and sandy loam throughout the soil layers. Boulders are on the surface and throughout the profile in some areas. Excess wetness is the major limitation to the use of these soils for crops. Undrained areas are too wet for crop use in most years.

Most areas in this mapping unit are in pasture or forest. The forest areas are in stands of elm, ash, spruce, and white-cedar and have an understory of tag alder, reeds, sedges, and cattails. A few areas of these soils are in corn, small grains, and hay. (Capability unit IIIw–6 (4c); woodland suitability group W)

Edwards Series

The soils of this series are very poorly drained organic soils and are on nearly level or depressed areas on till, outwash, and lake plains and moraines. They developed in organic materials, 12 to 42 inches thick, over marl. The organic materials are mixed woody, grassy, and sedge materials.

The upper 24 inches of these soils is black or very dark brown muck. It has moderate granular structure and is friable. Below this material, to a depth of about 30 inches, is very dark brown muck containing small quantities of calcareous shells. This material is massive and friable.

Light-gray marl underlies the organic material at about 30 inches. The marl contains numerous small fragments of shells and is massive. It is slightly sticky when wet and is high in lime content.

Available moisture capacity of these soils is high, and natural fertility is low. Water moves through the organic material rapidly but moves only moderately slowly through the marl. Runoff is very slow, and water often ponds in depressions. The moderately slow permeability of the marl hinders the movement of water through the profile and keeps the upper part of these soils wet. Unless these soils are artificially drained, the water table is within 12 inches of the surface. These soils are usually low in content of plant nutrients, especially many of the micronutrients.

A high water table and low fertility limit the use of these soils for crops. They are also subject to a major frost hazard and a wind erosion hazard.

Most areas of these soils are in woods or in pasture.

Typical profile of Edwards muck:

1—0 to 6 inches, black (10YR 2/1) muck; moderate, fine, granular structure; friable; neutral; diffuse, wavy boundary.
2—6 to 24 inches, very dark brown (10YR 2/2) muck; moderate, fine, granular structure; friable; mildly alkaline; gradual, wavy boundary.
3—24 to 30 inches, very dark brown (10YR 2/2) muck; small quantity of calcareous shells; massive; friable; moderately alkaline; abrupt, irregular boundary.
IIC—30 to 60 inches, light-gray (10YR 7/2) marl; numerous small shell fragments; massive; slightly sticky when wet; calcareous.

In some areas the organic material is mainly peat and little or no muck is present. Thin layers of sand, silt, or sandy loam material, ¼ inch to 4 inches thick, are in the underlying marl in a few areas.

Edwards soils are similar to the Warners soils but have a thicker layer of organic material over the marl. They have a thinner layer of organic material than either the Carbondale or Houghton soils.

Edwards muck (Er).—This soil is in low-lying depressions and along lakes. Texture of the surface layer is muck in most areas but is peat in several areas. The peat layer is 6 to 12 inches thick. In some areas this soil has thin layers of mineral or marl material in the organic layer. The upper few inches of the marl layer is not limy in some of the areas mapped.

Excess wetness, low fertility, and a frost and wind erosion hazard are the major limitations to use of the soil for crops.

Most areas of this soil are in trees or pasture. Wooded areas are in stands of elm, white-cedar, balsam fir, white birch, and aspen. Marl has been mined from some areas of this soil, but the marl should be tested for calcium carbonate content before it is applied to soils. (Capability unit Vwc–1 (M/mc); woodland suitability group J)

Ensley Series

Soils of this series are poorly drained and very poorly drained and are in nearly level or depressed areas on till plains and moraines. They formed in sandy loam glacial material. These soils do not occur alone in mapping units but are mapped with the Tonkey soils as Ensley and Tonkey loams.

The surface layer of Ensley soils is very dark grayish-brown loam about 7 inches thick. It has moderate granular structure and is friable.

The upper part of the subsoil is light brownish-gray loam mottled with yellowish brown. This layer is about 4 inches thick, has moderate blocky structure, and is friable. The lower part of the subsoil is light sandy clay loam and is brown, mottled with yellowish brown and light yellowish brown. It is about 22 inches thick, has moderate blocky structure, and is firm.

Pale-brown sandy loam underlies the subsoil at a depth of about 34 inches. It is mottled with brownish yellow and yellowish brown, has weak blocky structure, is friable, and is high in lime content.

Available moisture capacity and natural fertility of these soils are moderately high. In the absence of a high water table, water moves through the soil at a moderate rate. Runoff is very slow, and water ponds in low areas and depressions during wet periods. The gray color of the subsoil indicates that this soil is wet for extended periods. During spring and other wet periods, the water table is usually within 12 inches of the surface.

Excess wetness and the difficulty of installing drainage systems limit use of these soils for crops.

Most areas of these soils are in permanent pasture and in trees. A small acreage is in crops. The native vegetation was lowland hardwoods, predominantly elm, ash, and red maple.

Typical profile of Ensley loam:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) loam; moderate, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.
B21g—7 to 12 inches, light brownish-gray (10YR 6/2) loam; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; slightly acid; gradual, wavy boundary.
B22—12 to 34 inches, brown (10YR 5/3) light sandy clay loam; many, medium, distinct, yellowish-brown (10YR 5/6) and light yellowish-brown (10YR 6/4) mottles; moderate, medium, subangular blocky structure; firm; mildly alkaline; abrupt, wavy boundary.
Cg—34 to 60 inches, pale-brown (10YR 6/3) sandy loam; common, medium, distinct, brownish-yellow (10YR 6/8) and yellowish-brown (10YR 5/6) mottles; weak, coarse, subangular blocky structure; friable; calcareous.

Color of the surface layer is black or very dark brown in some areas, and the surface layer is 6 to 10 inches thick. In some undisturbed areas there is a 1- to 12-inch layer of muck or peat at the surface. In other undisturbed areas the surface layer is very dark grayish brown or very dark brown loam 5 to 8 inches thick. Color of the subsoil is grayish brown or gray in some areas, and texture is heavy loam or light clay loam in a few areas. Combined thickness of the surface layer and subsoil ranges from 28 to 40 inches. Layers of loamy sand underlie the subsoil in a few areas. Reaction of the

surface layer and subsoil ranges from slightly acid to mildly alkaline.

These soils and the McBride and Coral soils formed in similar material, but the Ensley soils are more poorly drained and are grayer. Ensley soils have finer textured subsoil layers than Edmore soils and have coarser textured subsoil layers than Sims soils.

Ensley and Tonkey loams (Es).—These two soils are mapped together in this unit and are in nearly level to depressed areas in narrow drainageways and low areas. Some areas of this mapping unit are predominantly Ensley soils; other areas are Tonkey soils. Both soils are present in a few areas. Tonkey soils are described in this soil survey in their alphabetical order. Ensley soils formed in sandy loam material, and Tonkey soils formed in stratified sand, loamy sand, and sandy loam. The water table is high, and both soils are saturated for long periods unless they are artificially drained. The texture of the surface soil ranges from loam to sandy loam. In some areas there is a 1- to 12-inch layer of muck or peat on the surface. A few boulders occur on the surface and throughout the soil profile in some areas.

Wetness and a frost hazard limit the use of these soils for crops. Most areas of these soils are in pasture or forest. Forest areas are in stands of elm, ash, and swamp maple. Only a small acreage of these soils has been drained. (Capability unit IIw–8 (3c); woodland suitability group W)

Ensley and Tonkey loams, overwash (Et).—These two soils are mapped together and are in nearly level to depressed narrow drainageways and low areas. Some areas mapped are predominantly Ensley soils; others are Tonkey soils. Both soils are present in a few areas. To a depth of 6 to 18 inches, a Tonkey soil is moderately dark colored loam, sandy loam, and fine sandy loam mineral material washed from surrounding upland areas. A few boulders occur on the surface and throughout the soil profile in most places. The Ensley soils formed in sandy loam material, and the Tonkey soils, in stratified sand, loamy sand, and sandy loam. The water table is high in both soils, unless they are drained. Runoff is very slow.

Excess wetness and a frost hazard limit the use of these soils for crops. Only a small acreage has been drained. Most areas of these soils are in pasture or forest. Forest areas are in dense stands of elm, ash, and aspen. (Capability unit IIw–8 (3c); woodland suitability group W)

Evart Series

Soils of this series are very poorly drained and are nearly level or are in depressed areas on river flood plains. They formed in sand and loamy sand material.

The surface layer is black sand about 10 inches thick. It has very weak granular structure and is very friable. Below the surface layer, to a depth of about 26 inches, is very dark grayish-brown sand that is single grain and loose.

Underlying these two layers is dark-brown or dark grayish-brown sand at a depth of 26 inches to 36 inches or more. It is single grain and loose.

Available moisture capacity and natural fertility of these soils are low. Water moves through them rapidly. Runoff is very slow, and water ponds on the surface during wet periods. These soils are subject to flooding for short periods during spring and after prolonged rainfall. Frequency of flooding varies greatly. The water table is high and is at or near the surface during spring.

Most areas of these soils are idle and are in brush or woods. Trees in the wooded areas are elm, maple, and cedar. Many areas of these soils are too small to be planted to crops, and the soils are rarely used for crops because of a flood hazard.

Typical profile of Evart sand:

A11—0 to 10 inches, black (10YR 2/1) sand; very weak, fine, granular structure; very friable; slightly acid; clear, smooth boundary.

A12—10 to 26 inches, very dark grayish-brown (10YR 3/2) sand; single grain, loose; neutral; abrupt, smooth boundary.

C1—26 to 36 inches, dark-brown (10YR 4/3) sand; single grain; loose; mildly alkaline; abrupt, smooth boundary.

C2—36 to 60 inches, dark grayish-brown (10YR 4/2) sand; single grain; loose; calcareous.

In some depressed areas there is a 1- to 12-inch layer of muck at the surface. The surface layer is sand or loam. Below the surface layer in some areas are thin layers of fine gravelly sand. Texture of the surface layer ranges from sand to clay loam. Texture below the surface layer is sand or loamy sand. Reaction of the soil ranges from slightly acid to mildly alkaline.

Evart loam (Eu).—This soil is nearly level or is in depressed areas along rivers and streams. The surface layer is sandy loam, loam, silt loam, or clay loam and is 6 to 12 inches thick. Below the surface layer the texture is sand or loamy sand. Narrow sand and gravel bars are common in some areas. Shallow organic soils occur in pockets and small depressions.

Because of the flooding hazard, this soil is seldom used for crops. Most areas are idle and in brush or trees. Many areas are too small to be used efficiently for crops. (Capability unit Vw–3 (L–4c); woodland suitability group O)

Evart sand (Ev).—This soil is nearly level or is in depressed areas along rivers and streams. The surface layer is sand, fine sand, or loamy sand and is 4 to 12 inches thick. Below this layer sand dominates in the profile. Gravel and sand bars and pockets of shallow organic soils were included in mapping this soil.

Use of this soil for crops is severely limited by a flooding hazard and by excess wetness. Most areas are idle and in brush or trees. Many areas are too small to be used efficiently for crops. (Capability unit Vw–3 (L–4c); woodland suitability group O)

Gladwin Series

The soils of this series are somewhat poorly drained, are level or gently sloping, and are on outwash plains, valley trains, and deltas. They formed in loamy sand and sand that overlies calcareous stratified gravel and sand.

The surface layer is about 7 inches thick and is very dark gray loamy sand that has weak granular structure and is very friable. The subsurface layer is gray loamy sand about 3 inches thick. It has weak granular structure and is very friable.

The upper part of the subsoil is dark reddish-brown or dark yellowish-brown loamy sand about 10 inches thick. It has distinct, strong-brown and grayish-brown mottles, has weak blocky structure, and is very friable. The lower part of the subsoil is dark yellowish-brown gravelly sandy loam about 10 inches thick. It is mottled with yellowish

brown. The structure is weak and blocky, and the material is friable.

Light brownish-gray stratified coarse sand and fine gravel are below a depth of about 30 inches. This material is single grain, loose, and high in lime content.

Available moisture capacity and natural fertility of these soils are moderately low. Permeability is moderate. Runoff is slow, and water ponds in depressed areas. Distinct mottles in the subsoil indicate that these soils are saturated for significant periods. The water table is high in spring but recedes as summer progresses.

Major limitations to the use of these soils for crops are excess wetness and moderately low fertility. The soils dry slowly in spring.

Many areas of these soils are used for crops and pasture. Undrained areas are still in woods or are idle and growing brush. The native vegetation was mixed hardwoods and some hemlock and white pine.

Typical profile of Gladwin loamy sand:

Ap—0 to 7 inches, very dark gray (10YR 3/1) loamy sand; weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

A2—7 to 10 inches, gray (10YR 5/1) loamy sand; weak, fine, granular structure; very friable, slightly acid; abrupt, wavy boundary.

B21hir—10 to 16 inches, dark reddish-brown (5YR 3/3) loamy sand; few, fine, distinct, strong-brown (7.5YR 5/6) and grayish-brown (10YR 5/2) mottles; weak, medium, subangular blocky structure; very friable; slightly acid; gradual, wavy boundary.

B22ir—16 to 20 inches, dark yellowish-brown (10YR 4/4) loamy sand; few, fine, distinct, grayish-brown (10YR 5/2) mottles; weak, fine, subangular blocky structure; very friable; neutral; clear, wavy boundary.

B't—20 to 30 inches, dark yellowish-brown (10YR 4/4) gravelly sandy loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable when moist, slightly sticky when wet; mildly alkaline; abrupt, wavy boundary.

IIC—30 to 60 inches, light brownish-gray (10YR 6/2), stratified coarse sand and fine gravel; single grain; loose; calcareous.

The surface layer ranges from sand to sandy loam. It is very dark grayish brown or dark brown in some areas and is 6 to 10 inches thick. Undisturbed areas have a very dark gray or black surface layer 2 to 4 inches thick. The subsurface layer is absent in some cultivated areas. In a few areas the lower part of the subsoil is heavy sandy loam, light loam, or light sandy clay loam 4 to 12 inches thick. Depth to the stratified sand and gravel ranges from 18 to 42 inches. In some areas this material is mainly fine sand or coarse sand. Reaction of the surface layer and subsoil ranges from medium acid to mildly alkaline.

Gladwin soils have coarser sized sands and more gravel in the subsoil than Brimley soils. They are finer textured than Au Gres soils.

Gladwin loamy sand, 0 to 2 percent slopes (GaA).—This soil is nearly level and is near the East Lake, Mancelona, and Wheatley soils. In a few areas the surface layer is sand. The subsoil is heavy loamy sand or light sandy loam in a few areas. Small areas of Mancelona and Wheatley soils were included in mapping some areas of this soil.

Major limitations to use of this soil for crops are excess wetness, moderately low fertility, a shortage of soil moisture during extreme drought, and a wind erosion hazard. The soil is slightly more droughty and erodes more readily than the Gladwin sandy loams.

Many areas of this soil have been drained and are in crops or pasture. Undrained areas are in trees or are idle. (Capability unit IIIw–5 (4b); woodland suitability group G)

Gladwin loamy sand, 2 to 6 percent slopes (GaB).—This soil is undulating to gently sloping and is on long, narrow side slopes near the East Lake, Mancelona, and Wheatley soils. The surface layer is predominantly loamy sand but is sand in a few areas. In undisturbed areas, especially in wooded areas, the surface layer is very dark gray. A few eroded spots have a dark-brown surface color. Slopes range outside specified limits over short distances. Small areas of East Lake and Mancelona soils on the upper slopes were included in mapping this soil.

Major limitations to use of this soil for crops are excess wetness, moderately low fertility, a shortage of moisture during extreme drought, and a wind erosion hazard. Artificial drainage is more difficult to install on this undulating soil than on the level Gladwin soils. This soil is slightly more droughty and erodes more readily than the Gladwin sandy loams.

Most areas of this soil are pastured or in crops, principally wheat and hay. Some areas are in forest. (Capability unit IIIw–5 (4b); woodland suitability group G)

Gladwin sandy loam, 0 to 2 percent slopes (GdA).—This soil is nearly level and is in broad areas near the East Lake, Mancelona, and Wheatley soils. The surface layer is very dark gray sandy loam 6 to 10 inches thick. Included in mapping this soil were Mancelona and East Lake soils on the slight rises and Wheatley soils in the depressions.

Major limitations to use of this soil for crops are excess wetness, moderately low fertility, and droughtiness. Wind erosion also is a hazard, but this is not so severe as on the Gladwin loamy sands. This sandy loam soil also is slightly less droughty than the Gladwin loamy sands.

Most areas of this soil are in pasture or forest. A few areas are planted to small grains and corn. (Capability unit IIIw–5 (4b); woodland suitability group G)

Gladwin sandy loam, 2 to 6 percent slopes (GdB).—This soil is gently sloping and undulating and is near the East Lake, Mancelona, and Wheatley soils. The surface layer is mainly sandy loam 6 to 10 inches thick. The underlying layer is predominantly loamy sand. Wheatley soils in slight depressions and Mancelona and East Lake soils on slight rises and knolls were included in mapping this soil.

Major limitations to use of this soil for crops are excess wetness, moderately low fertility, a shortage of soil moisture during extreme drought, and a wind erosion hazard. Installation of drainage is difficult in some areas because the soil is undulating. This soil is slightly less droughty and is less subject to erosion than the Gladwin loamy sands.

Most areas of this soil are in pasture or forest. A few areas are in small grains and corn. (Capability unit IIIw–5 (4b); woodland suitability group G)

Gravel and Sand Pits

Gravel and sand pits (Gp) occur where sand and gravel have been removed to a depth of several feet and used for road construction. These pits are in or near areas of Mancelona, Newaygo, and East Lake soils. Some of the pits were still in use at the time this survey was made. (Not placed in a capability unit or woodland suitability group)

Grayling Series

The soils of this series are well drained and sandy, are nearly level to steep, and are on till plains, moraines, and outwash plains. They formed in thick deposits of medium and coarse sand.

The surface layer is very dark grayish-brown sand about 2 inches thick. It has very weak granular structure and is very friable.

The subsoil is mainly yellowish-brown sand about 22 inches thick. It is single grain and loose.

Pale-brown sand is at a depth of about 24 inches. This sand is single grain and loose.

Available moisture capacity and natural fertility of these soils are low. Permeability is very rapid, and there is little runoff. Organic-matter content is low and is difficult to maintain. These soils are among the most droughty in the county.

Because of the droughtiness of these soils, they are used mainly for trees or wildlife. The trees are generally of poor quality and are poorly developed. Large areas of these soils have been cut over and now are sparsely covered with young jack pine and scrub red and white oaks. A large acreage is idle. Little of this soil is used for crops. The native vegetation was jack pine, scrub red and white oaks, and scattered red pines. There was a ground cover of blueberries, willows, sweetfern, and grasses.

Typical profile of Grayling sand:

O1—1 inch to 0, dark-brown (7.5YR 3/2) fibrous litter of leaves, needles, and twigs; all stages of decomposition.

A1—0 to 2 inches, very dark grayish-brown (10YR 3/2) sand; very weak, fine, granular structure; aggregates held together mainly by fine roots; very friable; medium acid; abrupt, smooth boundary.

B21ir—2 to 8 inches, yellowish-brown (10YR 5/4) sand; single grain; loose; strongly acid; gradual, wavy boundary.

B22ir—8 to 18 inches, yellowish-brown (10YR 5/6) sand; single grain; loose; strongly acid; gradual, wavy boundary.

B3—18 to 24 inches, brownish-yellow (10YR 6/8) sand; single grain; loose; medium acid; gradual, wavy boundary.

C—24 to 60 inches, pale-brown (10YR 6/3) sand; single grain; loose; medium acid.

A fibrous litter of leaves, needles, and twigs is on the surface in undisturbed areas. In a few areas there is a subsurface layer of brownish-gray sand 1 to 3 inches thick. The profile is predominantly medium and coarse sand, but lenses of fine sand and fine gravel are below a depth of 30 inches in some areas. The combined thickness of the surface layer and subsoil ranges from 18 to about 30 inches. Reaction of these layers ranges from medium to very strongly acid.

Grayling soils formed in coarser sands than Rousseau soils. They have lighter colored subsoil layers than either Rubicon or Rousseau soils. Grayling soils are better drained than Croswell or Au Gres soils.

Grayling sand, 0 to 6 percent slopes (GrB).—This soil is nearly level to undulating or gently sloping and is on plains and uplands. The surface layer is medium or coarse sand. It is very dark grayish brown in most areas, although in some areas it is brown or pale brown. The entire soil profile is mainly sand. Reaction is medium to very strongly acid to a depth of 6 feet or more in most areas. It is slightly acid to neutral below a depth of 4 feet in a few areas. Rubicon soils were included in mapping some areas of this soil.

This soil rarely is used for crops because of lack of available soil moisture, low fertility, and an erosion hazard. This soil is one of the most droughty soils in the county.

Most areas of this soil are in a ground cover of sweetfern and grasses. Jack pine, stunted aspen, or oak stands are in some areas. Other areas have been planted to jack and red pines. (Capability unit VIIs–1 (5.7a); woodland suitability group N)

Grayling sand, 6 to 12 percent slopes (GrC).—This soil is sloping and is on plains and uplands. The surface layer is very dark grayish brown to brown or pale brown and is medium or coarse sand. Medium sand predominates throughout the soil profile. In a few areas thin bands of loamy sand lie below a depth of 66 inches. Rubicon soils and small areas of Grayling soil with slopes exceeding 12 percent were included in mapping many areas of this soil.

Low fertility and low available moisture capacity severely limit use of this soil for crops. It also is subject to water and wind erosion if cultivated intensively. Most areas of this soil have a ground cover of sweetfern and grasses. A few clumps of aspen, and uniform stands of red and white oak, are dominant in wooded parts of some areas. (Capability unit VIIs–1 (5.7a); woodland suitability group N)

Grayling sand, 18 to 25 percent slopes (GrE).—This soil is steep, especially where it is adjacent to natural pits and drainageways. The surface soil ranges from very dark grayish brown to brown or pale brown. The texture is medium or coarse sand throughout the soil profile. In a few areas thin bands of loamy sand are below a depth of 66 inches. Small areas of Rubicon soils and areas of Grayling soil with slopes exceeding 25 percent were included in mapping several areas of this soil.

Major limitations to the use of this soil for crops are steep slopes, low fertility, and low available moisture capacity. Most areas are idle or in trees and support a sparse ground cover of sweetfern and scattered grasses. A few clumps of stunted aspen grow on the north-facing slopes. (Capability unit VIIs–1 (5.7a); woodland suitability group N)

Greenwood Series

The soils of this series are very poorly drained, extremely acid organic soils. They are nearly level or in depressed areas and are on till, outwash, and lake plains. They formed in strongly to extremely acid organic materials, more than 42 inches thick, that were derived principally from mosses and fibrous sedges.

The surface layer is dark grayish-brown sphagnum moss peat about 4 inches thick. It is coarse and fibrous. Below the surface layer is dark reddish-brown moss and fibrous peat, about 5 inches thick, that has weak platy structure and is very friable.

Yellowish-brown and reddish-brown peat, derived largely from fibrous material, underlies the surface and subsurface layer to a depth of 42 inches or more. It has weak platy structure and is very friable.

Available moisture capacity of these soils is high, and natural fertility is low. Permeability is variable but is generally rapid. Runoff is very slow, and water often ponds in the lowest areas, especially in spring and after rains. In most places these soils are low in content of phosphorus, potassium, and many of the micronutrients.

Major limitations to the use of these soils for farming are a high water table, low fertility, and an extremely acid reaction. Wind erosion and frost damage also are major

hazards. The native vegetation was leatherleaf, wintergreen, hyphum and sphagnum mosses, heath plants, Labrador-tea, and scattered black spruce and tamarack.

Typical profile of Greenwood peat:

1—0 to 4 inches, dark grayish-brown (10YR 4/2) sphagnum moss peat; coarse, fibrous structure; extremely acid; clear, wavy boundary.
2—4 to 9 inches, dark reddish-brown (5YR 3/4) moss and fibrous peat; weak, medium, platy structure; very friable; extremely acid; gradual, wavy boundary.
3—9 to 24 inches, yellowish-brown (10YR 5/6) peat derived from fibrous materials; weak, thick, platy structure; very friable; extremely acid; gradual, wavy boundary.
4—24 to 46 inches +, reddish-brown (5YR 4/4) peat derived largely from fibrous materials; weak, thick, platy structure; very friable; some fragments; extremely acid.

The surface layer of sphagnum moss ranges from 3 to 12 inches thick. Thickness of the organic material ranges from 42 inches to many feet. Reaction of the organic material ranges from very strongly acid to extremely acid.

Greenwood soils are more acid than Houghton or Carbondale soils. They have a thicker layer of organic material than Adrian or Tawas soils and also are more acid than these two soils.

Greenwood peat (Gt).—This organic soil is in low flats and depressions and is adjacent to small areas of Dawson soils in many places. The surface layer ranges from partially decomposed peat to unweathered moss and plant remains. At the outer edges of some areas of this soil, 4 to 12 inches of loam or sandy loam mineral material is on the surface.

Greenwood peat supports little useful vegetation and has limited value for wildlife and recreation. Major limitations to use of this soil are excess wetness, extreme acidity, low fertility, and the hazards of wind erosion and frost damage. (Capability unit VIIIw–1 (Mc–a); woodland suitability group L)

Gullied Land

Gullied land, coarse textured (Gu) is a rolling, sloping, or steep land type within areas of sands and loamy sands. It is adjacent to the Chelsea, Montcalm, and Blue Lake soils. There are numerous, deep, broad V-shaped gullies in areas of this land type in which the unweathered soil materials are exposed in the gully bottoms. Areas between gullies usually are severely eroded by wind and have a pale-brown or brown surface layer of sand or loamy sand.

Areas of Gullied land that are idle have little or no vegetative cover. They are not suitable for cultivation in their present condition. To prevent additional wind and water erosion, the gullies should be filled with soil material and a vegetative cover maintained. Once renovated, these areas still have low fertility and low available moisture capacity. (Capability unit VIIs–1 (5a); woodland suitability group C)

Gullied land, moderately fine textured (Gx) is undulating to steeply sloping and generally is in areas of silty clay loam, clay loam, or sandy loam. Adjacent soils generally are the Nester, Isabella, and McBride. There are numerous, deep, V-shaped gullies throughout this land type in which the unweathered soil materials are exposed. The gullies have steep side slopes, but the side slopes of adjacent gullies seldom meet. Consequently, areas between the gullies have profiles of weathered soil materials.

There is little or no vegetation in the gullies, and runoff must be diverted from them before vegetation can be established. If uncontrolled, the gullies continue to lengthen and invade nearby soils. Gullied land is seldom suited to crops, but most areas are pastured. (Capability unit VIIe–2 (1.5a); woodland suitability group B)

Houghton Series

The soils of this series are very poorly drained organic soils and are level or in depressed areas on outwash plains, lake and till plains, and moraines. They formed in organic materials derived mainly from reeds, sedges, and grasses. Thickness of the organic material is more than 42 inches.

The surface layer is black muck about 7 inches thick. It has weak granular structure and is very friable. Below this layer and down to a depth of about 23 inches is very dark brown muck. It has moderate granular structure and is friable.

Brown peaty muck starts at 23 inches and extends to a depth of 48 inches or more. This material has weak platy structure and is very friable.

Available moisture capacity is high, and natural fertility is moderate. Permeability is rapid in the absence of a high water table. Runoff is very slow and is usually ponded during spring. The water table is within 12 inches of the surface during spring and after prolonged rain. The content of plants nutrients is low, especially the content of micronutrients.

Use of this soil for crops is severely limited by excess wetness. Wind erosion and frost damage are hazards to crops.

Most areas remain in marsh grasses, sedges, and reeds and in scattered elms, cottonwoods, and cedars. There are tag alder, dogwood, and willow thickets in some areas. Only a small acreage has been cleared of trees and used for crops.

Typical profile of Houghton muck:

1—0 to 7 inches, black (10YR 2/1) muck; weak, fine, granular structure; very friable; medium acid; diffuse, smooth boundary.
2—7 to 23 inches, very dark brown (10YR 2/2) muck; moderate, medium, granular structure; friable; slightly acid; diffuse, wavy boundary.
3—23 to 48 inches+, brown (7.5YR 5/4) peaty muck; weak, thin, platy structure; very friable; slightly sticky when wet; slightly acid.

In some areas the material at a depth below 15 inches is peaty muck or peat. Reaction of the organic material ranges from medium acid to neutral.

Houghton soils lack the woody materials common in Carbondale soils and have thicker layers of organic material than either the Adrian or Tawas soils.

Houghton muck (Hm).—This organic soil is in depressions of various sizes and shapes. In most areas the surface layer is muck, but in a few areas it is partly decomposed peaty muck. Narrow areas of Adrian muck that have sand at a depth of less than 42 inches are near the edges of this soil in many areas.

Major limitations to use of this soil for crops are excess wetness, a wind erosion hazard, and a frost hazard. This soil remains wet most of the year.

Most areas of this soil are in grasses, sedges, or cattails. A few areas are in pasture or forest. (Capability unit Vwc–1 (Mc); woodland suitability group J)

Iosco Series

The soils of this series are somewhat poorly drained, are nearly level or undulating, and are on till plains or moraines. They formed in sandy material over loam, silty clay loam, heavy sandy loam, or clay loam. The sandy material is 18 to 42 inches thick.

The surface layer is very dark grayish-brown loamy sand about 8 inches thick. It has weak granular structure and is very friable. The subsurface layer also is loamy sand but is light gray and is about 2 inches thick. It is single grain and loose.

The upper part of the subsoil is dark-brown or brown sand about 22 inches thick. It has very weak blocky structure and is very friable. The lower part of the subsoil is reddish-brown silty clay loam about 10 inches thick. This layer has light brownish-gray mottles, has strong blocky structure, and is firm.

At a depth of about 44 inches is brown light silty clay loam mottled with strong brown and yellowish brown. This material has weak blocky structure, is firm, and is high in lime content.

Available moisture capacity and natural fertility of these soils are moderately low. Permeability is rapid throughout the upper part of the profile but is only moderately slow throughout the lower part. Runoff is slow, and water ponds in depressions. The water table is within 2 feet of the surface during spring and after prolonged rains. These soils dry quickly after the water table recedes.

Excess wetness in spring and droughtiness during midsummer limit use of these soils for crops.

Many areas of these soils are in hay, wheat, oats, potatoes, and corn. A large acreage also is in permanent pasture and trees. The native vegetation was white pine and northern hardwoods.

Typical profile of Iosco loamy sand:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—8 to 10 inches, light-gray (10YR 7/2) loamy sand; single grain; loose; medium acid; abrupt, wavy boundary.

B21ir—10 to 15 inches, dark-brown (7.5YR 4/4) sand; very weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—15 to 32 inches, brown (7.5YR 5/4) sand; common, medium, distinct, very pale brown (10YR 7/3) and yellowish-brown (10YR 5/4) mottles; single grain; loose; medium acid; abrupt, wavy boundary.

A'2—32 to 34 inches, grayish-brown (10YR 5/2) loamy sand; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; very friable; medium acid; abrupt, irregular boundary.

IIB't—34 to 44 inches, reddish-brown (5YR 4/3) silty clay loam; many, medium, distinct, light brownish-gray (10YR 6/2) mottles; grayish-brown (10YR 5/2) loamy sand, representing the A'2 horizon, occurs as thick coatings on peds and along cracks in the upper 2 to 4 inches; strong, medium, angular blocky structure; firm; slightly acid; abrupt, irregular boundary.

IIC—44 to 60 inches, brown (7.5YR 5/2) light silty clay loam; many, medium, distinct, strong-brown (7.5YR 5/6) and yellowish-brown (10YR 5/4) mottles; weak, medium, angular blocky structure; firm; calcareous.

Texture of the surface layer ranges from sand to sandy loam. This layer is very dark gray in some areas and ranges from 6 to 12 inches in thickness. In undisturbed areas it is very dark gray loamy sand 1 to 3 inches thick. The subsurface layer is absent in some cultivated areas. A layer of grayish-brown loamy sand about 2 inches thick is present in some areas between the upper and lower parts of the subsoil. The lower part of the subsoil ranges from silty clay loam to clay loam, heavy loam, sandy clay loam, or silt loam and is 2 to 20 inches thick. The material below the subsoil ranges from light silty clay loam to clay loam, loam, silt loam, or heavy sandy loam. Reaction of the surface layer and upper part of the subsoil ranges from slightly acid to strongly acid. Reaction of the lower part ranges from neutral to strongly acid.

Iosco soils are similar to Menominee soils but are more poorly drained and are mottled. Iosco soils have a coarser textured upper subsoil than Belding soils and a finer textured underlying material than the Au Gres soils.

Iosco loamy sand, 0 to 2 percent slopes (IcA).—This soil is nearly level. The surface layer is loamy sand in most areas but is sand in some areas. It is gray in wooded areas and very dark grayish brown in cultivated areas. Small eroded spots with a dark-brown or brown surface soil were included in mapping this soil in many cultivated areas.

Excess wetness, moderately low available moisture capacity when drained, moderately low fertility, and an erosion hazard are limitations to the use of this soil for crops. This soil is slightly more droughty and erodes more readily than Iosco sandy loam soils.

Most areas of this soil are in woods or pasture. (Capability unit IIIw–9 (4/2b); woodland suitability group G)

Iosco loamy sand, 2 to 6 percent slopes (IcB).—This soil is undulating to gently sloping. The surface layer is very dark gray and is thin in wooded areas, but it is very dark grayish brown in cultivated areas. In some areas it is sand. Small eroded areas with a brown or dark-brown surface soil were mapped in numerous places. Also included in mapping this soil were Menominee soils on slight rises and knolls in some areas. Other inclusions were small areas of Au Gres soils, loamy substratum, in areas where the thickness of the sandy layers exceeds 42 inches.

Limitations to the use of this soil for crops are excess wetness in spring, droughtiness, and a wind-erosion hazard.

Most areas of this soil have been in crops in the past, but only a relatively small acreage is in crops now. Corn, oats, wheat, and hay are the crops grown. Most areas of this soil are in pasture, and a small acreage is in forest. This soil is slightly more droughty and erodes more readily than the Iosco sandy loams. (Capability unit IIIw–9 (4/2b); woodland suitability group G)

Iosco sandy loam, 0 to 2 percent slopes (IdA).—This soil is nearly level. The surface layer is very dark grayish brown in most cultivated areas but is brown or dark brown in small eroded areas that are cultivated. It is very dark gray and is thin in forested areas. The surface layer is sandy loam, generally 8 to 12 inches thick, and is underlain by sand or loamy sand. A considerable amount of gravel is on the surface in a few areas.

Excess wetness, moderately low fertility, and a wind erosion hazard limit the use of this soil for crops. When drained, the soil tends to be droughty. It has slightly better available moisture capacity than the Iosco loamy sands and is less subject to erosion. Wet depressions are present.

Many areas of this soil are in permanent pasture or forest. A small acreage is in corn, potatoes, small grains, and hay crops. (Capability unit IIIw–9 (4/2b); woodland suitability group G)

Iosco sandy loam, 2 to 6 percent slopes (IdB).—This soil is undulating or gently sloping. The surface layer is very dark grayish brown in cultivated areas and very dark gray in wooded areas. Small eroded areas with a brown or

dark-brown surface layer are present in areas used for crops. The surface layer is 8 to 12 inches thick and is underlain by sand or loamy sand. Clay loam to silty clay loam is at a depth of about 25 to 35 inches. The clay loam is limy. In some areas stones are on the surface and throughout the soil profile. These stones are 10 inches to 6 feet in diameter, are 2 to 100 feet apart, and generally make cultivation impractical. This soil is slightly better drained than the nearly level Iosco soils. Menominee soils on slight rises or knolls were included in mapping some areas of this soil. The Menominee soils are better drained than this Iosco soil but erode more readily.

The major limitation to the use of this soil for crops is excess wetness. When drained, this soil tends to be droughty. Wet depressions that occur in areas of this soil are difficult to drain.

Most areas of this soil are in corn, oats, wheat, and hay. Some areas are in pasture or forest. (Capability unit IIIw–9 (4/2b); woodland suitability group G)

Isabella Series

Soils of this series are well drained and moderately well drained, are nearly level to steep, and are on till plains and moraines. They formed in sandy clay loam to light sandy clay glacial till.

The surface layer is very dark grayish-brown loam about 8 inches thick. It has weak granular structure and is friable.

The upper part of the subsoil is dark yellowish-brown or light brownish-gray sandy loam to a depth of about 14 inches. It has weak platy structure and is friable or brittle. The lower part is dark-brown or reddish-brown heavy sandy clay loam that extends to a depth of about 42 inches. This part has moderate and weak blocky structure and is firm.

Underlying the subsoil is brown sandy clay loam. It has weak blocky structure, is firm, and is high in lime content.

Available moisture capacity of these soils is high, and natural fertility ranges from moderate to moderately high. Permeability is moderately slow, and runoff ranges from medium on the gentle slopes to rapid on the steep slopes. In severely eroded areas of these soils, tilth is poorer and runoff more rapid than in uneroded areas.

Runoff of water and an erosion hazard are limitations to use of these soils for crops. These limitations increase as the steepness of the soil increases and as the soils are farmed more intensively. In moderately steep and steep areas, water erosion is a severe hazard and use of farm machinery is limited.

Most areas of the gently sloping to sloping soils are farmed intensively. The moderately steep soils are farmed to a lesser degree than the less sloping areas, and many areas are still in trees. The steep areas are used mainly for pasture or trees. Some of the areas that have been farmed intensively are severely eroded.

Typical profile of Isabella loam:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) loam; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

Bir—8 to 10 inches, dark yellowish-brown (10YR 4/4) sandy loam; weak, medium, granular structure; friable; medium acid; abrupt, wavy boundary.

A'2m—10 to 14 inches, light brownish-gray (10YR 6/2) sandy loam; weak, thick, platy structure; vesicular; compact fragipan; brittle when dry; medium acid; abrupt, irregular boundary.

A'2&B'21—14 to 23 inches, grayish-brown (10YR 5/2) sandy loam (A'2 horizon); dark-brown (7.5YR 4/4) sandy clay loam (B'2 horizon); peds of B'2 are partially or wholly surrounded by A'2 horizon; A'2 occurs as coatings on ped faces and as fillings in root channels and cracks; weak, coarse, subangular blocky structure; firm; medium acid; clear, irregular boundary.

B'22—23 to 42 inches, reddish-brown (5YR 4/4) heavy sandy clay loam; moderate, medium, angular blocky structure; firm; medium acid in upper part grading to neutral in lower part; abrupt, wavy boundary.

C—42 to 60 inches, brown (7.5YR 5/2) sandy clay loam; weak, coarse, angular blocky structure; firm; calcareous.

The surface layer ranges from very dark gray to brown and is 6 to 14 inches thick. The texture of this layer ranges from loamy sand to sandy clay loam. In undisturbed areas the surface layer is very dark gray loam about 1 to 3 inches thick. In some areas a weak to moderate fragipan is in the upper part of the subsoil. In a few areas the lower part of the subsoil is dark-brown clay loam or light sandy clay. The soil is mottled below a depth of 30 inches in some areas. Combined thickness of the surface layer and subsoil ranges from 36 to 60 inches. Texture of the material below the subsoil is clay loam in some areas. Reaction of the surface layer and subsoil ranges from slightly acid to strongly acid.

Isabella loam, 2 to 6 percent slopes (IeB).—This soil is undulating or gently sloping and is near other Isabella soils. The surface layer is very dark grayish-brown loam. In small irregularly shaped areas, the surface soil is brown or dark brown. Twining soils lie in the narrow waterways and were included in mapping this Isabella soil. The Twining soils are wet during spring and after rain, and this delays planting in some years.

Major limitations to use of this soil for crops are moderately slow permeability and an erosion hazard. The wet drainageways also limit use during spring and other wet periods.

Most areas of the soil are planted to corn, wheat, oats, and hay. (Capability unit IIe–2 (2.5a); woodland suitability group D)

Isabella loam, 6 to 12 percent slopes (IeC).—This soil is sloping and is near other Isabella soils. The surface soil is predominantly very dark grayish brown but has spots and narrow streaks of brown or dark brown. Texture is loam in most areas but is sandy loam or sandy clay loam in some areas. Small wet spots or areas of Twining soils are in several areas and were included in mapping this Isabella soil. Wetness of these areas delays planting in some years.

Major limitations to use of this soil for crops are slow permeability and an erosion hazard. The soil tends to be droughty during summer if runoff is excessive.

Most areas of the soil are planted to corn, oats, wheat, and hay. Some areas are in pasture or forest. (Capability unit IIIe–5 (2.5a); woodland suitability group D)

Isabella loam, 6 to 12 percent slopes, moderately eroded (IeC2).—This soil is sloping and is near other Isabella soils. The surface soil ranges from brown to very dark grayish brown, reddish brown, or pale brown. The different colors occur in spots and in narrow, irregular areas. In a few areas on the upper slopes, texture is sandy clay loam or gravelly loam. Moderate erosion has reduced the fertility and organic matter content of this soil and has left the surface layer in poor tilth. Runoff is greater than on similar Isabella soils that are uneroded. The present surface layer crusts readily, and this results in uneven stands of plants and reduced yields.

Erosion and poor tilth are major limitations to use of this soil for crops.

Most areas of the soil are in corn, oats, wheat, and hay, which are grown with moderate success. Some areas are in permanent pasture or are idle. (Capability unit IIIe–5 (2.5a) ; woodland suitability group D)

Isabella loam, 12 to 18 percent slopes (IeD).—This soil is moderately steep or rolling and generally is near other Isabella soils. The surface layer is a very dark gray loam in most areas but is brown or dark brown in a few areas. Small spots and streaks have a sandy loam texture. Included in mapping this soil were Twining soils that lie in small depressions in the rolling areas. These depressions dry slowly in spring, and as a result, planting is often delayed. In parts of some areas slopes range outside the specified limits of 12 to 18 percent.

Runoff is rapid in cultivated areas, erosion is a serious hazard, and available soil moisture is insufficient for crop needs in dry years.

Most areas of this soil are in crops. Hay is the dominant crop, but wheat, oats, and corn also are grown to some extent. A few areas are in forest. (Capability unit IVe–4 (2.5a) ; woodland suitability group D)

Isabella loam, 12 to 18 percent slopes, moderately eroded (IeD2).—This soil is moderately steep or rolling and is near other Isabella soils. It has an eroded surface that has a varied pattern of colors. The surface layer is predominantly brown loam but has spots and streaks of pale brown, dark grayish brown, gray, and reddish brown. In some severely eroded spots on the upper slopes, the sandy clay loam subsoil is exposed. Moderate erosion has left this soil in poor tilth, and runoff is more rapid than in uneroded areas of similar Isabella soils. The present surface layer crusts readily, and this results in uneven stands of plants and reduced yields.

Erosion is a serious hazard in the use of this moderately steep soil for crops, especially if cultivation is intensive.

Most areas of this soil are in crops, principally corn, oats, wheat, and hay. Some areas are in permanent pasture or are idle. (Capability unit IVe–4 (2.5a) ; woodland suitability group D).

Isabella loamy sand, 2 to 6 percent slopes (ImB).—This soil is undulating or gently sloping. The surface layer is very dark grayish-brown loamy sand about 14 inches deep. Small eroded areas are brown or dark brown. Below a depth of 14 inches is sandy clay loam. Included in mapping many areas of this soil were small areas of Menominee soils having loamy sand layers up to 25 inches thick. Slopes exceed 6 percent in some areas that were mapped.

This soil has good tilth. It dries quickly in spring and after rain. Except for the erosion hazard, there are few limitations to use of this soil for crops.

Most areas of the soil are planted to crops, such as corn, small grains, and hay. A few areas are in forest or permanent pasture. (Capability unit IIe–2 (2.5a) ; woodland suitability group D)

Isabella loamy sand, 6 to 12 percent slopes (ImC).—This soil is sloping and rolling. The surface layer is predominantly very dark grayish-brown loamy sand 8 to 12 inches thick. This loamy sand is 14 inches thick in some places. Small spots and irregularly shaped areas have a brown or dark-brown surface layer. Slopes exceed 12 percent in a few areas included in mapping this soil.

Most areas of this soil are farmed, but a few areas remain in trees or pasture. This soil has few limitations for crop use if runoff is controlled sufficiently to prevent any appreciable degree of erosion. It is easily tilled and dries quickly during spring and after rains. (Capability unit IIIe–5 (2.5a) ; woodland suitability group D)

Isabella loamy sand, 6 to 12 percent slopes, moderately eroded (ImC2).—This soil is sloping or rolling. The moderately eroded surface layer has a strikingly varied pattern of colors. Brown is predominant, but there are spots of pale brown, dark grayish brown, gray, and reddish brown. In most areas the surface layer is loamy sand 6 to 14 inches thick, but in some severely eroded spots it is sandy clay loam.

The present surface layer is lighter colored, is lower in organic matter and fertility, and crusts more readily than uneroded areas of similar Isabella soils. Small areas of Menominee soils were included in mapping some areas of this soil.

Runoff is rapid when this soil is cropped intensively, and as a result, the soil tends to be droughty during dry summer months.

All of this soil has been cleared and cultivated in the past. At present only a few areas are in crops. Many areas are in pasture. (Capability unit IIIe–5 (2.5a) ; woodland suitability group D)

Isabella loamy sand, 12 to 18 percent slopes (ImD).—This soil is moderately steep or hilly and is near the Montcalm and McBride soils. The surface layer in cultivated areas is mostly very dark grayish brown, but there are spots of brown and dark brown. Forested areas have a thin, very dark gray surface layer. In most areas the surface layer is loamy sand 8 to about 14 inches deep, but in some areas it is sandy loam. Montcalm and McBride soils were included in mapping many areas of this soil. Small rounded or elongated depressions of Twining soils were included in mapping the rolling areas. These depressions dry slowly, and wetness delays spring planting in some years.

Use of this soil for crops is severely limited by an erosion hazard and rapid runoff. The rate of runoff tends to leave the soil droughty in summer.

Most areas of this soil are planted to crops. Hay predominates, but some wheat, oats, and corn also are grown. Some areas are in forest or permanent pasture. (Capability unit IVe–4 (2.5a) ; woodland suitability group D)

Isabella loamy sand, 12 to 18 percent slopes, moderately eroded (ImD2).—This soil is moderately steep or hilly and is near Montcalm and McBride soils. In most areas the surface layer is brown or dark brown, but there are small spots and narrow streaks of grayish brown, reddish brown, and very dark grayish brown in some areas. The surface layer is loamy sand in most areas and is 6 to 14 inches deep. In small, severely eroded spots the surface layer is sandy clay loam.

The present surface layer is lower in fertility and organic-matter content than similar uneroded Isabella soils and crusts more readily. The crusting results in uneven stands of plants.

Use of the soil for crops is severely limited by an erosion hazard and rapid runoff. The rate of runoff tends to leave the soil droughty during summer.

Many areas of the soil are in permanent pasture. Some areas are planted to small grains and hay crops. (Capability unit IVe–4 (2.5a) ; woodland suitability group D)

298–861—69——3

Isabella sandy clay loam, 12 to 18 percent slopes, severely eroded (InD3).—This soil is moderately steep or hilly. Erosion has removed most of the surface, subsurface, and upper subsoil layers. The surface layer, once a loamy sand, is now sandy clay loam in most areas. Spots and narrow streaks of loamy sand and sandy loam occur in this layer. The color of the surface layer is brown or reddish brown, with spots and streaks of dark brown or very dark grayish brown. Erosion has severely reduced the fertility and the organic-matter content, the tilth, and the permeability of this soil. The surface layer crusts readily and makes a poor seedbed. Montcalm and Nester soils were included in mapping some areas of this soil.

Major limitations to use of this soil for crops are a severe erosion hazard, rapid runoff, poor tilth, and low fertility. This soil tends to be droughty during dry summer months.

Most areas of the soil are in crops, principally small grains and hay. Some areas are in permanent pasture or are idle. (Capability unit VIe–2 (2.5a); woodland suitability group D)

Isabella sandy clay loam, 18 to 25 percent slopes, severely eroded (InE3).—This soil is steep and is on ridges and knolls near other Isabella soils. Erosion has removed most of the surface, subsurface, and upper subsoil layers. The present surface soil is mostly sandy clay loam, but there are small spots and long narrow areas of sandy loam or loam. Color of the present surface layer is reddish brown in most areas but is spotted and streaked brown, very dark grayish brown, or dark brown on the ridgetops and lower slopes. Limy sandy clay loam is at a depth of about 35 inches. Small areas of moderately and slightly eroded soils were included in mapping this soil on ridgetops and lower side slopes. Also included were areas of Nester soils in some places.

Erosion has severely reduced this level of fertility, organic matter content, quality of tilth, and permeability of this soil. The present surface layer becomes hard and crusts readily when dry. Germination of seeds is uneven. The surface layer absorbs water slowly, and runoff is rapid.

Because of severe erosion, most areas of these soils are in pasture or are idle. The steep slopes hinder use of farm machinery. (Capability unit VIIe–2 (2.5a); woodland suitability group D)

Isabella sandy loam, 2 to 6 percent slopes (IsB).—This soil is gently sloping or undulating. The surface layer is very dark grayish-brown sandy loam that is 8 to 14 inches thick. Undisturbed areas have a very dark gray surface layer. Small areas of Ubly sandy loam and Menominee loamy sand were included in mapping this soil.

This soil has few limitations for crops. If the rotation includes close-growing crops, erosion is seldom a serious hazard.

Most areas are in crops, principally corn, wheat, and hay. (Capability unit IIe–2 (2.5a); woodland suitability group D)

Isabella sandy loam, 2 to 6 percent slopes, moderately eroded (IsB2).—This soil is gently sloping or undulating. The surface layer is mostly sandy loam, is 8 to 14 inches thick, and has small spots and narrow areas of loam, loamy sand, or sandy clay loam. The color is predominantly brown, with spots and elongated streaks of pale brown, very dark grayish brown, and reddish brown. Small areas of Montcalm and McBride soils were included in mapping many areas of this soil. These two included soils are slightly more droughty than this Isabella soil. Moderate erosion has lowered the level of fertility and organic-matter content of this soil and reduced its available moisture capacity.

An erosion hazard and the need to restore organic-matter content and fertility are the major limitations to the use of this soil for crops.

Most of the soil is in crops, principally corn, wheat, and hay. (Capability unit IIe–2 (2.5a); woodland suitability group D)

Isabella sandy loam, 6 to 12 percent slopes (IsC).—This soil is sloping and has a sandy loam surface layer 8 to 14 inches thick. Below the surface layer is predominantly sandy clay loam about 36 inches thick. Limy sandy clay loam material is at a depth of about 50 inches. A few small areas of Ubly sandy loam and Menominee loamy sand were included in mapping this soil.

Rapid surface runoff and a resulting erosion hazard limit the use of this soil for crops. Most of this soil is in crops commonly grown in the area. (Capability unit IIIe–5 (2.5a); woodland suitability group D)

Isabella sandy loam, 6 to 12 percent slopes, moderately eroded (IsC2).—This soil is sloping or rolling. The surface layer is predominantly sandy loam and is 8 to about 14 inches thick. Small spots and narrow streaks have a loam or sandy clay loam surface layer. Color of the surface layer is brown, with spots and narrow streaks of very dark gray, pale brown, and reddish brown in most areas. Moderate erosion has reduced the level of fertility and content of organic matter of this soil. As a result, the surface soil crusts and germination of seeds is uneven. Small areas of Ubly and McBride soils were included in mapping some areas of this soil.

Major limitations to use of this soil for crops are an erosion hazard, rapid surface runoff, and a need to restore fertility and organic-matter content.

All of this soil is in crops. Corn, wheat, and hay are generally grown. (Capability unit IIIe–5 (2.5a); woodland suitability group D)

Isabella sandy loam, 12 to 18 percent slopes (IsD).—This soil is moderately steep or hilly. The surface layer is sandy loam 8 to about 14 inches thick. Its color is very dark grayish brown in most cultivated areas, but there are spots and narrow streaks of brown in some areas. In undisturbed or forested areas this layer is very dark gray. Small areas of Twining soils were included in mapping many rolling areas of this soil. Twining soils dry slowly during wet spring months. Planting is delayed as a result.

Use of this Isabella soil for crops is severely limited by an erosion hazard, rapid surface runoff, and a resulting droughtiness of the soil during summer.

Most of this soil is used for hay crops and pasture. Wheat and corn are grown occasionally. (Capability unit IVe–4 (2.5a); woodland suitability group D)

Isabella sandy loam, 12 to 18 percent slopes, moderately eroded (IsD2).—This soil is moderately steep or hilly. The surface layer is mostly sandy loam 8 to about 14 inches thick, but there are spots and narrow elongated streaks of sandy clay loam or loam. The surface layer is mostly brown, but there are irregular areas of very dark grayish brown, pale brown, and reddish brown. Erosion has lowered the fertility level and organic-matter content of this soil, and the surface layer crusts more readily than

that of similar uneroded Isabella soils. The crusting hinders germination of plants. Included in mapping this soil were Twining soils in small depressions in hilly areas. Also included in some areas were McBride and Nester soils.

Use of the soil for crops is severely limited by an erosion hazard and rapid surface runoff. This soil is droughty during summer. Most areas of this soil have been cultivated in the past but are now used mostly for hay crops and pasture. (Capability unit IVe–4 (2.5a); woodland suitability group D)

Isabella sandy loam, 18 to 25 percent slopes (IsE).—This soil is steep or hilly and ranges from uneroded to moderately eroded. The surface layer is mostly very dark gray in forested areas, but in cultivated areas it is very dark grayish brown with small spots and streaks of brown. The surface layer is mostly sandy loam, 8 to 14 inches thick, but it is loam or sandy clay loam in a few places. In the moderately eroded areas, the surface layer is lighter colored, is lower in fertility and organic-matter content, and crusts more readily than in uneroded areas. Twining soils in small depressions were included in mapping this soil. These soils dry slowly in spring, and the resulting wetness delays planting in some years.

Erosion and rapid surface runoff are major limitations to the use of this soil for crops. The soil is too steep to be used intensively for crops without excessive loss of soil and water. Most of this soil is in forest, but a few areas are in pasture or crops. (Capability unit VIe–1 (2.5a); woodland suitability group D)

Kalkaska Series

The soils of this series are well drained and sandy and range from level to very steep. They are on outwash and till plains, valley trains, and moraines. They formed in medium and coarse sands. Stones and cobblestones or gravel lie on the surface in some areas.

The surface layer is very dark gray humus mixed with gray sand and is about 2 inches thick. It has weak granular structure and is very friable. The subsurface layer is pinkish-gray sand about 2 inches thick. It is single grain and loose.

The upper part of the subsoil is dark reddish-brown or dark-brown sand about 14 inches thick. It has very weak granular or blocky structure and is very friable. The lower part of the subsoil is strong-brown or brownish-yellow sand about 22 inches thick. It is single grain and loose.

Pale-brown sand is at a depth of about 40 inches. This sand is single grain and loose.

Available moisture capacity and natural fertility of these soils are low. Water moves rapidly through them. Surface runoff is very slow in nearly level to gently sloping areas, but the rate increases with degree of slope. Moisture content of these soils is rarely adequate for crop growth during dry summers.

Low available moisture capacity, low natural fertility, and a wind erosion hazard severely limit the use of these soils for crops. On steeply sloping areas water erosion is a severe hazard and use of farm machinery is limited.

Some of the level to sloping areas have been used in the past for crops, such as oats, hay, and potatoes, but most areas are now in pasture or trees. The native vegetation was mainly sugar maple, beech, yellow birch, elm, ironwood, hemlock, and some white pine.

Typical profile of Kalkaska sand:

O1—2 inches to 0, partially decomposed leaves and raw organic matter.
A1—0 to 2 inches, very dark gray (10YR 3/1) humus mixed with gray (10YR 6/1) sand; weak, fine, granular structure; very friable; strongly acid; numerous fine roots; abrupt, smooth boundary.
C—40 to 60 inches, pale-brown (10YR 6/3) sand; single grain; loose; medium acid; abrupt, wavy boundary.
B21h—4 to 8 inches, dark reddish-brown (5YR 2/2) sand; very weak, medium, granular structure; very friable; medium acid; clear, irregular boundary.
B22ir—8 to 18 inches, dark-brown (7.5YR 4/4) sand; very weak, medium, subangular blocky structure; very friable; strongly acid; gradual, irregular boundary.
B23ir—18 to 24 inches, strong-brown (7.5YR 5/6) sand; single grain; loose; medium acid; gradual, irregular boundary.
B3—24 to 40 inches, brownish-yellow (10YR 6/6) sand; single grain; loose; medium acid; gradual, wavy boundary.
C–40 to 60 inches, pale-brown (10YR 6/3) sand; single grain; loose; slightly acid.

The surface layer is very dark grayish brown in some areas and is 1 to 3 inches thick. In cultivated areas the surface layer is very dark grayish brown or dark grayish brown. Combined thickness of the surface layer and subsoil ranges from 24 to 45 inches. Reaction of these layers is medium acid to strongly acid in most areas but ranges to slightly acid in a few areas.

Kalkaska soils have a darker colored subsoil than either Rubicon or Grayling soils. They lack the cemented subsoil layer of the Wallace soils and the finer textured layers of the Chelsea and Montcalm soils. They are more acid than the East Lake soils and lack the limy sand and gravel present in the East Lake soils.

Kalkaska gravelly sand, 2 to 6 percent slopes (KaB).—This soil is undulating or gently sloping. The content of gravel in the surface layer ranges from 20 to about 50 percent. Occasionally, the gravel occurs throughout the soil profile, but in most areas it is confined to the surface layer and the soil below a depth of 6 inches is predominantly sand. Color of the surface soil is predominantly very dark grayish brown, but in most cleared areas there are spots and narrow streaks of dark brown or brown. In a few areas the surface soil is predominantly brown.

A relatively high gravel content, low fertility, and low available moisture capacity are major limitations to the use of this soil for crops. Most areas of this soil are in pasture, but a few areas are planted to small grains. A few areas are in forest. (Capability unit IVs–4 (5a); woodland suitability group E)

Kalkaska sand, 0 to 6 percent slopes (KkB).—This soil is nearly level or gently sloping and is generally near other Kalkaska soils that are in higher positions. The surface layer is sand in most areas but is loamy sand in some areas. Color of the surface layer is predominantly very dark grayish brown, but there are streaks and spots of brown or pale brown. Small areas of Rubicon and Blue Lake soils were included in mapping many areas of this soil. Also included were small areas of Isabella soils in some places.

Use of this soil for crops is severely limited by low fertility and low available moisture capacity. Wind erosion is a hazard.

Most of the soil has been cleared and cultivated in the past. Some areas are now in small grains and hay, but most areas are in low-grade pasture or are idle. Some areas are in forest. (Capability unit IVs–4 (5a); woodland suitability group E)

Kalkaska sand, 6 to 12 percent slopes (KkC).—This soil is rolling or sloping. The slopes generally are less than 300 feet long. In forested areas the surface soil is very dark gray and is thin. In cultivated areas it is predominantly very dark grayish brown or dark grayish brown and there are streaks of dark brown. Gravel lies on the surface in a few areas. It does not interfere with tillage but does increase wear of tillage implements. Small inclusions of the Rubicon soils and the Rubicon loamy substratum soils were included in mapping many areas of this soil.

Most areas of this Kalkaska soil have little value for crops because fertility and available moisture capacity are low. Wind erosion is a hazard if the soil is cultivated intensively.

Most areas of this soil are in forest. Some areas are in low-grade pasture or are idle. (Capability unit VIs–1 (5a); woodland suitability group E)

Kalkaska sand, 6 to 12 percent slopes, severely eroded (KkC3).—This soil is gently rolling and sloping and is severely eroded. Slopes usually are less than 300 feet long. The surface layer is predominantly pale brown, with small streaks of dark brown and reddish brown. A mixture of the subsoil and the underlying sand makes up the present sand surface layer. Numerous shallow gullies dissect some areas, but they usually can be crossed by farm machinery.

A severe erosion hazard, low fertility, and low available moisture capacity are major limitations to use of this soil for crops. Most areas of this soil are in low-grade pasture or are idle. A few areas adjacent to finer textured soils are planted to small grains and hay. (Capability unit VIs–1 (5a); woodland suitability group E)

Kalkaska sand, 12 to 18 percent slopes (KkD).—This soil is hilly and moderately steep. Few slopes exceed 200 feet in length. In cultivated areas the surface soil is mostly very dark grayish brown or dark grayish brown, but there are streaks of brown or dark brown. Forested areas have a thin, very dark gray surface layer. Slopes are generally between 12 and 18 percent but range outside these limits over short distances. A few depressions are present. They dry slowly in spring. Rubicon soils were included in mapping most areas of this soil.

An erosion hazard, low available moisture capacity, and low fertility are major limitations to use of this soil for crops. Most areas of this soil are in forest. Some areas are in low-grade pasture, are idle, or have been planted to pines. (Capability unit VIIs–1 (5a); woodland suitability group E)

Kalkaska sand, 12 to 18 percent slopes, severely eroded (KkD3).—This soil is hilly or moderately steep and is severely eroded. The slopes are short and complex and seldom exceed 100 feet in length. The sand surface layer is very pale brown and is a mixture of the original surface soil and underlying layers. Numerous shallow gullies dissect some areas. Rubicon soils were included in mapping most areas of this soil.

A severe erosion hazard, low available moisture capacity, and low fertility are major limitations to use of this soil for crops. Most areas are in pasture or are idle. A few small areas near areas of finer textured soils are planted to small grains and hay. (Capability unit VIIs–1 (5a); woodland suitability group E)

Kalkaska sand, 18 to 25 percent slopes (KkE).—This soil is steep and is on ridges and knolls, and in other areas near other Kalkaska soils. In forested areas the surface layer is very dark gray and is thin. In cultivated or pastured areas, it is dark grayish brown. Small wet depressions are in many areas. Rubicon, Menominee, and McBride soils were common inclusions in mapping this soil.

An erosion hazard, rapid runoff, low available moisture capacity, low fertility, and the difficulty of operating machinery on steep slopes are major limitations to the use of this soil for crops.

Most areas of this soil remain in forest, but some areas are in pasture. (Capability unit VIIs–1 (5a); woodland suitability group E)

Kalkaska sand, 18 to 25 percent slopes, severely eroded (KkE3).—This soil is steep and is on ridges and knolls and in other sloping areas near other Kalkaska soils. The present surface layer is a mixture of the original surface layer and underlying layers and is mostly very pale brown. Numerous shallow gullies dissect some areas, and a few natural pits are in the rolling areas. Rubicon soils were included in mapping this soil. Also included were small areas of finer textured soils on the lower part of the slopes.

Severe erosion, rapid surface runoff, low fertility, and low available moisture capacity are major limitations to use of this soil for crops. The steep slopes hinder use of machinery.

All areas of this soil have been cultivated in the past. At present they are idle and have little vegetative cover. (Capability unit VIIs–1 (5a); woodland suitability group E)

Kalkaska sand, 25 to 55 percent slopes (KkF).—This soil is steep and is on ridges and knolls and in other sloping areas. The slopes are short, seldom more than 200 feet in length. This soil is near other Kalkaska soils that are more gently sloping. The surface layer of moderately eroded and severely eroded areas of this soil is lighter colored and lower in organic-matter content than that of uneroded or slightly eroded areas. In forested areas the surface layer is very dark gray and is thin. Rubicon and East Lake soils were commonly included in mapping this soil. Also included were narrow bands of finer textured soils that are on the lower part of slopes in most areas.

Erosion, rapid surface runoff, low fertility, low available moisture capacity, and the difficulty of using power equipment on the steep slopes are the major limitations to use of this soil for crops. Most areas of this soil are in forest. Hard maple is predominant. (Capability unit VIIs–1 (5a); woodland suitability group E)

Kalkaska stony sand, 0 to 6 percent slopes (KlB).—This soil is nearly level or gently sloping. It has a stony or very stony surface layer. The stones range from 10 inches to 6 feet in diameter and are 25 to 100 feet apart. In some areas there are stones throughout the soil profile.

Stoniness, erosion, low fertility, and low available moisture capacity are the major limitations to use of this soil for crops. Unless the stones are removed, it is extremely difficult to cultivate this soil with farm machinery. Most areas of this soil are in forest or are idle and have a sparse vegetative cover. (Capability unit VIIs–1 (5a); woodland suitability group E)

Kalkaska stony sand, 6 to 12 percent slopes (KlC).—This soil is rolling and sloping. Slopes rarely exceed 150 feet in length. Some areas are moderately eroded, and in these the surface layer is dark brown. In most areas the surface layer is stony or very stony. The stones range from 10 inches to 6 feet in diameter and are 30 to 100 feet apart. In some areas stones occur throughout the soil profile. Slopes range outside the specified limits in some areas.

Stoniness, erosion, low fertility, and low available moisture capacity are the major limitations to use of this soil for crops. Unless the stones are removed from the surface, it is extremely difficult to cultivate this soil with farm machinery. Most areas of this soil are in forest or are idle. (Capability unit VIIs–1 (5a); woodland suitability group E)

Kalkaska stony sand, 12 to 25 percent slopes (KlE).—This soil is hilly or steep. The surface layer is stony or very stony. Its color ranges from very dark gray to grayish brown, depending on how much the soil has been disturbed or eroded. The stones on the surface range from 10 inches to about 6 feet in diameter and are 30 to 100 feet apart. In some areas stones occur throughout the soil profile.

Stoniness, erosion, low fertility, and low available moisture capacity are major limitations to the use of this soil for crops. Unless stones are removed from the surface, it is extremely difficult to cultivate this soil with farm machinery in most areas. Most areas of this soil are in forest or are idle. (Capability unit VIIs–1 (5a); woodland suitability group E)

Kawkawlin Series

The soils of this series are somewhat poorly drained, are nearly level to undulating or gently sloping, and are on till plains and moraines. They formed in clay loam or silty clay loam material. Stones lie on the surface in some areas.

The surface layer is very dark gray loam about 6 inches thick. It has weak granular structure and is friable. The subsurface layer is pinkish-gray loam, is about 4 inches thick, has moderate platy structure, and is friable.

The subsoil is brown or grayish-brown silty clay loam about 10 inches thick. The upper part has moderate blocky structure and is firm. The lower part has distinct dark-brown and reddish-brown mottles, has strong blocky structure, and is firm.

A light reddish-brown silty clay loam, mottled with brown and grayish brown, is at a depth of about 20 inches. This material has weak blocky structure, is firm, and is high in lime content.

Available moisture capacity and natural fertility of these soils are high. Permeability is moderately slow. Surface runoff is slow to medium, depending on the degree of slope.

Distinct mottles in the subsoil indicate that these soils are saturated for extended periods. Wetness delays planting and hinders root development and operation of farm machinery. Wetness during spring and after rain is the main limitation to the use of these soils for crops.

These soils are used for crops, pasture, and woods. Crops commonly grown are small grains, hay, and corn for silage.

Typical profile of Kawkawlin loam:

Ap—0 to 6 inches, very dark gray (10YR 3/1) loam; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

Figure 3.—**A Kawkawlin soil in the light area in the foreground, a Nester soil in the darker plowed area beyond, and a Menominee soil in the far background in grass and trees.**

A2—6 to 10 inches, pinkish-gray (7.5YR 6/2) loam; moderate, medium, platy structure; friable; slightly acid; abrupt, wavy boundary.

B21—10 to 12 inches, brown (7.5YR 5/4) silty clay loam; moderate, fine, subangular blocky structure; firm; slightly acid; clear, wavy boundary.

B22g—12 to 20 inches, grayish-brown (10YR 5/2) silty clay loam; many, medium, distinct, dark-brown (7.5YR 4/4) and reddish-brown (5YR 5/4) mottles; strong, medium, angular blocky structure; firm when moist, plastic when wet; slightly acid; abrupt, wavy boundary.

C—20 to 60 inches, light reddish-brown (5YR 6/4), silty clay loam; many, medium, distinct, brown (7.5YR 5/4) and grayish-brown (10YR 5/2) mottles; weak, medium, angular blocky structure; firm; calcareous.

The surface layer is very dark grayish brown in some areas and is 6 to 10 inches thick. The texture of this layer ranges from sandy loam to loam. In undisturbed areas the surface layer is very dark gray and is 2 to 4 inches thick. The subsurface layer is absent in some cultivated areas. Depth to mottling ranges from 6 to about 16 inches. The subsoil is clay loam or light clay in a few areas. Combined thickness of the surface layer and subsoil ranges from 16 to about 36 inches. In some areas the material below the subsoil is clay loam. Reaction of the surface layer and subsoil ranges from medium acid to neutral.

Kawkawlin soils are more poorly drained than Nester soils (fig. 3) but are better drained and not so gray as the Sims soils. Kawkawlin soils have drainage similar to that of the Selkirk soils but are coarser textured.

Kawkawlin loam, 0 to 2 percent slopes (KnA).—This soil is nearly level and is on uplands. It is near the Nester soils, which are in higher positions, and near the poorly drained and very poorly drained Sims soils, which are in lower positions. The surface soil is very dark gray or very dark grayish brown. Depth to free lime is about 25 inches. Sims soils in small drainageways and sags were included in mapping many areas of this soil. These areas are wet, and they dry slowly in spring and after rains. The wetness hinders use of farm machinery.

Wetness and moderately slow permeability are major limitations to use of this soil for crops. This soil is used

for pasture and hay in most areas, but some corn is grown for silage. Some areas are in forest. (Capability unit IIw–2 (1.5b); woodland suitability group Z)

Kawkawlin loam, 2 to 6 percent slopes (KnB).—This soil is undulating and gently sloping. It is near the well drained and moderately well drained Nester soils that are in higher positions and is near the poorly drained and very poorly drained Sims soils that are in slight depressions. The surface layer is very dark gray or very dark grayish brown. Small rises and knolls of Nester soils, and narrow depressions and drainageways of Sims soils, were included in mapping in numerous areas of this soil. The Sims soils remain wet longer than the Kawkawlin soil. This wetness delays planting during spring.

Excess wetness limits use of this soil for crops, and most areas are in pasture or forest. A few areas are in hay and corn. (Capability unit IIw–3 (1.5b); woodland suitability group Z)

Kawkawlin loam, overwash, 0 to 2 percent slopes (KoA).—This soil is nearly level and is on uplands. In most areas it is near the Nester soils that are in higher positions and the Sims soils that are in lower positions. Most of this Kawkawlin loam soil has 6 to 18 inches of recently deposited brown loam on top of the original very dark gray loam surface layer. The soil is mottled with grayish brown at a depth of about 25 inches. Depth to free lime is 30 inches or more.

Water ponds on the surface of this soil for short periods after heavy rains. Excess wetness and moderately slow movement of water through the soil are the main limitations to its use for crops. The wetness hinders use of farm machinery.

Most areas of this soil are in forest or pasture. (Capability unit IIw–2 (1.5b); woodland suitability group Z)

Kawkawlin loam, overwash, 2 to 6 percent slopes (KoB).—This soil is on the lower parts of gentle slopes near the well-drained Nester soils and near the poorly drained and very poorly drained Sims soils.

Most of the Kawkawlin soil has from 6 to 18 inches of recently deposited brown loam on top of the original very dark gray loam surface layer. The overwash is loam in most areas but is sandy loam or silt loam in some areas. The soil is mottled grayish brown at a depth of about 25 inches. Depth to free lime is 30 inches or more. The soil receives some surface runoff from surrounding slopes.

Excess wetness restricts the use of this soil for crops. The soil dries slowly in spring and after rain.

Most of this soil is in pasture or forest. A few areas are in hay and corn. (Capability unit IIw–3 (1.5b); woodland suitability group Z)

Kawkawlin sandy loam, 0 to 2 percent slopes (KrA).—This soil is nearly level and is on uplands. Generally, it is in positions that are between the Nester and the Sims soils. The surface layer is very dark gray or very dark grayish-brown sandy loam 8 to 14 inches thick. Belding soils were included in mapping this soil in many areas. Sims soils were also included; they were in some of the sags and drainageways. The Sims soils dry more slowly than the Kawkawlin soils, and this delays planting in some years.

Wetness and moderately slow permeability are the major limitations to use of this soil for crops. The wetness hinders use of farm machinery.

Most areas of this soil are in pasture or forest. (Capability unit IIw–2 (1.5b); woodland suitability group Z)

Kawkawlin sandy loam, 2 to 6 percent slopes (KrB).—This soil is undulating and gently sloping and is on uplands. In most areas it is near the better drained Nester soils, which are in high positions, and near the more poorly drained Sims soils, which are in lower positions. The surface layer is sandy loam 8 inches to about 14 inches thick. It is predominantly very dark grayish brown with small streaks of brown. Small areas of Belding soils were included in mapping many areas of this soil.

Excess wetness restricts use of this soil for crops. Most areas are in pasture or crops. Crops commonly grown are small grains, hay, and some corn for silage. (Capability unit IIw–3 (1.5b); woodland suitability group Z)

Kawkawlin stony loam, 2 to 6 percent slopes (KsB).—This soil is undulating and gently sloping and is on uplands. In most areas it is near the better drained Nester soils, which are in higher positions, and near the more poorly drained Sims soils, which are in lower positions. The surface layer is predominantly loam, but it is sandy loam in some areas. Color is predominantly very dark grayish brown, with narrow streaks and areas of brown. Stones on the surface range from 1 to 4 feet in diameter and are 30 to 100 feet apart. Unless they are removed, it is extremely difficult to work this soil with farm machinery. Excess wetness and moderately slow permeability also limit the use of this soil for crops.

Most areas of this soil are in forest or pasture. (Capability unit IIw–3 (1.5b); woodland suitability group Z)

Kent Series

The soils of this series are well drained and moderately well drained and are gently sloping to moderately steep. They formed in clay or silty clay glacial material and are on till plains and moraines.

The surface layer is dark grayish-brown loam or silt loam about 6 inches thick. It has moderate granular structure and is friable. The subsurface layer is grayish-brown loam or silt loam about 2 inches thick. It has weak granular structure and is friable.

The subsoil is clayey. The upper 3 inches is grayish-brown silt loam and reddish-brown silty clay. The silt loam part is in the form of thin coatings. This material has weak granular or moderate blocky structure and is friable to very firm. The lower part of the subsoil is reddish-brown silty clay about 9 inches thick. It has strong blocky structure and is very firm.

Underlying the subsoil at a depth of about 20 inches is reddish-brown silty clay. This material has weak blocky structure, is very firm, and is high in lime content.

Available moisture capacity of these soils is high, and natural fertility is moderately high. Water moves at a slow rate through these soils. Runoff is medium on mild slopes and rapid on moderately steep slopes. Tilth is poor, and runoff is more rapid in moderately eroded areas than in areas not eroded.

Most of these soils have been cleared and are planted to small grains, hay, and corn. The steeper areas are in permanent pasture or trees. Use of the sloping and moderately steep areas is limited by a serious erosion hazard. The native vegetation consisted of northern hardwoods, including sugar maple, elm, beech, and some hemlock and white pine.

Typical profile of Kent silt loam:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—6 to 8 inches, grayish-brown (10YR 5/2) silt loam; weak, fine, granular structure; friable; slightly acid; abrupt, irregular boundary.

A2&B21—8 to 11 inches, grayish-brown (10YR 5/2) silt loam (A2 horizon); reddish-brown (5YR 5/3) silty clay (B21 horizon); A2 occurs as coatings on peds and along cracks; B21 occasionally occurs as isolated peds surrounded or nearly surrounded by A2; massive to weak, coarse, granular structure (A2); moderate, fine, angular blocky structure (B21); friable (A2) to very firm (B21); medium acid; gradual, wavy boundary.

B22—11 to 20 inches, reddish-brown (5YR 5/4) silty clay; thin coatings and crack fillings of light gray (10YR 7/2) and grayish brown (10YR 5/2); a few thin clay films of dark brown (7.5YR 4/2) and reddish brown (5YR 4/4) on some peds; strong, medium, angular blocky structure; very firm; medium acid; clear, wavy boundary.

C—20 to 60 inches, reddish-brown (5YR 5/3) silty clay; weak, medium, angular blocky structure; very firm; calcareous.

Color of the surface layer is very dark grayish brown or grayish brown in some areas, and thickness ranges from 5 to 9 inches. In undisturbed areas the surface layer is very dark brown silt loam about 1 to 3 inches thick. Thickness of the subsurface layer ranges from 2 to 6 inches. Thickness of the subsurface layer and subsoil ranges from 14 to about 25 inches. The subsoil and the material below the subsoil is clay in some areas. Reaction of the surface layer and subsoil ranges from medium acid to neutral.

Kent soils are better drained than Selkirk soils and are finer textured than Nester soils.

Kent loam, 2 to 6 percent slopes (KtB).—This soil is undulating and gently sloping. Individual areas of the soil are mostly small and commonly are near Manistee, Selkirk, and Allendale soils. The surface layer is predominantly dark grayish-brown loam, but there are spots and streaks of brown or reddish brown. The loam texture extends to a depth of 8 to 11 inches. Small areas have a silty clay loam, sandy loam, or silt loam surface layer. Small areas of Selkirk and Menominee soils were included in mapping this soil. The Selkirk soils are in narrow drainageways in many areas. They dry slowly in spring and delay planting and other use of the soil. The Menominee soils occur on the upper parts of some slopes.

Permeability is slow, and runoff is medium. Erosion is a hazard when this Kent soil is cultivated.

Most areas of this soil are used for pasture or crops. (Capability unit IIIe–3 (1a); woodland suitability group B)

Kent loam, 6 to 12 percent slopes (KtC).—This soil is sloping and is on rolling uplands. Individual areas of this soil are mostly small and commonly are near small areas of other soils having widely differing textures. The surface layer is dark grayish brown in most areas but is brown in a few areas. Texture is predominantly loam but ranges to silt loam. Below a depth of 8 to 11 inches, the soil is clay to silty clay. Slopes range outside specified limits over short distances.

An erosion hazard, slow movement of water through the soil, and medium runoff are the major limitations to the use of this soil for crops. Small closed depressions and narrow waterways occur in many areas. They often are too wet to support farm machinery, and planting and harvesting are thereby delayed.

Most areas of this soil are used for crops or pasture. Small grains, hay, and some corn are the crops commonly grown. (Capability unit IIIe–2 (1a); woodland suitability group B)

Kent loam, 6 to 12 percent slopes, moderately eroded (KtC2).—This soil is sloping and gently rolling and is on uplands. Individual areas of this soil are mostly small and are near other soils having a texture ranging from sand to clay. The surface layer is predominantly dark brown, but there are spots and small narrow streaks of reddish brown and dark grayish brown. Texture of the surface layer is predominantly loam, but it is sandy loam or silty loam in some areas. Below a depth of about 8 inches, the texture is clay to silty clay. Slopes range outside specified limits over short distances.

Moderate erosion has reduced the fertility and content of organic matter of this soil and has reduced its ability to absorb water. An erosion hazard, slow movement of water through the soil, poor tilth, and rapid runoff are the main limitations to its use for crops. Also, small depressions and narrow waterways occur in most areas. They remain wet in spring for longer periods than adjacent areas, and the wetness delays seeding and cultivation.

Most areas of this soil are in small grains, hay, corn, or permanent pasture. (Capability unit IIIe–2 (1a); woodland suitability group B)

Kent loam, 12 to 18 percent slopes (KtD).—This is a hilly and moderately steep soil on uplands. Individual areas are mostly small and commonly are near other soils having a texture ranging from sand to clay. The surface layer is predominantly dark grayish brown but in small areas is brown or dark brown. Texture is predominantly loam but ranges to silt loam or sandy loam. Slopes range outside the specified limits over short distances and are complex and short in many areas.

An erosion hazard, steepness, rapid runoff, and slow movement of water through the soil are the major limitations to use of this soil for crops.

Most areas of this soil have been cleared and are used for crops or pasture. Small grains, hay, and some corn for silage are grown. (Capability unit IVe–1 (1a); woodland suitability group B)

Kent loam, 12 to 18 percent slopes, moderately eroded (KtD2).—This soil is hilly and moderately steep and is on uplands. Individual areas are small and commonly are near other soils having a texture that ranges from sand to clay. The texture of the surface layer is predominantly loam, but it ranges to silt loam or sandy loam, and in small streaks, to silty clay loam and clay. The surface soil is mostly dark brown, but there are small areas of very dark brown, grayish brown, and reddish brown. Texture of most reddish-brown areas is silty clay loam or clay, and the soil is cloddy and difficult to work in these areas.

Erosion has reduced the level of fertility and the organic-matter content of this soil, its ability to take in water, and the quality of its tilth. The present surface layer crusts readily and becomes hard and cloddy if it is tilled when too wet.

Most areas of this soil are used for crops or permanent pasture. (Capability unit IVe–1 (1a); woodland suitability group B)

Kerston Series

The soils of this series are very poorly drained and are on flood plains of slowly flowing streams. They consist of alternate layers of organic and mineral material. The mineral layers are thinner than the organic layers in most places.

The surface layer of these soils is black muck about 6 inches thick. It has moderate granular structure and is friable when moist.

Below the surface layer to a depth of 30 inches or more are alternate layers of peat and sandy loam or loamy sand. The peat layers are very dark brown and are about 2 to 20 inches thick. The peat is fibrous and friable. The sandy loam or loamy sand layers are very dark gray or light gray and are 2 to 20 inches thick. These mineral layers are single grain and friable.

Available moisture capacity of these soils is high, and fertility is moderate. Water moves through these soils moderately rapidly. Runoff is very slow, and water ponds on the surface in depressions. These soils are subject to flooding, especially during spring and after prolonged rainfall. These soils are difficult to drain. Frost is a hazard to crops.

Most areas of Kerston soils are in lowland hardwoods or cedar. The native vegetation consisted of willow, elm, red maple, alder, and sedges and water-tolerant grasses.

Typical profile of Kerston muck:

1—0 to 6 inches, black (10YR 2/1) muck; moderate, fine, granular structure; soft when dry, friable when moist; mildly alkaline; gradual, smooth boundary.
2—6 to 15 inches, very dark brown (10YR 2/2) peat; fibrous; friable; slightly acid; clear, wavy boundary.
3—15 to 18 inches, very dark gray (5YR 3/1) sandy loam; massive, friable; mildly alkaline; clear, wavy boundary.
4—18 to 23 inches, very dark brown (10YR 2/2) peat; fibrous; friable; mildly alkaline; clear, wavy boundary.
5—23 to 26 inches, very dark gray (5YR 3/1) loamy sand; single grain; loose; mildly alkaline; clear, wavy boundary.
6—26 to 30 inches, very dark brown (10YR 2/2) peat; fibrous; friable; mildly alkaline; clear, wavy boundary.
7—30 to 60 inches, light-gray (5YR 6/1) loamy sand; single grain; loose; mildly alkaline.

In some areas the surface layer is a dark gray or very dark gray loam or sandy loam. Thickness and sequence of the layers of organic material vary greatly in these soils. Thickness of the individual layers ranges from 2 to 20 inches. Texture of the mineral material ranges from sand to loamy sand, sandy loam, loam, silt loam, or clay loam. Reaction of the profile ranges from medium acid to mildly alkaline.

Kerston soils and other alluvial soils occupy similar areas, but Kerston soils have layers of organic material that other alluvial soils in Michigan lack. They have thinner layers of organic material than do Carbondale and Houghton soils.

Kerston loam (Kv).—This soil is on nearly level and depressed river and stream flood plains and is very poorly drained. Individual areas of this soil vary in size. The surface layer is predominantly loam or sandy loam, but there are small areas of muck and clay. Thickness of the surface layer ranges from 2 to 20 inches. This layer is underlain by stratified organic and mineral material.

This soil is difficult to drain, and even after it is drained, it is subject to flooding. Frost is a hazard to crops. Many areas are too small to be farmed.

Most areas of this soil are in lowland hardwoods or cedars. Some areas of this soil are suited to pasture if they are dry and are not subject to periodic flooding. (Capability unit Vw–3 (L–4c); woodland suitability group J)

Kerston muck (Kw).—This soil is poorly drained and is on nearly level stream flood plains. Most areas are large and commonly are near other organic and bottom-land soils. The surface layer is black, is predominantly muck, and is 2 to 10 inches thick. Under it are alternate layers of mineral and organic material. Small pockets of deep organic deposits and mineral sediments are common.

This soil is difficult to drain, and even when drained, it is subject to flooding. Frost is a hazard to crops.

Most areas of this soil are in lowland hardwoods and cedars. Some areas are suited to pasture if they are dry and are not subject to periodic flooding. (Capability unit Vw–3 (L–4c); woodland suitability group J)

Kinross Series

The soils of this series are very poorly drained and sandy and are on nearly level to depressed flats on outwash plains and moraines. They developed in acid, medium and coarse sands.

The surface layer is very dark gray sand about 3 inches thick. It has very weak granular structure and is very friable. The subsurface layer is very dark gray loamy sand about 13 inches thick.

The subsoil is dark reddish-brown sand about 24 inches thick. It is single grain and loose.

The underlying material is brown sand at a depth of about 40 inches. It has single grain structure and is loose.

Available moisture capacity and natural fertility are low. In the absence of a high water table, water moves very rapidly through these soils, but the water table is at or near the surface during most of the year. Runoff is very slow, and water ponds in depressed areas during the spring and after rainfall.

These soils are seldom used for crops. Most areas are idle and have a cover of leatherleaf mosses, grasses, small trees, and brush. The native vegetation consisted of sedges, reeds, water-tolerant grasses, dwarf heath, shrubs, tamarack, and black spruce.

Typical profile of Kinross sand:

O1—3 inches to 0, peaty mat of undecomposed organic material.
A1—0 to 3 inches, very dark gray (10YR 3/1) sand; very weak, medium, granular structure; very friable; very strongly acid; clear, smooth boundary.
A2—3 to 16 inches, very dark gray (10YR 3/1) loamy sand; dark reddish-brown (5YR 3/4) linings in fine root channels; single grain; loose; very strongly acid; clear, wavy boundary.
B21—16 to 30 inches, dark reddish-brown (5YR 2/2) sand; single grain; loose; very strongly acid; diffuse, irregular boundary.
B22—30 to 40 inches, dark reddish-brown (5YR 3/2) sand; single grain; loose; strongly acid; gradual, wavy boundary.
C—40 to 60 inches, brown (7.5YR 5/4) sand; single grain; loose; very strongly acid.

In some areas the surface layer is black and is 1 to 4 inches thick. The subsurface layer is dark brown in a few areas, and its thickness ranges from 7 to 14 inches.

Kinross soils are more acid than Roscommon soils and are more poorly drained than Au Gres soils.

Kinross sand (Kx).—This soil is on broad, flat, depressed outwash plains. Commonly, it is near the somewhat poorly drained Au Gres soils, which are in slightly higher posi-

tions. The surface layer is very dark gray or black. It is predominantly sand but in some places consists of an organic mat of living and dead plant material as much as 10 inches thick. Some small spots of Dawson peat were included in mapping this soil.

Kinross sand is strongly acid to extremely acid, is low in fertility, and is very poorly drained. Excess wetness and low fertility are the main limitations to its use for crops. Frost also is a hazard. If this soil is drained, available moisture during extreme drought is not sufficient for optimum crop growth.

Most areas of this soil are idle and are covered with mosses, leatherleaf, and a few stunted trees. (Capability unit IIIw–11 (5c); woodland suitability group Q)

Linwood Series

The soils of this series are very poorly drained organic soils in nearly level or depressed areas on lake, outwash, and till plains and moraines. They formed from plant remains derived from coniferous and deciduous woody materials mixed with fibrous material. The organic material is underlain by loam at a depth ranging from 12 to 42 inches.

The top 9 inches of these soils is black or dark-brown muck containing numerous fragments of wood. This layer has weak or moderate granular structure and is friable. Below the top layer, to a depth of 23 inches, is dark yellowish-brown peaty muck and dark reddish-brown peat. This material has weak platy structure and is friable.

Dark grayish-brown loam underlies the organic material at a depth of about 23 inches. The loam lacks structure, is friable, and is high in lime content.

Available moisture capacity of these soils is high and natural fertility is moderate. Water moves rapidly through the upper part of the soils but moderately slowly through the underlying loamy material. Runoff is very slow, and water ponds in some of the depressions and flats. In undrained areas the water table is at or near the surface during most of the year. These soils are low in content of phosphorus, potassium, and most of the micronutrients. They settle readily after they are artificially drained.

Most of these soils are in woods, brush, or pasture. Only a small acreage has been cleared and used for crops. The native vegetation consisted of water-tolerant sedges and grasses and of such trees as elm, white birch, white-cedar, and balsam fir. Common shrubs were willow, dogwood, and alder.

Typical profile of Linwood muck:

1—0 to 3 inches, black (10YR 2/1) muck; numerous woody fragments and many fine living roots; moderate, fine, granular structure; friable; medium acid; clear, wavy boundary.

2—3 to 9 inches, dark-brown (7.5YR 3/2) muck; numerous fragments of wood; weak, coarse, granular structure; friable; medium acid; clear, wavy boundary.

3—9 to 16 inches, dark yellowish-brown (10YR 4/4) peaty muck; numerous fragments of woody and fibrous material; massive to weak, thick, platy structure; friable; medium acid; diffuse, wavy boundary.

4—16 to 23 inches, dark reddish-brown (5YR 3/4) peat derived chiefly from grasses and sedges; weak, thick, platy structure; slightly sticky when wet; medium acid; abrupt, wavy boundary.

IIC—23 to 60 inches, dark grayish-brown (2.5YR 4/2) loam; massive; friable; calcareous.

The surface layer is very dark brown in some areas. Reaction of the organic material ranges from strongly acid to neutral. Reaction of the loamy underlying material ranges from slightly acid to calcareous. Texture of the underlying material ranges from loam to sandy loam, clay loam, or silty clay loam.

Linwood soils have a thinner layer of organic material than do Carbondale and Houghton soils. They are underlain by finer textured material than are either Adrian or Tawas soils.

Linwood muck (Lm).—This soil is mostly in small depressions that are surrounded by undulating to steeply sloping soils. The surface layer is black or very dark brown and is mainly muck. The muck is 6 to 20 inches thick and grades to peat. In many areas the organic layer becomes thin at the edges, and some spots of mineral soils occur. These were included in mapping this soil, as were small areas of Carbondale muck in the center of some areas of this soil. In the Carbondale muck, the deposit of organic material is more than 42 inches thick.

Use of Linwood muck for crops is severely limited by a high water table, low fertility, a wind erosion hazard, and a frost hazard.

Most of this soil is in woods. (Capability unit Vwc–1 (M/3c); woodland suitability group J)

Loxley Series

The soils of this series are very poorly drained organic soils in depressions or on nearly level flats that are on outwash and till plains, moraines, and valley trains. They formed in extremely acid organic remains from woody and fibrous plants. Thickness of the organic materials is greater than 42 inches.

The surface layer is very dusky red muck about 10 inches thick. It contains many living roots, has moderate granular structure, and is friable. The next layer, to a depth of about 28 inches, is black peaty muck. It has weak granular structure, is friable, and contains some woody and fibrous plant remains.

The third layer is black peaty muck. It is massive and friable.

Available moisture capacity of these soils is high, and fertility is moderate. Water moves through the soil moderately rapidly when the water table is low. Runoff is very slow and ponds in depressions. Organic-matter content of these soils is very high, but the content of plant nutrients, especially most micronutrients, is low. These soils settle readily when artificially drained.

Because of an extremely acid reaction, low fertility, and excess wetness, these soils are seldom used for crops. Native vegetation consists of herbaceous plants that include leatherleaf, grasses, reeds, sedges, and mosses. There are a few pines and hardwoods.

Typical profile of Loxley muck:

1—1 inch to 0, mixture of living and dead organic material from leatherleaf and other herbaceous plants and moss; extremely acid; abrupt, smooth boundary.

2—0 to 10 inches, very dusky red (2.5YR 2/2) muck; numerous living roots; moderate, medium, granular structure; friable; extremely acid; gradual, smooth boundary.

3—10 to 28 inches, black (5YR 2/1) peaty muck; weak, medium, granular structure; friable; some identifiable woody and herbaceous plant remains; extremely acid; gradual, wavy boundary.

4—28 to 44 inches +, black (5YR 2/1) peaty muck; massive; friable; less decomposed than layers above; some identifiable plant remains; extremely acid.

A 2- to 12-inch layer of hypnum moss is at the surface in some areas. Thin layers of sedimentary peat, 1 to 3 inches thick, are

298–861—69——4

present in some areas. Reaction of the profile is mainly extremely acid, but in some areas it is very strongly acid.

Loxley soils are more acid than Carbondale, Lupton, or Houghton soils. They have a thicker layer of organic material than Adrian, Linwood, or Tawas soils.

Loxley muck (Lo).—This soil is nearly level, is very poorly drained, and is in bogs on moraines and outwash plains. These bogs are surrounded by undulating to steeply sloping mineral soils. The texture of the surface layer is muck. Below a depth of 8 to 10 inches, the material ranges from muck to peaty muck. The organic materials are thin or absent at the edges of areas of this soil. Small areas of Saugatuck and Dawson soils were included in mapping some areas of this soil.

Excessive wetness and an extremely acid reaction severely limit use of this soil. Frost also is a hazard to crops. The muck is covered with acid-tolerant plants, such as leatherleaf, mosses, and grass. (Capability unit VIIIw–1 (Mc–a) ; woodland suitability group L)

Lupton Series

The soils of this series are very poorly drained and are on level bottom lands adjacent to rivers. They formed mainly from woody material derived from deciduous and coniferous trees that was mixed with fibrous material. Thickness of the organic material exceeds 42 inches in most areas and is many feet in some areas.

The surface layer is black muck about 12 inches thick. It has weak granular structure and is friable. Below the surface layer, to a depth of about 42 inches, is black muck that has weak or moderate granular structure in the upper part and is massive in the lower part. This muck is friable and soft.

Below 42 inches is black muck that contains a small amount of woody material. This material is massive and friable.

Available moisture capacity of these soils is high, and natural fertility is low. The content of soil micronutrients is especially low. Water moves through the soil moderately rapidly. Runoff is very slow or ponded. The water table is at or near the surface unless these soils are artificially drained. These soils settle readily when drained.

The use of these soils for crops is severely limited by the high water table, low fertility, and the frost hazard.

Most areas of these soils are in forest or in permanent pasture.

Typical profile of Lupton muck:

1—0 to 12 inches, black (10YR 2/1) muck; weak, medium, granular structure; friable; mildly alkaline; gradual, wavy boundary.

2—12 to 24 inches, black (10YR 2/1) muck; moderate, medium, granular structure; friable; mildly alkaline; gradual, wavy boundary.

3—24 to 42 inches, black (10YR 2/1) muck; weak, medium, granular structure, grading to massive in lower part; soft when dry, friable when moist, slightly sticky when wet; moderately alkaline; gradual, wavy boundary.

4—42 inches +, black (10YR 2/1) muck; small amount of woody material; massive; friable when moist, slightly sticky when wet; moderately alkaline.

In a few areas the surface layer is very dark brown and the second layer is dark reddish brown. In some areas thin layers of marl, 2 to 4 inches thick, are present between a depth of 24 and 66 inches. Reaction of the profile ranges from mildly alkaline to moderately alkaline.

Lupton soils are less acid than Loxley, Carbondale, or Houghton soils. They have a thicker layer of organic material than Tawas, Linwood, or Adrian soils.

Lupton muck (Lu).—This soil is in nearly level or depressed areas and has a profile similar to the one described for the series. It commonly is near level to undulating soils formed in calcareous sand and gravel. Small spots of Markey soils were included in mapping some areas of this soil. The Markey soils are underlain by sandy material at a depth ranging from 18 to 42 inches. Some small areas of Markey soils have 6 to about 18 inches of loamy mineral material on the surface.

This Lupton soil is very poorly drained, and fertility is low. If cleared and drained, this soil is subject to wind erosion. Frost is a hazard to crops.

Most areas of this soil are in woods. (Capability unit Vwc–1 (Mc) ; woodland suitability group J)

Mancelona Series

In this series are well drained and moderately well drained, nearly level to steep soils on outwash and lake plains, deltas, and kames. The soils formed in loamy sand, gravelly loamy sand, and sand and overlie calcareous sand and gravel. The underlying material is calcareous at a depth ranging from 18 to 42 inches.

The surface layer is very dark brown loamy sand about 10 inches thick. It has very weak granular structure and is very friable.

The upper part of the subsoil is dark reddish-brown loamy sand about 20 inches thick. It has very weak blocky structure and is very friable. The lower part is dark-brown gravelly sandy loam about 4 inches thick. This material has weak blocky structure and is friable.

Light yellowish-brown stratified sand and gravel are present at a depth of about 40 inches. This material is single grain, loose, and high in lime content.

Available moisture capacity and natural fertility of these soils are moderately low. Water moves through the soils rapidly. Runoff varies according to steepness of the soils; it is slow in level areas and medium or rapid in steep areas. During long dry periods in midsummer, available moisture is insufficient for optimum crop growth. Erosion is a serious hazard when the sloping to steep soils are in crops. Gullies form readily and are difficult to control.

Many of the level to sloping areas of these soils are in crops (fig. 4). The more steeply sloping soils are used for pasture or woods. The native vegetation consisted of northern hardwoods.

Typical profile of Mancelona loamy sand:

Ap—0 to 10 inches, very dark brown (10YR 2/2) loamy sand; very weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

Bir—10 to 30 inches, dark reddish-brown (5YR 3/4) loamy sand; very weak, medium, subangular blocky structure; very friable; medium acid; clear, wavy boundary.

A'2—30 to 36 inches, yellowish-brown (10YR 5/4) loamy sand; very weak, fine, subangular blocky structure; very friable; medium acid; clear, irregular boundary.

B't—36 to 40 inches, dark-brown (10YR 4/4) gravelly sandy loam; weak, medium, subangular blocky structure; friable when moist, slightly sticky when wet; neutral; abrupt, irregular boundary.

C—40 to 60 inches, light yellowish-brown (10YR 6/4) sand and gravel; single grain; loose; calcareous.

Figure 4.—Alfalfa on a Mancelona loamy sand.

The surface layer ranges from very dark brown to dark brown and is 6 to 10 inches thick. Its texture ranges from loamy sand to sandy loam. In undisturbed areas the surface layer is very dark grayish brown, is 2 to 4 inches thick, and is underlain by a light brownish-gray subsurface layer. In many areas a layer of yellowish-brown loamy sand, 6 inches thick, is present between the upper and lower parts of the subsoil. Depth to stratified sand and gravel ranges from 18 to 42 inches. Reaction of the surface layer and subsoil ranges from medium acid to mildly alkaline.

Mancelona and Gladwin soils formed in similar material, but Mancelona soils are better drained than Gladwin soils. They have a finer textured subsoil than East Lake soils but have a coarser textured subsoil than Newaygo soils.

Mancelona loamy sand, 0 to 2 percent slopes (MaA).—This soil is on nearly level outwash plains. It commonly is near other Mancelona soils and near Montcalm soils. The surface layer is very dark brown loamy sand, but a few small areas have a sand or sandy loam surface layer. Small areas of Gladwin soils were included in mapping some areas of this soil. Gladwin soils are wetter and dry more slowly in spring than this Mancelona soil. Stones on the surface in some areas of this soil hinder cultivation. Slopes exceed 2 percent in places.

This soil is droughty, and the water-erosion hazard is slight. Moderately low available moisture capacity, moderately low fertility, and a wind-erosion hazard are the major limitations to use for crops.

Most areas of this soil are in crops. (Capability unit IIIs–3 (4a); woodland suitability group C)

Mancelona loamy sand, 2 to 6 percent slopes (MaB).—This soil is undulating and gently sloping and is on outwash plains, benches, and terraces. The surface layer is very dark brown loamy sand in most areas but is brown or dark brown on the upper slopes of cultivated areas where there are small spots of moderate erosion. Slopes range outside the specified limits over short distances. Loamy material lies below a depth of 42 inches in a few areas.

Low available moisture capacity, moderately low fertility, and a moderate wind erosion hazard are the major limitations to the use of this soil for crops.

This soil is used mainly for crops, but a small acreage is in pasture or woods. (Capability unit IIIs–4 (4a); woodland suitability group C)

Mancelona loamy sand, 6 to 12 percent slopes (MaC).—This soil is sloping and is on outwash plains and terraces. The surface layer is very dark brown loamy sand in most areas, but a few small areas have a brown or dark-brown surface layer. In wooded areas the surface layer is very dark gray and is 2 to 4 inches thick. The surface soil is sand or sandy loam in a few areas and contains a considerable amount of gravel. Several areas are underlain by loamy material at a depth of 42 to 66 inches. Slopes range outside specified limits in a few areas.

Moderately low available moisture capacity, moderately low fertility, and a moderately severe erosion hazard are the major limitations to the use of this soil for crops.

This soil is in pasture, crops, and woods. (Capability unit IIIe–9 (4a); woodland suitability group C)

Mancelona loamy sand, 12 to 18 percent slopes (MaD).—This soil is moderately steep and is on outwash plains, terraces, and kames. It is near Montcalm and Chelsea soils in most areas. The surface layer is very dark brown loamy sand in most areas, but it is sand and sandy loam in some areas. Slopes are short and complex in many areas, and they range outside specified limits over short distances.

Available moisture capacity and fertility of this soil are moderately low. In cultivated areas runoff is rapid and soil moisture is insufficient for optimum crop growth in midsummer and late summer. Steepness of the slopes hinders use of machinery. The erosion hazard is severe in cultivated areas.

This soil is in pasture, woods, and crops. (Capability unit IVe–9 (4a); woodland suitability group C)

Mancelona loamy sand, 18 to 25 percent slopes (MaE).—This soil is steep and is on outwash plains, terraces, and kames. It is near less steeply sloping Mancelona and Montcalm soils in most areas. The surface layer is very dark brown in most areas, but it is brown in some areas. In wooded areas the surface layer is very dark gray and is 2 to 4 inches thick. The surface layer is predominantly loamy sand, but it ranges to sand or sandy loam that contains varying amounts of gravel.

Available moisture capacity and fertility of this soil are moderately low, and the soil is droughty in summer. The steep slopes severely restrict use of farm machinery, and the hazard of erosion is severe when this soil is cultivated.

Most areas of this soil are in woods. (Capability unit VIe–2 (4a); woodland suitability group C)

Mancelona sandy loam, 0 to 2 percent slopes (McA).—This soil is nearly level and is on outwash plains and terraces. It is near Mancelona loamy sands in most areas. The surface layer is very dark brown sandy loam. In some areas the lower part of the subsoil is stratified, and there are several layers of sandy loam with loose, calcareous gravel and sand between the layers. Slopes exceed 2 percent in a few areas. Small areas of Mancelona loamy sand and of the wetter Gladwin soils were included in mapping this soil.

Available moisture capacity and natural fertility of this soil are moderately low. The wind erosion hazard is slight, but the soil is droughty during prolonged dry periods. It is similar to Mancelona loamy sands but has slightly higher available moisture capacity and fertility and erodes less readily when exposed to the wind.

Most areas of this soil are in crops or pasture. (Capability unit IIIs–3 (4a); woodland suitability group C)

Manistee Series

Soils of this series are well drained and moderately well drained and range from gently sloping to moderately steep. They are on lake and outwash plains and moraines and formed in sand or loamy sand 18 to 42 inches thick over clay or silty clay.

The surface layer is very dark grayish-brown loamy sand about 8 inches thick. It has very weak granular structure and is very friable. The subsurface layer is light brownish-gray loamy sand about 2 inches thick. It has very weak granular structure and is very friable.

The upper part of the subsoil is dark yellowish-brown or strong-brown loamy sand and sand about 15 inches thick. It has single grain or very weak granular structure and is very friable or loose. The lower part of the subsoil is brown clay about 5 inches thick. It has strong blocky structure and is very firm.

A brown clay underlies the subsoil at a depth of about 35 inches. This material has moderate blocky structure, is very firm, and is high in lime content.

Available moisture capacity and natural fertility of these soils are moderately low. Water moves rapidly through the upper sandy part of the profile and slowly through the underlying clayey part. Surface runoff varies according to steepness of the slope and ranges from slow in gently sloping areas to rapid in moderately steep areas. In most years these soils are nearly saturated at the start of the growing season. As the season progresses, rainfall normally is not adequate to replenish water used by plants. The finer textured underlying clay layers keep the sandy material above them moist and increases the amount of soil moisture in otherwise droughty soils.

The major limitation to the use of these soils for crops is their droughtiness during extended dry periods. The soils also are subject to wind erosion during dry periods.

Most areas of gently sloping or sloping soils of this series have been cleared and are used for crops. Areas of more steeply sloping soils are idle or are in trees. The native vegetation consisted of hardwoods and scattered white pines.

Typical profile of Manistee loamy sand:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) loamy sand; very weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—8 to 10 inches, light brownish-gray (10YR 6/2) loamy sand; very weak, medium, granular structure; very friable; strongly acid; abrupt, irregular boundary.

B21ir—10 to 14 inches, dark yellowish-brown (10YR 4/4) loamy sand; very weak, coarse, granular structure; very friable; strongly acid; gradual, wavy boundary.

B22ir—14 to 25 inches, strong-brown (7.5YR 5/6) sand; single grain; loose; medium acid; gradual, wavy boundary.

A'2—25 to 30 inches, light yellowish-brown (10YR 6/4) sand; single grain; loose; slightly acid; abrupt, wavy boundary.

IIB'—30 to 35 inches, brown (7.5YR 5/4) clay; strong, fine, angular blocky structure; very firm; slightly acid; abrupt, wavy boundary.

IIC—35 to 60 inches, brown (7.5YR 5/4) clay; moderate, coarse, angular blocky structure; very firm; calcareous.

The surface layer is very dark brown in some areas. It is very dark gray and is 2 to 4 inches thick in undisturbed areas. There is light yellowish-brown sand, about 5 inches thick, between the upper and lower part of the subsoil in many areas. Reaction of the surface layer and the upper part of the subsoil ranges from strongly acid to slightly acid, and that of the lower part of the subsoil is slightly acid to mildly alkaline.

These soils are better drained than Allendale soils. They have finer textured underlying material than Menominee soils.

Manistee loamy sand, 2 to 6 percent slopes (MdB).—This soil is gently sloping or undulating. In most areas it is near deep, sandy soils, which are in higher positions, and near clayey soils, which are in lower positions. The surface layer is loamy sand in most areas but ranges to fine sand or sand in some places. Color of the surface layer is very dark grayish brown in most areas but is brown or dark brown in some areas. Small areas of Rubicon soils, loamy substratum, were included in mapping this soil in some areas. In these included areas the depth to clay is more than 42 inches.

This soil is droughty and subject to moderate wind erosion when cultivated. Moderately low fertility and moderately low available moisture capacity also limit its use for crops. Water erosion is not a hazard in most places.

Most areas of this soil are used for crops, pasture, or woods. A few areas are idle. (Capability unit IIIs–4 (4/2a); woodland suitability group C)

Manistee loamy sand, 6 to 12 percent slopes (MdC).—This soil is sloping and is on ridges and side slopes of sand-covered clay uplands. It is near deep, well-drained sandy soils. The surface layer is loamy sand in most areas but is sand in some areas. Color of the surface layer is predominantly very dark grayish brown but ranges to brown or dark brown. Thickness of the sandy layers in the upper part of the profile is between 18 and 42 inches in most areas but ranges outside these limits over short distances.

This soil is subject to moderate wind and water erosion. Moderately low fertility and moderately low available moisture are other limitations to its use for crops. The soil dries quickly in the spring and can be tilled early, but it becomes droughty during dry summer months.

Most areas of this soil are used for pasture and crops. Some areas are in woods or are idle. (Capability unit IIIe–9 (4/2a); woodland suitability group C)

Manistee loamy sand, 12 to 18 percent slopes (MdD).—This soil is moderately steep and is on the edges of sandy outwash plains and moraines. The surface layer is loamy sand in most areas but is sand or loam in a few areas. Color of the surface layer is very dark grayish brown in most areas but is brown or dark brown in some areas. Thickness of the sandy upper part of the profile varies but is between 18 and 42 inches in most areas. In a few areas it is less than 18 inches, and in a few areas it is more than 42 inches.

Use of this soil for crops is severely limited by a wind and water erosion hazard and by a shortage of available soil moisture. Steepness of slope hinders use of machinery and harvesting of crops.

Most areas of this soil are in pasture or woods. (Capability unit IVe–9 (4/2a); woodland suitability group C)

Markey Series

The soils of this series are very poorly drained organic soils. They are in level or depressional areas and on bottom lands along rivers. They formed in mixed woody and fibrous organic material, 12 to 42 inches thick, that overlies sand or loamy sand.

The uppermost 26 inches of these soils is black muck that contains many fine roots. The muck has weak granular structure and is friable. Below this muck is dark reddish-brown peat to a depth of about 28 inches. The peat is fibrous and friable.

The underlying material is gray sand. It is single grain, loose, and high in lime content.

Available moisture capacity of these soils is high, and natural fertility is low. Water moves through the organic material rapidly, and through the sandy material very rapidly. Surface runoff is very slow and ponds in many depressional areas. The water table is at or near the surface in undrained areas. Excess wetness hinders use of farm machinery and prevents early tillage of these soils. They dry slowly in spring and after heavy rains and are difficult to drain. Wind erosion is a serious hazard if large areas of these soils are cultivated. Crops are subject to frost damage.

Most areas of these soils are in woods. In a few areas these soils are used for late summer pasture.

Typical profile of Markey muck:

1—0 to 5 inches, black (10YR 2/1) muck; many fine roots and variable quantities of woody plant remains; weak, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

2—5 to 26 inches, black (10YR 2/1) muck; weak, medium, granular structure; friable; mildly alkaline; gradual, wavy boundary.

3—26 to 28 inches, dark reddish-brown (5YR 3/2) peat; plant remains distinguishable; fibrous; friable; mildly alkaline; abrupt, smooth boundary.

IIC—28 to 60 inches, gray (10YR 5/1) sand; single grain; loose; calcareous.

In some areas there is no peat layer. In other areas the muck is only 10 to 20 inches thick. The texture of the underlying mineral material is loamy sand or fine gravelly sand in some areas.

These soils have a thinner layer of organic material than the Lupton, Carbondale, or Houghton soils. They contain more woody material than the Adrian soils and are less acid than either the Adrian or Tawas soils.

Markey muck (Me).—This soil is nearly level and is in depressions and on broad depressed flats. It is near the deep organic Lupton soils and the sandy and gravelly Wheatley soils in most areas. The profile characteristics are similar to those described as typical for the Markey series. Small areas of Wheatley soils and Lupton soils were included in mapping this soil. The Wheatley soils are on the outer parts of some areas of Markey muck. The Lupton soils are in areas where the organic material is more than 42 inches thick.

This soil is saturated, dries slowly, and is difficult to drain. Wind erosion is a hazard if large acreages are farmed. Crops are subject to frost damage.

Most areas of this soil are in woods, but a few areas are in pasture. (Capability unit Vwc–1 (M/4c); woodland suitability group J)

McBride Series

Soils of this series are well drained and moderately well drained and are gently sloping to steep. They are on till plains and moraines and formed in sandy loam material deposited by glaciers. Stones and gravel are on the surface in some areas.

The surface layer is very dark grayish-brown sandy loam about 6 inches thick. It has weak granular structure and is very friable.

The upper part of the subsoil is dark yellowish-brown and grayish-brown sandy loam or loamy sand about 22 inches thick. It has moderate granular structure or very weak platy structure and is very friable to brittle. An 8-inch fragipan lies between the upper and lower parts of the subsoil. The lower part of the subsoil is dark-brown sandy clay loam about 16 inches thick. It has moderate blocky structure and is firm.

Underlying the subsoil at a depth of about 52 inches is brown sandy loam that has weak blocky structure. It is friable and high in content of lime.

Available moisture capacity of these soils is moderately high, and natural fertility is moderate. Water moves through the soil at a moderate rate, except in the fragipan layer, where permeability is moderately slow. Surface runoff varies with steepness of slope and ranges from slow in gently sloping areas to rapid in steep areas. Erosion is a serious hazard if sloping to steep areas are farmed intensively. Stones and gravel make tillage difficult.

Gently sloping and sloping areas of these soils are mostly in crops. The principal crops are corn, oats, wheat, and hay, but a large acreage also is planted to potatoes. Moderately steep and steep areas are used for pasture or are in trees.

Typical profile of McBride sandy loam:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) sandy loam; weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

Bir—6 to 20 inches, dark yellowish-brown (10YR 4/4) sandy loam; moderate, medium, granular structure; very friable; medium acid; abrupt, wavy boundary.

A'2m—20 to 28 inches, grayish-brown (10YR 5/2) loamy sand; very weak, medium, platy structure; brittle and hard when dry; fragipan; medium acid; abrupt, irregular boundary.

A'2&B'21—28 to 36 inches, pale-brown (10YR 6/3) loamy sand (A'2 horizon); reddish-brown (5YR 4/4) sandy clay loam (B'21 horizon); peds of B'21 are partially or wholly surrounded by A'2 horizon; A'2 occurs as coatings around peds and as fillings in root channels and cracks; A'2 is massive, compact, brittle; B'21 has moderate, coarse, subangular blocky structure; firm; medium acid; clear, irregular boundary.

B'22—36 to 52 inches, dark-brown (7.5YR 4/4) sandy clay loam; moderate, medium, subangular blocky structure; firm; medium acid; clear, wavy boundary.

C—52 to 60 inches, brown (7.5YR 5/4) sandy loam; weak, coarse, subangular blocky structure; friable; calcareous.

In undisturbed areas the surface layer is very dark brown and is 1 to 3 inches thick. It is underlain by a light brownish-gray or pinkish-gray subsurface layer 2 to 4 inches thick. In other areas the surface layer ranges from very dark grayish brown to dark grayish brown and is 6 to 10 inches thick. The texture of the surface layer is loamy sand, gravelly sandy loam, or stony sandy loam. There is a weak to strongly developed fragipan in the upper part of the subsoil. It is brittle and hard when dry. Layers and pockets of loamy sand are below the subsoil in many areas. Combined thickness of the surface layer and subsoil ranges from 40 to 60 inches. Reaction of these layers ranges from slightly acid to strongly acid.

McBride soils and Coral soils formed in similar material, but McBride soils are better drained. The McBride soils have finer textured subsoil layers than the Montcalm soils and have coarser textured subsoil layers than the Isabella soils.

McBride gravelly sandy loam, 6 to 12 percent slopes (MgC).—This soil is on uplands and is near other McBride soils and near Isabella soils. The surface layer is very dark grayish brown in most areas but is brown in some areas. The texture is gravelly sandy loam. The content of gravel

ranges from 15 to 50 percent, by volume. The gravel does not materially affect tillage but increases wear on tillage implements.

The major limitations to the use of this soil for crops are an erosion hazard and moderately rapid surface runoff. In some years soil moisture is insufficient for optimum plant growth during dry summer months.

This soil is used for pasture, crops, and woods. Crops grown include corn, potatoes, small grains, and hay. (Capability unit IIIe–6 (3a) ; woodland suitability group A)

McBride loamy sand, 2 to 6 percent slopes (MIB).—This soil is undulating and gently sloping and is near other McBride soils and Montcalm soils that are in rolling and hilly areas. The surface layer is very dark grayish-brown loamy sand in most areas but is brown in a few areas. Moderately eroded areas have a lighter colored and less friable surface layer than uneroded areas. Texture of the subsurface layer, upper subsoil, and fragipan layers also is loamy sand. Slopes range outside the specified limits in a few areas.

This soil warms early in spring but is somewhat droughty during prolonged dry periods. Wind and water erosion are moderate hazards if this soil is used for crops.

Most areas of this soil are in crops and pasture. About one-fourth of the acreage is in forest. (Capability unit IIe–3 (3a) ; woodland suitability group A)

McBride loamy sand, 6 to 12 percent slopes (MIC).—This soil is sloping; it is near other McBride soils and near Montcalm soils that are strongly sloping.

The surface layer is very dark grayish-brown loamy sand. Color of the surface soil is brown in a few areas. Texture of the subsurface layer, upper subsoil, and fragipan also is loamy sand. In some areas the sandy clay loam lower subsoil is less than 10 inches thick. Slopes range outside the specified limits in some areas. Included in mapping this soil were small areas of Montcalm soils.

This soil warms early in spring but is somewhat droughty during prolonged dry periods. A moderately severe erosion hazard and a slight droughtiness during prolonged dry spells are the major limitations to the use of this soil for crops.

Most areas of this soil are in crops and pasture. Second-growth hardwoods cover the remaining areas. (Capability unit IIIe–6 (3a) ; woodland suitability group A)

McBride loamy sand, 6 to 12 percent slopes, moderately eroded (MIC2).—This soil is sloping and is near strongly sloping McBride soils and near Montcalm soils that are strongly sloping.

The surface layer is pale-brown loamy sand. Texture of the subsurface layer, the upper subsoil, and the fragipan also is loamy sand. The loamy sand layers of the profile are 10 to 20 inches thick. Erosion and tillage have removed some of the original surface layer and mixed the remaining part with the upper subsoil. The present surface layer in eroded areas is lighter colored, is lower in fertility and organic-matter content, and is more gravelly than the surface layer in uneroded areas. Slopes range outside the specified limits in some areas.

Areas of Montcalm loamy sand, 6 to 12 percent slopes, moderately eroded, are intricately distributed throughout areas of this soil and occupy up to 20 percent of the acreage.

This McBride soil warms early in spring but is somewhat droughty during prolonged dry periods. The erosion hazard is moderate. Surface runoff is moderately rapid if the soil is farmed intensively, and the soil becomes more droughty as a result.

This soil is used for crops and pasture. (Capability unit IIIe–6 (3a) ; woodland suitability group A)

McBride loamy sand, 12 to 18 percent slopes (MID).—This soil is moderately steep and is near other McBride soils and Montcalm soils that are sloping to steep. The surface soil is very dark grayish-brown loamy sand in most areas, but it is brown, pale brown, or very dark gray in a few areas. The texture of the subsurface layer, upper subsoil, and fragipan also is loamy sand. Slopes range outside the specified limits in some areas.

Areas of Montcalm loamy sand, 12 to 18 percent slopes, are intricately distributed throughout areas of this soil and occupy up to 20 percent of the acreage.

This McBride soil warms early in spring but is somewhat droughty during prolonged dry periods. Surface runoff is rapid in cultivated areas, and erosion is a serious hazard. Slopes are complex and short in many areas.

Most areas of this soil are used for crops and pasture. The rest is in hardwoods. (Capability unit IVe–4 (3a) ; woodland suitability group A)

McBride loamy sand, 12 to 18 percent slopes, moderately eroded (MID2).—This soil is moderately steep and is near other McBride soils and Montcalm soils that are sloping to steep. The surface layer is pale-brown loamy sand in most areas but is very dark brown and brown in a few areas. Texture of the upper subsoil and fragipan layer also is loamy sand. Erosion and tillage have removed some of the original surface layer and mixed the rest with the upper subsoil. As a result, natural fertility and content of organic matter have been lowered. Slopes range outside the specified limits in some areas.

Areas of Montcalm loamy sand, 12 to 18 percent slopes, moderately eroded, are intricately distributed throughout areas of this soil and occupy up to 20 percent of the acreage. These Montcalm soils are coarser textured and more droughty than the McBride soils.

Surface runoff is rapid in cultivated areas, and the erosion hazard is serious. This soil tends to be droughty during dry summer months. Slopes are complex and short in many areas.

Most areas of this soil are in crops and pasture. (Capability unit IVe–4 (3a) ; woodland suitability group A)

McBride loamy sand, 18 to 25 percent slopes (MIE).—This soil is steep and is adjacent to drainageways and deep pits in rolling and hilly areas near other McBride soils and near Montcalm soils. The surface layer is very dark grayish brown in most areas but ranges to brown and pale brown in some areas. It is very dark gray in wooded areas. The texture of the surface layer, subsurface layer, upper subsoil, and fragipan is loamy sand. Slopes range outside the specified limits over short distances.

Use of this soil for row crops and small grains is severely limited by steep slopes and an erosion hazard. The soil is droughty in summer. Steep slopes hinder use of farm machinery.

Most areas of this soil are in woods, but a few areas are in pasture. (Capability unit VIe–2 (3a) ; woodland suitability group A)

McBride sandy loam, 0 to 2 percent slopes (MmA).—This soil is nearly level to gently undulating and is on upland areas. The surface soil is very dark grayish brown in most areas but is brown, pale brown, and very dark gray in some areas. Runoff is slow, and water erosion is seldom a hazard. This soil is slightly droughty during dry summer months.

About half of the acreage of this soil is in crops. The rest is in pasture or woods. Major crops are corn, small grains, hay, and potatoes. (Capability unit IIe–3 (3a); woodland suitability group A)

McBride sandy loam, 2 to 6 percent slopes (MmB).—This soil is undulating and gently sloping. It is near the Nester, Isabella, and Montcalm soils and near other McBride soils. The surface soil is very dark grayish brown in most areas but is brown, pale brown, or very dark gray in some areas. In moderately eroded areas the surface layer is lighter colored and less friable than in uneroded areas. Slopes range outside specified limits over short distances.

Water erosion is not so serious a hazard as it is on more steeply sloping soils. Available moisture capacity is slightly better than that of the McBride loamy sands.

Most areas of this soil are used for crops and pasture. The rest are in woods. Principal crops are corn, small grains, and hay. (Capability unit IIe–3 (3a); woodland suitability group A)

McBride sandy loam, 2 to 6 percent slopes, moderately eroded (MmB2).—This soil is undulating and gently sloping. It is near the Nester or Isabella soils and also is near the Montcalm soils and other McBride soils.

Erosion and tillage have removed part of the original surface layer and have mixed the remaining part with the upper subsoil. The present surface soil is pale brown in most areas but is brown and very dark grayish brown in a few areas. Natural fertility and organic-matter content are lower than in uneroded soils. Slopes range outside the specified limits over short distances.

An erosion hazard and droughtiness are slight limitations to the use of this soil for crops. The soil warms quickly in spring.

Most areas of this soil are in crops and pasture. Principal crops are corn, small grains, and hay. (Capability unit IIe–3 (3a); woodland suitability group A)

McBride sandy loam, 6 to 12 percent slopes (MmC).—This soil is in sloping areas near rolling and hilly areas of Isabella and Montcalm soils and other McBride soils. The surface soil is very dark grayish brown in most areas, but in small spots and in other areas it is brown or pale brown. In some areas the surface texture is fine sandy loam instead of sandy loam. Small moderately eroded spots are common in areas of the steeper soils. In these eroded spots the surface layer is lighter colored and fertility and the content of organic matter are lower than in uneroded areas. Slope ranges outside the specified limits over short distances.

Areas of Montcalm sandy loam and loamy sand, 6 to 12 percent slopes, are intricately distributed throughout areas of this soil and occupy up to 20 percent of the acreage.

This soil warms quickly in spring and is ready for planting before the finer textured and less sloping soils. Runoff is medium, and erosion is a hazard to the use of this soil for crops. This soil also is slightly droughty during dry summer months.

This soil is used for crops, pasture, and woods. The principal crops are corn, small grains, and hay. (Capability unit IIIe–6 (3a); woodland suitability group A)

McBride sandy loam, 6 to 12 percent slopes, moderately eroded (MmC2).—This soil is sloping and is near rolling and hilly areas of the Isabella and Montcalm soils and near other McBride soils.

Erosion and tillage have removed part of the surface layer and have mixed the remaining part with the upper part of the subsoil. The present surface soil is pale brown in most areas, but it is brown or very dark grayish brown in a few areas. Fertility and organic-matter content are lower than in uneroded areas, and the surface crusts more readily than in uneroded areas. Slopes range outside the specified limits over short distances.

Areas of Montcalm sandy loam and loamy sand, 6 to 12 percent slopes, moderately eroded, are intricately distributed throughout areas of this soil and occupy up to 20 percent of the acreage. The Montcalm soils are coarser textured and slightly more droughty than McBride soils and have similar limitations if used for crops.

Available moisture capacity is moderately high, and natural fertility is moderate. Both are slightly higher than for McBride loamy sand, 6 to 12 percent slopes. Surface runoff is moderately rapid in areas that are cropped intensively, and such areas are droughty during dry periods. Erosion is a serious hazard when this soil is in crops.

This soil is used for crops and pasture. The principal crops are small grains and hay. (Capability unit IIIe–6 (3a); woodland suitability group A)

McBride sandy loam, 12 to 18 percent slopes (MmD).—This soil is moderately steep and is near hilly and rolling Montcalm and Isabella soils and other McBride soils. The surface layer is very dark grayish brown in most areas but is pale brown or grayish brown in a few areas. Surface texture is fine sandy loam instead of sandy loam in some areas. Stones are on the surface in a few areas and hinder tillage. Slopes range outside the specified limits over short distances.

Areas of a Montcalm sandy loam and a Montcalm loamy sand that have slopes of 12 to 18 percent are intricately distributed throughout areas of this soil and occupy up to 20 percent of the acreage.

Available moisture capacity of this soil is moderately high, and natural fertility is moderate. Both are slightly higher than for McBride loamy sand, 12 to 18 percent slopes. Surface runoff is rapid in areas that are cropped, and erosion is a serious hazard. Steepness limits the use of this soil for crops. In many areas slopes are complex and short. This soil often is droughty during summer.

Most areas of this soil are used for woods or pasture, but some are in crops. The principal crops are small grains and hay. (Capability unit IVe–4 (3a); woodland suitability group A)

McBride sandy loam, 12 to 18 percent slopes, moderately eroded (MmD2).—This moderately steep soil is near rolling and hilly areas of Isabella and Montcalm soils and near other McBride soils.

Erosion and tillage have removed part of the surface layer and mixed the remaining part with the upper subsoil. The present surface soil is pale brown in most areas but is very dark grayish brown in a few areas. Because of moderate erosion, natural fertility and organic-matter content are lower than in uneroded areas and the soil is

less suited to use for crops. Slopes range outside the specified limits over short distances.

Areas of a moderately eroded Montcalm sandy loam and a moderately eroded loamy sand that have slopes of 12 to 18 percent are intricately distributed throughout this mapping unit and occupy up to 15 percent of the acreage. The Montcalm soils are coarser textured and more droughty than McBride soils but have similar limitations for crop use.

Surface runoff is rapid in cultivated areas, and erosion is a serious hazard in such areas. This soil often is droughty during dry summer months. Steep slopes also limit its use for crops. Slopes are complex and short in many areas.

This soil is used for crops and pasture. The principal crops are small grains and hay. (Capability unit IVe–4 (3a); woodland suitability group A)

McBride sandy loam, 12 to 18 percent slopes, severely eroded (MmD3).—This soil is moderately steep and is near rolling to hilly areas of Montcalm and Isabella soils and near other McBride soils.

Erosion and tillage have removed most of the original surface layer and mixed the remaining part with the upper part of the subsoil. In a few areas the color of the surface layer is pale brown or very dark grayish brown. The sandy clay loam of the lower subsoil is exposed in some areas. There are occasional shallow gullies in some areas, but they can be crossed by farm machinery. Erosion has severely damaged this soil and reduced its natural fertility and content of organic matter. The present surface layer crusts readily. Slopes range outside the specified limits over short distances.

A severe erosion hazard, rapid surface runoff, low fertility, and poor tilth are the major limitations to use of this soil for crops. This soil is droughty during dry summer months.

This soil has been used for crops and pasture in the past. At present, only a few areas are in small grains and hay, and most areas are idle. (Capability unit IVe–4 (3a); woodland suitability group A)

McBride sandy loam, 18 to 25 percent slopes (MmE).—This steep soil is near Montcalm and Isabella soils and near other McBride soils. The surface layer is very dark grayish brown in most areas and is brown or pale brown in a few areas. Texture of the solum, to a depth of about 20 inches, is fine sandy loam in some areas. Slopes range outside the specified limits over short distances.

Areas of a moderately eroded Montcalm sandy loam and a moderately eroded loamy sand that have slopes of 18 to 25 percent are intricately distributed throughout areas of this soil and occupy up to 20 percent of the acreage. Montcalm soils are slightly more droughty and coarser textured than McBride soils. They have limitations for crop use similar to those of McBride soils.

This soil is severely limited for crop use by steep slopes and an erosion hazard. It often is droughty during dry summer months. Steep slopes hinder use of farm machinery.

This soil is used for woods and pasture. A few areas are in small grains and hay. (Capability unit VIe–2 (3a); woodland suitability group A)

McBride sandy loam, 18 to 25 percent slopes, moderately eroded (MmE2).—This soil is steep and is near areas of Montcalm, Isabella, and other McBride soils.

Erosion and tillage have removed part of the surface layer and mixed the remaining part with the upper part of the subsoil. The color of the present surface layer is pale brown or brown in most areas but is very dark grayish brown in a few areas. Texture of the solum, to a depth of about 20 inches, is fine sandy loam in some areas rather than sandy loam. Erosion has reduced the content of organic matter and the natural fertility of this soil. The present surface layer crusts readily. Slopes range outside the specified limits over short distances.

Areas of a moderately eroded Montcalm sandy loam and a moderately eroded loamy sand that have slopes of 18 to 25 percent are intricately distributed throughout areas of this soil and occupy up to 10 percent of the acreage. Montcalm soils are coarser textured and slightly more droughty than McBride soils but are similar in their limitations for use.

Steep slopes and a severe erosion hazard are the major limitations to the use of this soil for crops. The soil is droughty during dry summer months. Steep slopes hinder use of farm machinery.

A few areas of this soil and adjacent areas are used for crops and pasture. Principal crops are small grains and hay. (Capability unit VIe–2 (3a); woodland suitability group A)

McBride sandy loam, 18 to 25 percent slopes, severely eroded (MmE3).—This soil is steep and is near areas of Montcalm and Isabella soils and near other McBride soils. Erosion and tillage have removed most of the original surface layer and mixed the remaining part with the subsoil. The present surface layer is brown in most areas but is pale brown or very dark grayish brown in some places. The sandy clay loam lower subsoil is exposed in some areas, and there are occasional shallow gullies that can be crossed by farm machinery. Erosion has severely damaged this soil and reduced its natural fertility and organic-matter content. The present surface layer crusts readily, and runoff is rapid. Slopes range outside the specified limits over short distances.

Steep slopes and an erosion hazard severely limit the use of this soil for crops. The soil is droughty during dry summer months. Steep slopes hinder use of farm machinery.

This soil has been used for crops and pasture in the past, but most areas now are idle or are in low-grade pasture. (Capability unit VIIe–2 (3a); woodland suitability group A)

McBride stony sandy loam, 2 to 6 percent slopes (MnB).—This soil is undulating and gently sloping and is near Montcalm and Isabella soils and near other McBride soils.

The surface layer is sandy loam. Large rounded stones, 1 to 4 feet in diameter, lie 30 to 100 feet apart on the surface in most places. Stones are present throughout the profile in most areas. Unless stones are removed from the surface layer, it is extremely difficult to work this soil with ordinary farm machinery.

Most areas of this soil are in pasture or remain in hardwoods. (Capability unit VIIs–1 (3a); woodland suitability group A)

McBride stony sandy loam, 6 to 12 percent slopes (MnC).—This soil is sloping and is near areas of Montcalm and Isabella soils and near other McBride soils.

The surface layer is sandy loam. Large rounded stones, 1 to 4 feet in diameter, lie 30 to 100 feet apart on the sur-

face in most places. The stones are present throughout the soil profile in most areas. Unless the stones are removed from the surface layer, it is extremely difficult to work this soil with ordinary farm machinery.

Most areas of this soil are in pasture or remain in hardwoods. (Capability unit VIIs–1 (3a) ; woodland suitability group A)

McBride soils, 25 to 45 percent slopes (MoF).—These soils are very steep and are near areas of Montcalm and Isabella soils and near other McBride soils. The surface layer is very dark grayish-brown loamy sand and sandy loam in most areas, but it is brown or pale brown in some areas. Texture of the surface layer and subsoil, to a depth of 20 inches, is fine sandy loam in some areas. Slopes range outside the specified limits over short distances. An intricate distribution of a Montcalm sandy loam and a Montcalm loamy sand that have slopes of 25 to 45 percent is included in mapping, and these soils occupy as much as 20 percent of some areas of this soil.

Steep slopes and a severe erosion hazard limit use of this McBride soil for crops. It is droughty during dry summer months.

This soil is used for woods and pasture. (Capability unit VIIe–2 (3a) ; woodland suitability group A)

Menominee Series

The soils of this series are well drained and moderately well drained and are on till and outwash plains and moraines. The soils are gently sloping or sloping in most areas but are level or moderately steep to steep in other areas. They formed in sand or loamy sand that overlies loam, clay loam, or silty clay loam.

The surface layer is very dark grayish-brown loamy sand about 9 inches thick. It has very weak granular structure and is very friable.

The upper part of the subsoil is dark-brown or yellowish-brown sand about 26 inches thick. It has very weak, blocky or single grain structure and is very friable or loose. The lower part of the subsoil is dark-brown clay loam about 10 inches thick. It has strong blocky structure and is firm.

Brown clay loam underlies the subsoil at a depth of about 45 inches. It has weak blocky structure, is firm, and is high in lime content.

Available moisture capacity and natural fertility of these soils are moderately low. Water moves rapidly through the sandy part of the soil profile but only moderately slowly through the underlying loamy material. Surface runoff varies with steepness of slope and the kind of vegetation, and it ranges from slow in gently sloping areas to rapid in steep areas. Moisture content of these soils is rarely adequate for crop needs, especially in the steeply sloping areas. The underlying finer textured layers of these soils hold a significant amount of moisture, which keeps the sandy overlying material moist. The soils are less droughty as a result. A water erosion hazard is the major limitation to the use of these soils for crops. Droughtiness and moderately low fertility also limit their use.

Many areas of the nearly level to sloping soils have been cleared of trees and are planted to crops. Principal crops are corn, small grains, hay, and potatoes. Sloping to steep areas remain in woods or are in pasture. Native vegetation consisted of mixed hardwoods and conifers.

Typical profile of Menominee loamy sand:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) loamy sand; very weak, medium, granular structure; very friable; medium acid; abrupt, smooth boundary.

B2ir—9 to 18 inches, dark-brown (7.5YR 4/4) sand; very weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B3—18 to 32 inches, yellowish-brown (10YR 5/4) sand; single grain; loose; medium acid; clear, wavy boundary.

A'2—32 to 35 inches, pale-brown (10YR 6/3) loamy sand; weak, medium, subangular blocky structure; very friable; medium acid; abrupt, irregular boundary.

IIB'—35 to 45 inches, dark-brown (7.5YR 4/4) clay loam; thin coatings of material from the A'2 horizon on ped faces and in cracks in upper 2 to 4 inches; strong, medium, angular blocky structure; firm; slightly acid; abrupt, wavy boundary.

IIC—45 to 60 inches, brown (7.5YR 5/4) clay loam; weak, medium, angular blocky structure; firm; calcareous.

The surface layer is very dark gray or is dark grayish brown in some areas and is 6 to 10 inches thick. In undisturbed areas there is a surface layer of very dark gray loamy sand 1 to 3 inches thick and a subsurface layer of light brownish-gray sand. Weakly cemented sand is present in the upper part of the subsoil in a few areas. Thickness of the sandy part of the horizon ranges from 18 to 42 inches.

Texture of the lower part of the subsoil and of the underlying material ranges from clay loam to loam or silty clay loam. Reaction of the sandy material ranges from slightly acid to strongly acid. Reaction in the lower part of the subsoil ranges from slightly acid to medium acid.

Menominee soils have coarser textured upper subsoil layers than Ubly soils and have coarser textured underlying material than Manistee soils. The Menominee and Iosco soils formed in similar material, but the Menominee soils are better drained.

Menominee loamy sand, 0 to 2 percent slopes (MpA).—This soil is nearly level and is near deep, sandy soils that are in higher positions and clay loam soils that are in lower positions. The texture of the surface layer is sand in some areas. Thickness of the sandy part of the horizon varies greatly over short distances and is less than 18 inches in some places and more than 42 inches in others. This soil is easy to till but is subject to a wind-erosion hazard. Surface runoff is slow, and water erosion is seldom a problem. The soil is slightly droughty during dry summer periods.

Most areas of this soil are in crops, but some are in pasture and forest. The principal crops are corn, small grains, hay, and potatoes. (Capability unit IIIs–3 (4/2a) ; woodland suitability group C)

Menominee loamy sand, 2 to 6 percent slopes (MpB).—This soil is gently sloping or undulating and is near deep, sandy soils that are in higher positions and near clay loam soils that are in lower positions. The surface soil is very dark grayish brown in most areas but is very dark gray in wooded areas. It is brown or dark brown in a few eroded areas that were included in mapping. Texture of the surface layer is sand in a few areas. Thickness of the sandy part of the horizon varies greatly over short distances and is less than 18 inches in some places and more than 42 inches in others. Rubicon soils, loamy substratum, and Nester soils were included in mapping many areas of this soil.

Runoff is slow, but this soil is easily worked throughout a wide range of moisture content. It is subject to wind erosion and is droughty.

Most areas of this soil are used for crops, but some are in pasture or forest. The principal crops are corn, small

grains, hay, and potatoes. (Capability unit IIIs–4 (4/2a); woodland suitability group C)

Menominee loamy sand, 6 to 12 percent slopes (MpC).—This soil is sloping and is near deep, sandy soils that are in higher positions and clay loam soils that are in lower positions. The surface layer is very dark grayish-brown loamy sand in most areas but is sand in some areas. Thickness of the sandy part of the horizon varies over short distances and ranges from less than 18 inches to more than 42 inches. Nester soils, Rubicon soils, loamy substratum, and other Rubicon soils are common in many areas and were included in mapping this soil.

This soil is easy to till but erodes readily if it is farmed intensively. Surface runoff is rapid, and the soil becomes droughty in summer if crops are planted up and down the slope. Wind erosion is a hazard if large areas are exposed by cultivation.

Most areas of this soil are used for crops. Some areas are in pasture or woods. Corn, small grains, and hay are the principal crops. (Capability unit IIIe–9 (4/2a); woodland suitability group C)

Menominee loamy sand, 6 to 12 percent slopes, moderately eroded (MpC2).—This soil is sloping and is near areas of Nester soils and Isabella soils. Erosion and tillage have removed part of the surface layer and mixed the remaining part with the subsoil. The present surface layer is brown in most areas, but in some areas it is very dark grayish brown. Thickness of the sandy part of the soil varies within short distances but is generally between 18 and 36 inches. Erosion has reduced the content of organic matter and the fertility of this soil and has also reduced its available moisture capacity. Nester soils, Rubicon soils, loamy substratum, and other Rubicon soils were included in mapping most areas of this soil. Spots of clay loam are common.

This soil is easy to till but erodes readily if it is farmed intensively. Surface runoff is rapid in areas planted to crops, and soil moisture is reduced.

Most areas of this soil are in crops. Corn, small grains, and hay are the principal crops. A few areas are idle. (Capability unit IIIe–9 (4/2a); woodland suitability group C)

Menominee loamy sand, 12 to 18 percent slopes (MpD).—This soil is moderately steep and is near areas of deep, sandy soils that are in higher positions and clay loam soils that are in lower positions. The surface layer is very dark grayish brown in most areas but is brown or pale brown in some. Texture of the surface layer is sand in a few places. Thickness of the sandy part of the solum varies within short distances and ranges from less than 18 inches to more than 42 inches. Nester soils, Rubicon soils, loamy substratum, and other Rubicon soils were included in mapping most areas of this soil.

Runoff is rapid, and erosion, including gullying, is a severe hazard in areas planted to crops or in overgrazed pasture. Soil moisture sometimes is inadequate for crops during dry summer months, especially in areas where runoff is uncontrolled.

Most areas of this soil are used for pasture or forest. A few areas are in small grains and hay. Some areas are idle. (Capability unit IVe–9 (4/2a); woodland suitability group C)

Menominee loamy sand, 12 to 18 percent slopes, moderately eroded (MpD2).—This soil is moderately steep and is near areas of Nester soils and Isabella soils. Erosion and tillage have removed part of the surface layer and mixed the remaining part with the subsoil. The present surface layer is brown in most places, but in some areas it is very dark grayish brown. Erosion has reduced the content of organic matter in the soil, its natural fertility, and its ability to store moisture. Thickness of the sandy part of the soil profile generally is between 18 and 30 inches, but it is variable over short distances. Nester soils and Rubicon soils were common inclusions in mapping most areas of this soil.

Surface runoff is rapid, and erosion, including gullying, is a severe hazard in areas planted to crops or areas that are overgrazed. Soil moisture is sometimes inadequate for crops during dry summer months, especially if runoff is uncontrolled.

Most areas of this soil are in small grains and hay. Some areas are idle. (Capability unit IVe–9 (4/2a); woodland suitability group C)

Menominee loamy sand, 18 to 25 percent slopes (MpE).—This soil is steep and is near areas of deep, sandy soils that are in high positions and near clay loam soils that are in lower positions. In some places this soil is on side slopes of knolls that consist of shallow sands over clay loam till. The surface layer is very dark grayish brown in most areas but is very dark gray in wooded areas and is brown in small eroded areas. Thickness of the sandy part of the soil profile varies over short distances and ranges from less than 18 inches to more than 42 inches. Slopes exceed 25 percent in a few areas. Nester soils, Rubicon soils, and Rubicon soils, loamy substratum, were included in mapping most areas of this soil.

Runoff is rapid in cropped areas, and erosion, including gullying, is a serious hazard. Use of this soil for crops also is severely limited by steep slopes and droughtiness.

Most areas of this soil are forested. A small acreage is in pasture or crops. The principal crops are small grains and hay. (Capability unit VIe–2 (4/2a); woodland suitability group C)

Montcalm Series

Soils of this series are well drained and moderately well drained and sandy and are on till and outwash plains and moraines. These soils formed in loamy sand and sand material deposited by glaciers. Slopes range from nearly level to very steep. Stones and gravel are at the surface in many areas.

The surface layer is dark grayish-brown loamy sand about 7 inches thick. It has very weak granular structure and is very friable. The subsurface layer is light-gray loamy sand about 2 inches thick. It has very weak granular structure and is very friable.

The upper part of the subsoil is brown loamy sand about 17 inches thick. It has very weak blocky structure and is very friable. The lower part of the subsoil extends to a depth of about 60 inches and consists of alternate layers of loamy sand or sand and sandy loam. The loamy sand and sand layers are light brownish gray, have very weak platy structure or are single grain, and are very friable or loose. The sandy loam layers are reddish brown, have weak blocky structure, and are friable. Thickness of the sandy layers ranges from ¼ inch to 12 inches. Thickness of the sandy loam layers ranges from ½ inch to 4 inches.

Figure 5.—**Poor pasture on steep Montcalm soils; new tree planting on far hill.**

The material underlying the subsoil is pale-brown loamy sand and is single grain, loose, and high in lime content.

Available moisture capacity and natural fertility of these soils are moderately low. Permeability is moderately rapid, and surface runoff ranges from slow in nearly level areas to rapid in steep areas. Normally, the soils are saturated at the start of the growing season but lack adequate moisture for crops during dry periods. Yields are reduced during extreme drought. Droughtiness and an erosion hazard are major limitations to the use of these soils for crops.

Most level to sloping areas have been cleared of trees and planted to corn, small grains, hay, or potatoes. Sloping to steep areas are in trees or pasture (fig. 5). Native vegetation was oak, hickory, other hardwoods, and white pine.

Typical profile of Montcalm loamy sand:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2), loamy sand; very weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

A2—7 to 9 inches, light-gray (10YR 7/2) loamy sand; very weak, fine, granular structure; very friable; medium acid; clear, smooth boundary.

Bhir—9 to 26 inches, brown (7.5YR 4/4) loamy sand; very weak, fine, subangular blocky structure; very friable; medium acid; clear, wavy boundary.

A'2—26 to 32 inches, light brownish-gray (10YR 6/2) loamy sand; very weak, thin, platy structure; very friable; medium acid; clear, wavy boundary.

B't—32 to 36 inches, reddish-brown (5YR 4/4) sandy loam; weak, medium, subangular blocky structure; friable; medium acid; abrupt, wavy boundary.

A'2&B't—36 to 60 inches, light brownish-gray (10YR 6/2) sand (A'2 horizon); thin bands, layers, and lenses of reddish-brown (5YR 4/4) heavy loamy sand ½ inch to 4 inches thick (B't horizon); the A'2 part is single grain and loose; the B't is massive and friable; medium acid; clear, wavy boundary.

C—60 inches +, pale-brown (10YR 6/3) loamy sand; single grain; loose; calcareous.

In undisturbed areas there is leaf litter ½ inch to 1 inch thick on the surface. The surface layer ranges from loamy sand to sandy loam. In some cultivated areas the subsurface layer is absent. The layers of sandy loam often are not continuous and vary greatly in thickness. Depth to the loamy sand layer that contains a large amount of lime ranges from 48 to about 70 inches. In some areas this material is loamy sand and sand stratified with 1- to 3-inch layers of loam. Reaction of the surface layer and subsoil ranges from medium acid to slightly acid. Reaction of the lowest layer ranges from slightly acid to very strongly alkaline.

Montcalm soils have coarser textured subsoil layers than McBride soils and have finer textured subsoil layers than either the Chelsea or the Rubicon soils.

Montcalm gravelly loamy sand, 0 to 6 percent slopes (MrB).—This soil is nearly level and is near natural drainageways and near Montcalm and Chelsea soils. The surface layer is dark grayish-brown gravelly loamy sand. Wooded areas have a very dark gray, thin surface layer. In some areas there is a gravelly sandy loam surface layer. Content of gravel ranges from 15 to 50 percent, by volume. The gravel does not materially affect soil productivity but increases wear on tillage implements. The layers below the surface layer also contain some gravel in some places. Some of the deep gravelly spots have been mined for commercial purposes.

Runoff is slow, and water erosion seldom is a hazard. This soil is easily cultivated over a wide range of moisture content, but excessive tillage increases the hazard of wind erosion. Soil moisture is inadequate for crops during dry

periods, and yields are severely reduced during extreme drought.

Most areas of this soil are used for crops, pasture, and woods. Crops include corn, small grains, potatoes, and hay. (Capability unit IIIs–4 (4a); woodland suitability group C)

Montcalm gravelly loamy sand, 6 to 12 percent slopes (MrC).—This soil is sloping, is near natural drainageways, and also is near other Montcalm and Chelsea soils.

The surface layer is dark grayish brown; it is gravelly loamy sand in most areas but gravelly sandy loam in some areas. Content of gravel ranges from 15 to 50 percent, by volume. The gravel does not materially affect productivity but does increase wear on tillage implements. The layers below the surface layer also contain gravel in some places. In some areas gravel has been removed for commercial purposes.

Use of the soil for crops is limited mainly by an erosion hazard, moderately low fertility, moderately low available soil moisture, and a gravelly surface layer. Tillage of this soil is easy, but surface runoff is moderately rapid in cultivated areas.

Most areas of this soil are in crops, pasture, and trees. Crops include corn, small grains, potatoes, and hay. Shallow-rooted crops lack sufficient soil moisture during dry summer months. (Capability unit IIIe–9 (4a); woodland suitability group C)

Montcalm gravelly loamy sand, 12 to 18 percent slopes (MrD).—This soil is moderately steep and is adjacent to natural drainageways and to other Montcalm soils and Chelsea soils. The surface layer is dark grayish-brown gravelly loamy sand. In some places the layers below the surface layer contain gravel that ranges from 15 to 50 percent, by volume. The gravel does not materially affect soil productivity but increases wear on tillage implements. In some areas gravel has been removed for road surfacing material. Included in the mapping of this soil were small areas having a brown surface soil. Slopes range outside the specified limits in some areas.

Use of the soil for crops is severely limited by an erosion hazard and insufficient soil moisture during summer months. Runoff is rapid in cultivated areas.

Most areas of this soil have been cultivated in the past but are now in pasture or are idle. (Capability unit IVe–9 (4a); woodland suitability group C)

Montcalm gravelly loamy sand, 18 to 25 percent slopes (MrE).—This soil is steep, is near natural drainageways, and is near other Montcalm soils and near Chelsea soils. The surface layer generally is brown gravelly loamy sand, but in some areas the color is very dark grayish brown. Content of gravel ranges from 15 to 50 percent, by volume. The gravel increases wear on tillage implements. Erosion and tillage have removed part of the surface layer and mixed surface and subsoil layers in some areas. The upper subsoil now dominates the present surface layer in some areas. Some of the deep gravel spots are mined for road-surfacing material.

Use of this soil for crops is severely limited by steep slopes, rapid surface runoff, a severe erosion hazard, moderate available moisture capacity, and moderate fertility.

This soil was formerly cultivated but now is used chiefly for pasture or is idle. (Capability unit VIe–2 (4a); woodland suitability group C)

Montcalm loamy sand, 0 to 6 percent slopes (MsB).—This soil is nearly level and is near areas of undulating to sloping Montcalm soils and near McBride and Chelsea soils. The surface layer is dark grayish brown and is predominantly loamy sand. In some areas it is sand. In some areas the surface soil is brown. The underlying layers are predominantly loamy sand. Small areas of McBride and Chelsea soils were included in mapping many areas of this soil.

Surface runoff is slow, and water erosion seldom is a problem. The soil is easily cultivated over a wide range of moisture content, but excessive tillage increases the hazard of wind erosion. Soil moisture is insufficient for crop needs in dry periods, and crop yields are severely reduced during periods of extreme drought.

Most areas of this soil have been cultivated in the past. A considerable acreage of this soil now is planted to corn, small grains, potatoes, and hay. Some areas are in pasture or forest. (Capability unit IIIs–4 (4a); woodland suitability group C)

Montcalm loamy sand, 6 to 12 percent slopes (MsC).—This soil is sloping and is near areas of other Montcalm soils and areas of McBride and Chelsea soils. The surface layer is dark grayish brown. It is predominantly loamy sand but ranges to sand or gravelly loamy sand in some areas. The surface soil is brown in some areas. The underlying layers are predominantly loamy sand. Small areas of McBride and Chelsea soils were included in mapping most areas of this soil.

Use of the soil for crops is limited mainly by an erosion hazard, moderately low fertility, and moderately low available moisture. This soil is easy to till, but surface runoff is moderately rapid in cultivated areas. Shallow-rooted crops are damaged by lack of moisture in dry summer months.

Most areas of this soil have been cultivated in the past. A considerable acreage now is planted to corn, small grains, potatoes, and hay. A smaller acreage is in permanent pasture or trees. (Capability unit IIIe–9 (4a); woodland suitability group C)

Montcalm loamy sand, 6 to 12 percent slopes, moderately eroded (MsC2).—This sloping soil is near areas of other Montcalm soils and near McBride, Chelsea, and Isabella soils. Erosion and tillage have removed part of the original surface layer and mixed the rest with the upper subsoil. Material from the upper subsoil is dominant in the present surface layer and makes it brown. Small areas of the surface layer are very dark gray. Erosion also has reduced the level of fertility and organic matter and the available moisture capacity of this soil. Small areas of McBride, Chelsea, and Isabella soils were included in mapping most areas of this soil. Slopes range outside the specified limits in a few areas.

Use of this soil for crops is limited by moderately low available moisture capacity, moderately low fertility, an erosion hazard, and loss of available moisture through surface runoff.

All of this soil has been cultivated in the past. The principal crops grown now are corn, potatoes, and alfalfa-brome mixtures. Areas not cultivated are in pasture or are idle and growing weeds and trees. (Capability unit IIIe–9 (4a); woodland suitability group C)

Montcalm loamy sand, 6 to 12 percent slopes, severely eroded (MsC3).—This soil is sloping and is adjacent to areas of other Montcalm soils and areas of McBride, Chelsea, and Isabella soils. Water and wind erosion and tillage have removed most of the upper part of the soil and mixed the rest with the upper subsoil layers. Material from the subsoil is dominant in the present surface layer, and because of this, the color of the surface layer is pale brown. Erosion has seriously damaged this soil by reducing the level of fertility and organic-matter content. Small depressions have been blown out by wind, and all of the surface layer and subsoil in those areas has been carried away. In many areas the combined thickness of the surface layer and subsoil is less than half that of the original surface layer. A few shallow gullies are present in some areas. Small areas of McBride, Chelsea, and Isabella soils were included in mapping most areas of this soil.

Severe erosion damage, moderately low available moisture capacity, and moderately low natural fertility are the main limitations to the use of this soil for crops.

All of this soil has been cultivated in the past. At present only a small acreage is in small grains and hay. Most areas are in low-grade pasture or are idle. (Capability unit IIIe–9 (4a) ; woodland suitability group C)

Montcalm loamy sand, 12 to 18 percent slopes (MsD).—This soil is moderately steep and is near areas of other Montcalm soils and areas of McBride and Chelsea soils. The surface layer is dark grayish brown and is predominantly loamy sand but ranges to sand in some areas. The surface soil is brown in some areas. The underlying layer is predominantly loamy sand. Small areas of McBride, Chelsea, and Isabella soils were included in mapping most areas of this soil.

Surface runoff is rapid in cultivated areas, and erosion is a serious hazard. Soil moisture is inadequate for crops during dry summer months. Wind erosion also is a hazard when large areas are exposed by tillage.

Most areas of this soil have been cultivated in the past, but only a small acreage is now used for hay and small grains. Most areas are in pasture or are idle. A small acreage is in forest. (Capability unit IVe–9 (4a) ; woodland suitability group C)

Montcalm loamy sand, 12 to 18 percent slopes, moderately eroded (MsD2).—This soil is moderately steep and is near areas of other Montcalm soils and near McBride, Chelsea, and Isabella soils. It lies adjacent to drainageways in a few areas. Erosion and tillage have removed part of the original surface layer and mixed the rest with the upper part of the subsoil. Material from the subsoil is now dominant in most areas of the present surface layer. As a result, the color of this layer is generally brown, but small areas of the surface layer are very dark grayish brown. Because of erosion the present surface layer is lighter colored, is lower in fertility and organic-matter content, and absorbs less water than the original surface layer. Small areas of McBride, Isabella, and Chelsea soils were included in mapping most areas of this soil.

Surface runoff is rapid in cultivated areas, and water erosion is a serious hazard. Wind erosion also is a serious hazard if large areas are exposed to the wind. There is insufficient soil moisture during dry summer months.

Many areas of this soil are in crops, mostly small grains and hay. A small acreage of corn is grown. Other areas are in permanent pasture or are idle. (Capability unit IVe–9 (4a) ; woodland suitability group C)

Montcalm loamy sand, 12 to 18 percent slopes, severely eroded (MsD3).—This soil is moderately steep and is near other Montcalm soils and near McBride and Isabella soils. Water and wind erosion and tillage have removed most of the upper part of the soil and have mixed the rest with material from the subsoil. Material from the subsoil is dominant in the present surface layer. The surface layer is pale brown in most areas but is brown or dark brown in some places. Erosion has seriously damaged this soil by reducing the level of fertility and the organic-matter content. Combined thickness of the surface layer and subsoil is less than half of the original thickness of these two layers in many areas. In some local blowouts, all of the surface layer and subsoil have been removed. A few shallow gullies are present in some areas. Small areas of Chelsea, McBride, and Isabella soils were included in mapping many areas of this soil.

Use of this soil for crops is severely limited by erosion damage, moderately low fertility, moderately low available moisture capacity, and a hazard of further erosion. Surface runoff is rapid, and soil moisture is short during dry summer months.

Most areas of this soil are in low-grade permanent pasture or are idle. (Capability unit VIe–2 (4a) ; woodland suitability group C)

Montcalm loamy sand, 18 to 25 percent slopes (MsE).—This steep soil is near other Montcalm soils and near McBride and Chelsea soils. The surface layer is predominantly very dark grayish-brown loamy sand but is sand or sandy loam in a few areas. Chunks of clayey material occur throughout the profile, and there are gravel layers below a depth of 48 inches in some places. In moderately eroded areas that have been tilled, the rest of the original surface layer is mixed with the upper part of the subsoil. In a few severely eroded areas, shallow gullies and blowouts are present. McBride, Isabella, and Chelsea soils were commonly included in mapping most areas of this soil.

Use of this soil for crops is limited by steep slopes that hinder use of farm machinery, by a serious erosion hazard, and by moderately low available soil moisture. Surface runoff is rapid in cultivated areas, and this soil generally is not suitable for crops that require large amounts of moisture and permit excessive runoff.

Most areas of this soil remain in forest. A few areas are in permanent pasture. (Capability unit VIe–2 (4a) ; woodland suitability group C)

Montcalm sandy loam, 0 to 6 percent slopes (MtB).—This soil is nearly level and is on uplands near other Montcalm soils and near McBride and Isabella soils. The surface layer is very dark grayish brown. It is predominantly sandy loam, but there are some small areas of loamy sand. Small areas of McBride and Isabella soils were included in mapping many areas of this soil.

Use of this Montcalm sandy loam for crops is limited mainly by moderately low available moisture capacity, moderately low fertility, and a wind-erosion hazard. Because surface runoff is slow, water erosion seldom is a problem. Soil moisture is insufficient for crop needs during dry periods, and yields are reduced during extreme drought. This soil has slightly better available moisture capacity and fertility than the Montcalm loamy sands.

Most areas of this soil are planted to crops, principally corn, small grains, hay, and potatoes. (Capability unit IIIs–4 (4a); woodland suitability group C)

Montcalm sandy loam, 6 to 12 percent slopes (MtC).—This soil is sloping and is on uplands near other Montcalm soils and near McBride and Isabella soils. In most places the surface layer is very dark grayish brown, with small areas of brown or pale brown. It is dominantly sandy loam, but small areas are loamy sand. Small areas of McBride and Isabella soils were included in mapping many areas of this soil.

Use of this Montcalm soil for crops is restricted mainly by moderately low available moisture capacity, moderately low fertility, an erosion hazard, and loss of water through surface runoff. This soil has slightly higher fertility and slightly higher available moisture capacity than the Montcalm loamy sands and is less likely to erode when exposed to the wind.

Most areas of this soil are in crops, principally corn, small grains, and hay. A few areas are in pasture or forest. (Capability unit IIIe–9 (4a); woodland suitability group C)

Montcalm sandy loam, 12 to 18 percent slopes (MtD).—This soil is moderately steep and is on uplands near other Montcalm soils and near McBride and Isabella soils. The surface layer is predominantly very dark grayish brown, with small areas of brown. In most places it is sandy loam, but there are small areas of loamy sand. Small areas of McBride and Isabella soils were included in mapping many areas of this soil. These two soils are finer textured and more productive than Montcalm soils.

Surface runoff is rapid in cultivated areas, and erosion is a serious hazard. The runoff results in a shortage of soil moisture during dry summer months. Wind erosion also is a hazard if large areas are exposed to the wind. Slopes are short and complex. The soil has slightly higher fertility and slightly higher available moisture capacity than the Montcalm loamy sands and also is more resistant to wind erosion.

Many areas of this soil are idle or are used to a limited extent for crops. Some areas remain in woods. (Capability unit IVe–9 (4a); woodland suitability group C)

Montcalm stony loamy sand, 2 to 6 percent slopes (MuB).—This soil is undulating and gently sloping and is on uplands near other Montcalm stony loamy sands. Large, rounded stones, 1 to 4 feet in diameter, lie 30 to 100 feet apart on the surface and are present throughout the soil profile. Unless these stones are removed from the surface layer, it is extremely difficult to work this soil with farm machinery. Pasturing of some areas has mixed the surface and subsurface layers of this soil. The surface layer ranges from very dark gray in forested areas to brown in pastured areas.

Stoniness, an erosion hazard, moderately low available moisture capacity, and moderately low fertility are major limitations to use of this soil for crops.

This soil mainly is in pasture or trees. (Capability unit VIIs–1 (4a); woodland suitability group C)

Montcalm stony loamy sand, 6 to 12 percent slopes (MuC).—This is a sloping soil of the uplands. Large, rounded stones, 1 to 4 feet in diameter, lie 30 to 100 feet apart on the surface and are present throughout the soil profile. Unless these stones are removed from the surface layer, it is extremely difficult to work this soil with farm machinery. The surface layer ranges from very dark grayish brown in wooded areas to brown in pastures. Pasturing of some areas has mixed the surface and subsurface layers.

Stoniness, slope, moderately rapid runoff, moderately low available moisture capacity, and moderately low fertility are major limitations to the use of this soil for crops.

This soil mainly is in pasture or trees. (Capability unit VIIs–1 (4a); woodland suitability group C)

Montcalm stony loamy sand, 12 to 18 percent slopes (MuD).—This soil is moderately steep and is on uplands. Large, rounded stones, 1 to 4 feet in diameter, lie 30 to 100 feet apart on the surface and are present throughout the soil profile. Unless these stones are removed from the surface, it is extremely difficult to work this soil with farm machinery. The surface layer ranges from very dark gray in wooded areas to dark grayish brown or brown in pastures. Pasturing of some areas has mixed the surface and subsurface layers. A few areas are either moderately eroded or severely eroded.

Stoniness, slope, rapid surface runoff, an erosion hazard, moderately low available moisture capacity, and moderately low fertility are major limitations to the use of this soil for crops.

This soil is used for pasture or trees. (Capability unit VIIs–1 (4a); woodland suitability group C)

Montcalm stony loamy sand, 18 to 25 percent slopes (MuE).—This soil is steep and is on uplands. Large, rounded stones, 1 to 4 feet in diameter, are 30 to 100 feet apart on the surface and in most places are present throughout the soil profile. Unless these stones are removed from the surface layer, it is extremely difficult to work this soil with farm machinery. Pasturing of some areas has mixed the surface and subsurface layers. The surface layer is very dark grayish brown in most places but is brown or pale brown in some areas.

Stoniness, an erosion hazard, rapid surface runoff, moderately low available moisture capacity, and moderately low fertility are major limitations to the use of this soil for crops.

This soil is used for pasture or forest. (Capability unit VIIs–1 (4a); woodland suitability group C)

Montcalm soils, 25 to 45 percent slopes (MvF).—These soils are steep and are near areas of other Montcalm soils and near McBride and Chelsea soils. They are next to drainageways in many areas. The surface layer is very dark grayish brown and is loamy sand in most areas but is sand or sandy loam in a few areas. Chunks of clayey material occur occasionally throughout the profile, and there are gravel layers below a depth of 48 inches in a few areas. Slope exceeds 45 percent in a few places. A few areas are moderately eroded. Included in mapping most areas of these soils in most places were small areas of McBride, Isabella, Chelsea, and Menominee soils.

Surface runoff is very rapid, and erosion is a serious problem if row crops are planted. Because of the rate of runoff, little water enters the soil and plants suffer from lack of moisture in dry summer months. Steepness of slope restricts use of farm machinery and tree planting equipment.

Most areas of this soil remain in forest. A few areas are in permanent pasture. (Capability unit VIIe–2 (4a); woodland suitability group C)

Munuscong Series

The soils of this series are poorly drained and very poorly drained, are nearly level or in depressions, and are on lake and till plains and moraines. They formed in sandy loam and fine sandy loam material overlying clay or silty clay. Thickness of the sandy loam or fine sandy loam material ranges from 18 to 42 inches.

The surface layer is black fine sandy loam about 8 inches thick. It has weak granular structure and is friable.

The subsoil is gray sandy loam about 22 inches thick and is mottled with yellowish brown and brownish yellow. It has weak blocky structure and is friable.

Below the subsoil, at a depth of about 30 inches, is reddish-gray silty clay mottled with dark brown. This material has weak blocky structure, is very firm, and is high in lime content.

Available moisture capacity of these soils is high, and natural fertility is moderately high. Permeability is moderate throughout the upper part of the profile but is slow throughout the lower part. Runoff is very slow, and water ponds in depressions, especially during spring. The gray color of the subsoil and underlying material indicates that these soils are saturated for long periods. The water table is at or near the surface unless the soils are artificially drained. This wetness limits depth of the root zone and hinders tillage. Use of the soils for crops is limited by excess wetness and poor surface drainage.

Most areas of these soils are in pasture or trees. A few areas have been drained and are used for crops. The native vegetation was mixed swamp hardwoods and conifers.

Typical profile of Munuscong fine sandy loam:

A1—0 to 8 inches, black (10YR 2/1) fine sandy loam; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

Bg—8 to 30 inches, gray (10YR 5/1) sandy loam; many, medium, distinct, yellowish-red (5YR 4/8) and brownish-yellow (10YR 6/6) mottles; weak, medium, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

IICg—30 to 60 inches, reddish-gray (5YR 5/2) silty clay; common, medium, distinct, dark-brown (7.5YR 4/4) mottles; weak, medium, angular blocky structure; very firm; calcareous.

A layer of muck or peat, 1 to 12 inches thick, is on the surface of the soil in undisturbed areas. The surface layer is very dark brown in some areas and is 5 to 9 inches thick. The subsoil is mainly sandy loam or fine sandy loam but contains thin layers of loam and loamy sand. In some areas the subsoil is mainly gray and lacks mottling. Reaction of the surface layer and subsoil ranges from slightly acid to mildly alkaline.

Munuscong fine sandy loam (Mw).—This soil is in depressions and on depressed flats. The surface layer is predominantly black fine sandy loam, but it ranges from loamy fine sand to light loam over short distances. Some clayey, sandy, or mucky spots are present in small areas. The water table is very close to the surface most of the time unless this soil has been drained. Runoff is very slow, and water ponds on the surface during wet periods.

Most areas of this soil are in forest or permanent pasture. A few areas have been artificially drained and planted to crops, principally corn and small grains. (Capability unit IIw-8 (3/1c); woodland suitability group P)

Figure 6.—Nester soils on gently sloping till plain; Kawkawlin soils are in drainageways and depressions.

Nester Series

The soils of this series are well drained or moderately well drained and range from nearly level to very steep. They formed in clay loam or silty clay loam material deposited by glaciers and are on till plains and moraines (fig. 6). In some areas the soils are severely eroded. Stones are at the surface in places.

The surface layer is very dark grayish-brown loam about 6 inches thick. It has weak granular structure and is very friable.

The subsurface layer, about 2 inches thick, is grayish-brown loam that is friable and has weak granular structure.

The upper part of the subsoil is about 6 inches thick and has moderate blocky structure. This layer contains both subsurface and subsoil materials and consists of grayish-brown loam and brown silty clay loam. The loam is friable, but the silty clay loam is firm.

The lower part of the subsoil is reddish-brown silty clay loam about 12 inches thick. It has strong blocky structure and is firm.

Underlying the subsoil at a depth of about 26 inches is reddish-brown silty clay loam. This material is firm, has moderate blocky structure, and has a high content of lime.

The available moisture capacity of the Nester soils is high. Their natural fertility is moderate. Water moves moderately slowly through these soils. Surface runoff varies according to steepness of slope and type of vegetation, or from slow on nearly level soils to rapid on the very steep soils.

The hazard of erosion is a major limitation to use of Nester soils for crops. Severely eroded Nester soils have poorer tilth than the soils not eroded. Also, they are more difficult to work and have cobblestones and gravel on their surface.

The gently sloping or sloping Nester soils are used mainly for wheat, oats, rye, hay, corn, and other commonly grown crops. The steep soils are used mostly for pasture and woods.

Typical profile of Nester loam:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2)) loam; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—6 to 8 inches, grayish-brown (10YR 5/2) loam; weak, coarse, granular structure; friable; slightly acid; gradual, irregular boundary.

A2&B21—8 to 14 inches, grayish-brown (10YR 5/2) loam (A2 horizon), and brown (7.5YR 5/4) silty clay loam (B21 horizon); B21 horizon occurs as peds, surrounded or nearly surrounded by A2; moderate, fine, angular blocky structure; A2 is friable, and B21 is firm; medium acid; clear, wavy boundary.

B22—14 to 26 inches, reddish-brown (5YR 4/4) silty clay loam; light-gray (10YR 6/1) or pale-brown (10YR 6/3) loamy material occurs as coatings and crack fillings in upper 3 or 4 inches; a few, thin, reddish-brown (5YR 5/3) and yellowish-red (5YR 5/6) clay films on ped faces; strong, medium, angular blocky structure; firm; medium acid; abrupt, irregular boundary.

C—26 to 60 inches, reddish-brown (5YR 5/3) silty clay loam; moderate, medium, angular blocky structure; firm; calcareous.

The color of the surface layer ranges to dark grayish brown in some areas, and its thickness ranges from 5 to 9 inches. The surface layer ranges from loamy sand to clay loam. Where it has not been disturbed, this layer is very dark brown or very dark gray loam 1 to 3 inches thick. The color of the lower part of the subsoil is dark brown in some places, and the texture is clay loam. The combined thickness of the surface layer and subsoil ranges from 20 to 40 inches. Reaction ranges from slightly acid to strongly acid in the surface layer and subsoil. Texture of the material below the subsoil is clay loam or silty clay loam.

Nester soils are better drained than Kawkawlin soils. They are coarser textured than Kent soils.

Nester clay loam, 6 to 12 percent slopes, severely eroded (NaC3).—Erosion has removed most of the original surface layer and part of the original subsoil from this soil. As a result, the profile differs from the typical one for the Nester series.

The surface layer is brown and is sticky and slippery when wet and hard when dry. Gravel and cobblestones lie on it. The limy layer is at a depth of less than 25 inches in most places.

Included with this soil in mapping were some areas where the surface layer is very dark grayish brown. Shallow gullies are present in some places.

The organic-matter content and fertility of this soil are lower than in uneroded Nester soils. Also, runoff is greater and the surface layer crusts more readily. Because of the crusting, seeds do not germinate uniformly and stands of plants are uneven. The gravel and cobblestones cause wear of tillage implements. The runoff causes further erosion unless a protective cover of vegetation is maintained.

Much of this soil has been farmed, but many areas are now in pasture or are idle. Erosion has made this soil less suitable for crops than the uneroded soils. (Capability unit IIIe–4 (1.5a); woodland suitability group B)

Nester clay loam, 12 to 18 percent slopes, severely eroded (NaD3).—Erosion and tillage have removed most of the original surface layer and part of the subsoil of this moderately steep soil. Material from the subsoil is dominant in the present surface layer. The surface layer is brown in most areas and is predominantly clay loam, but it is very dark grayish brown in many areas. Because of severe erosion, this soil has a lower level of fertility and organic-matter content than it formerly had, and it crusts more readily. Runoff is rapid, and little water enters the soil. The present surface layer is sticky and slippery when wet and is hard after drying. Seeds do not germinate uniformly, and stands of plants are poor. Gravel and cobblestones are on the surface and increase wear on tillage implements. Shallow gullies are present in many areas. The depth to the limy underlying layer is generally less than 25 inches.

Most areas of this soil have been cultivated in the past, but many areas now are idle or are in pasture. (Capability unit VIe–1 (1.5a); woodland suitability group B)

Nester clay loam, 18 to 25 percent slopes, severely eroded (NaE3).—Erosion and tillage operations have removed most of the original surface layer and part of the subsoil layer of this steep soil. Subsoil material is dominant in the present surface layer. The present surface layer is brown in most areas and is predominantly clay loam, but small areas have a very dark grayish-brown heavy loam surface layer. Erosion has severely damaged this soil and has reduced its organic-matter content and fertility. Runoff is greater than on uneroded soils, and the surface layer crusts more readily. Surface runoff is very rapid in cultivated areas. The surface layer is sticky and slippery when wet and becomes hard on drying. Seeds germinate unevenly, and stands of plants are poor. Gravel and cobblestones are on the surface and increase wear on tillage implements. Shallow gullies are present in many areas. Depth to the limy underlying layer generally is less than 25 inches.

Steep slopes, severe erosion damage, and a severe erosion hazard limit the use of this soil for crops. Most areas of this soil have been farmed in the past but are now idle or are in pasture. (Capability unit VIIe–2 (1.5a); woodland suitability group B)

Nester gravelly loam, 6 to 12 percent slopes (NcC).—This soil is sloping and is on uplands. The surface layer is very dark grayish brown in most areas and is gravelly loam. Small areas have a brown surface layer. The gravel content ranges from 12 to 50 percent, by volume, and is mainly present in the surface and subsurface layers. The gravel does not materially affect soil productivity but does increase wear on tillage implements. The surface layer is underlain by clay loam or silty clay loam. Slopes exceed 12 percent in some areas that were included in mapping this soil.

A high content of gravel and an erosion hazard limit the use of this soil for crops. Surface runoff is rapid in cultivated areas.

Most areas of this soil are in pasture or forest. A small acreage is cultivated. (Capability unit IIIe–4 (1.5a); woodland suitability group B)

Nester loam, 0 to 2 percent slopes (NeA).—This nearly level soil is on the uplands. The surface layer is very dark grayish brown. Both the surface layer and the subsurface layer are dominantly loam, but the texture is silt loam in small areas in the surface layer. The subsoil is mainly clay loam or silty clay loam, but tongues of loam extend downward from the subsurface layer into the subsoil.

Included with this soil in mapping were areas of a Kawkawlin loam in narrow waterways and small areas of wet organic soils and of a poorly drained Sims loam. The Kawkawlin and Sims soils dry out slowly and hinder planting in some places.

Most of the acreage is cultivated or in permanent pasture. Small grains and hay are the principal crops, but some areas are in corn. Runoff is slow, and erosion is not a

hazard in most places. Random tile drains and surface drains will remove the excess water from wet depressions and drainageways. (Capability unit IIs–1 (1.5a); woodland suitability group B)

Nester loam, 2 to 6 percent slopes (NeB).—This soil is undulating and gently sloping and is on uplands. The surface layer is very dark grayish brown in most areas and is predominantly loam. Small areas have a brown surface layer. Included in the mapping of this soil were Kawkawlin soils in narrow waterways and Sims and organic soils in small wet spots. Wetness of these included soils often delays tillage.

Erosion is the major limitation to the use of this soil for crops.

Most areas of this Nester soil are in small grains, hay, and corn or are in permanent pasture. Some areas are in forest. (Capability unit IIe–1 (1.5a); woodland suitability group B)

Nester loam, 2 to 6 percent slopes, moderately eroded (NeB2).—This soil is undulating and gently sloping and is on uplands. The loam surface layer is mainly brown, but small areas are very dark brown. Erosion and tillage have removed part of the original surface and subsurface layers and have mixed the rest with the upper part of the subsoil. Subsoil material is dominant in the present surface layer. Moderate erosion has reduced the level of fertility and organic-matter content of this soil and the quality of its tilth. The present surface layer crusts readily, and the crusting hinders emergence of seedlings. Surface runoff is greater than in uneroded areas. Included in mapping this soil were Kawkawlin soils in narrow waterways and Sims and organic soils in small wet spots. These three soils delay tillage because of their wetness.

Erosion damage, an erosion hazard, and the presence of somewhat poorly drained and poorly drained soils in some areas are the main limitations to the use of this soil for crops.

Most areas of this soil are in such crops as small grains, hay, and corn. (Capability unit IIIe–3 (1.5a); woodland suitability group B)

Nester loam, 6 to 12 percent slopes (NeC).—This soil is sloping and is on uplands. The surface layer is very dark grayish brown in most areas but is brown in a few areas. Included in mapping this soil were areas of somewhat poorly drained Kawkawlin soils in narrow waterways and poorly drained or very poorly drained Sims and organic soils in small depressions. Tillage is delayed because these soils dry slowly in spring and after rains.

Runoff is rapid in cultivated areas, and erosion is a hazard. Slopes are short and complex in some areas.

Most of this Nester loam is in pasture or forest. Some areas are in crops. Small grains and hay are the principal crops. (Capability unit IIIe–4 (1.5a); woodland suitability group B)

Nester loam, 6 to 12 percent slopes, moderately eroded (NeC2).—This soil is sloping and is on uplands near areas of other Nester soils. The surface layer is generally brown loam, but small areas have a very dark grayish-brown surface layer. Erosion and tillage have partly removed the original surface and subsurface layers of this soil and have mixed the remaining material with the upper part of the subsoil. This has reduced the level of fertility and organic-matter content of the soil and the quality of its tilth. The present surface layer is lighter colored, crusts more readily, and makes a poorer seedbed than the former uneroded surface layer. Included in mapping this soil were areas of somewhat poorly drained Kawkawlin soils in narrow waterways and poorly drained or very poorly drained Sims soils and organic soils in small depressions. These included soils remain wet for long periods in spring, and the wetness delays planting during some years. Runoff is very slow, and water ponds in these areas.

Erosion damage, an erosion hazard, and the presence of small wet spots are the major limitations to use of this soil for crops. Areas that are cultivated tend to be droughty because of loss of moisture from surface runoff.

All of this soil is cultivated. Small grains and hay are the principal crops. (Capability unit IIIe–4 (1.5a); woodland suitability group B)

Nester loam, 12 to 18 percent slopes (NeD).—This soil is moderately steep and is on uplands near other Nester soils. The surface layer generally is very dark grayish-brown loam, but it is brown in a few areas. Included in mapping this soil were areas of somewhat poorly drained Kawkawlin soils in narrow waterways and areas of poorly drained Sims soils and organic soils in small depressions.

An erosion hazard, rapid surface runoff, and the presence of small, wet depressions are the major limitations to the use of this soil for crops.

Most areas of this soil are in pasture or forest. A few areas have been cultivated. (Capability unit IVe–1 (1.5a); woodland suitability group B)

Nester loam, 12 to 18 percent slopes, moderately eroded (NeD2).—This soil is moderately steep and is on uplands near other Nester soils. The surface layer is brown loam 6 to 9 inches thick over a clay loam or silty clay loam subsoil. The limy clay loam to silty clay loam underlying material lies at a depth of about 25 inches. Erosion and tillage have removed part of the original surface and subsurface layers of this soil and have mixed the rest with the upper part of the subsoil. Because of erosion, the present surface layer is lighter colored, crusts more readily, and makes a poorer seedbed than the former uneroded surface layer. The level of fertility, the organic-matter content, and the quality of tilth have been reduced. Included in mapping this soil were somewhat poorly drained Kawkawlin soils in narrow waterways and the poorly drained Sims soils in depressions. The Kawkawlin and Sims soils dry slowly, and their wetness delays planting during some years.

Most areas of this Nester soil are cultivated. The principal crops are small grains and hay. A few areas are idle or are in low-grade pasture. (Capability unit IVe–1 (1.5a); woodland suitability group B)

Nester loamy sand, 2 to 6 percent slopes (NlB).—This soil is gently sloping and is on uplands. The surface layer is very dark grayish-brown loamy sand 8 to 14 inches thick. It is underlain by clay loam or silty clay loam. The limy clay loam to silty clay loam underlying material lies at a depth of 30 to 40 inches. Small spots of Nester and Menominee soils were included in mapping some areas of this soil.

Because of its sandy surface layer, this soil has slightly better tilth and absorbs water more rapidly than the Nester loams and sandy loams. Surface runoff is slow, and water erosion is seldom a hazard.

This soil is used for pasture, forest, and crops. The principal crops are small grains, hay, and corn. (Capability unit IIe–1 (1.5a) ; woodland suitability group B)

Nester loamy sand, 6 to 12 percent slopes (NlC).—This is a sloping soil of the uplands. The surface layer is very dark grayish-brown loamy sand 8 to 14 inches thick. Beneath it is a clay loam or silty clay loam subsoil. At a depth of 30 to 40 inches, there is limy clay loam to silty clay loam underlying material. Small spots of Nester and Menominee soils were included in mapping some areas of this soil.

This Nester soil has slightly better tilth and absorbs water better than the Nester loams and Nester sandy loams. Surface runoff is rapid, and erosion is a hazard in cultivated areas.

Most areas of this soil are in crops or in forest, but a few areas are in permanent pasture. Crops grown are small grains and hay. (Capability unit IIIe–4 (1.5a) ; woodland suitability group B)

Nester loamy sand, 12 to 18 percent slopes (NlD).—This soil is moderately steep and is on uplands. The surface layer is very dark grayish-brown loamy sand 6 to 14 inches thick. The subsoil is clay loam or silty clay loam. Underlying the subsoil at a depth of 25 to 35 inches is limy clay loam or silty clay loam. Small spots of Nester and Menominee soils were included in mapping some areas of this soil.

Rapid runoff and an erosion hazard are the main limitations to the use of this soil for crops. Most of it is in permanent pasture or forest. A small acreage is used for small grains and hay. (Capability unit IVe–1 (1.5a) ; woodland suitability group B)

Nester sandy loam, 0 to 2 percent slopes (NmA).—The surface layer of this soil is very dark grayish-brown sandy loam 8 to 14 inches thick. The next layer is clay loam or silty clay loam. Limy clay loam or silty clay loam lies at a depth of 30 to 40 inches.

Included with this soil in mapping were areas of Kawkawlin sandy loam in narrow waterways and of Sims loam in small depressions. Also included were some small areas of Nester soils that have slopes greater than 2 percent, and some areas that have a brown surface layer.

This Nester soil has slightly better tilth and takes in water more readily than the Nester loams or the Nester clay loams. The hazard of erosion is slight. The areas of Kawkawlin and Sims soils delay tillage because they remain wet longer than the Nester soil.

Most areas of this Nester soil are used for crops or for pasture. The principal crops are small grains, hay, and corn. A few areas are wooded. (Capability unit IIs–1 (1.5a) ; woodland suitability group B)

Nester sandy loam, 2 to 6 percent slopes (NmB).—This soil is gently sloping or undulating and is on uplands. The surface layer is very dark grayish-brown sandy loam 8 to 14 inches thick. The subsoil is clay loam or silty clay loam. Limy clay loam or silty clay loam lies at a depth of 30 to 40 inches. Included in mapping this soil were Kawkawlin sandy loams in narrow waterways and Sims loams in small depressions. Also included in mapping were some eroded areas where the surface layer is brown. Slopes range outside the specified limits over short distances.

Surface runoff is slow or medium on this gently sloping soil. The soil has better tilth and absorbs water more readily than the Nester loams and Nester clay loams. Small areas of somewhat poorly drained and poorly drained soils that were included in mapping delay tillage. If large areas of this soil are exposed by tillage, wind erosion is a hazard.

Most areas of this soil are used for crops or pasture. A few areas are in forest. The principal crops are small grains, hay, and corn. (Capability unit IIe–1 (1.5a) ; woodland suitability group B)

Nester sandy loam, 2 to 6 percent slopes, moderately eroded (NmB2).—This soil is undulating to gently sloping and is on uplands. The surface layer is brown, ranges from sandy loam to light loam, and is 6 to 14 inches thick. In some areas the color of the surface soil is very dark grayish brown. The second layer is clay loam or silty clay loam. Limy clay loam to silty clay loam underlying material lies at a depth of 25 to 40 inches. Erosion and tillage have removed part of the original surface and subsurface layers and mixed the rest with the upper part of the subsoil. As a result, the level of fertility and organic-matter content are lower and the quality of tilth is poorer. The present surface layer crusts readily, and emergence of seedlings is uneven. Small areas of Nester loams, Ubly sandy loams, and Menominee loamy sands were included in mapping many areas of this soil. Also included were small areas of Kawkawlin soils adjacent to narrow drainageways and of Sims and Kawkawlin soils in depressions. The Sims and Kawkawlin soils often are wet, and their wetness delays tillage.

All of this soil is in crops. The principal crops are small grains, hay, and corn. A moderate erosion hazard and a reduction of crop yields resulting from past erosion damage are the principal limitations to the use of this soil for crops. (Capability unit IIIe–3 (1.5a) ; woodland suitability group B)

Nester sandy loam, 6 to 12 percent slopes (NmC).—This soil is sloping, is on uplands, and generally is near other Nester soils and near Ubly and Menominee soils. The surface layer is very dark grayish-brown sandy loam 6 to 14 inches thick. In some places the surface layer is brown. The second layer is clay loam or silty clay loam. Limy clay loam to silty clay loam underlying material is at a depth of 25 to 35 inches. Included in mapping this soil were small areas of Kawkawlin sandy loam in narrow waterways and Sims loam in small depressions. These soils often are wet, and tillage is delayed as a result. Slopes range outside the specified limits over short distances.

This soil takes in water more readily and has better tilth than either the Nester loams or Nester clay loams. Surface runoff is rapid in cultivated areas, and erosion is a hazard.

Most areas of this soil are used for crops and pasture. A few areas are in forest. Crops include small grains, hay, and corn. (Capability unit IIIe–4 (1.5a) ; woodland suitability group B)

Nester sandy loam, 6 to 12 percent slopes, moderately eroded (NmC2).—This soil is sloping and is on uplands near other Nester soils and near the Ubly and Menominee soils. The surface layer is brown sandy loam to loam and is 6 to 14 inches thick. In some small areas its color is very dark grayish brown. The second layer is clay loam or silty clay loam. Underlying this layer, at a depth of 25 to 35 inches, is limy clay loam or silty clay loam. Erosion and tillage operations have removed part of the original surface and subsurface layers of this soil and mixed the rest with the upper part of the subsoil. Included in mapping many areas of this soil were small areas of Nester loams, Ubly sandy loams, and Menominee loamy sands. Also in-

cluded were small areas of Kawkawlin soils adjacent to narrow drainageways and of Sims and Kawkawlin soils in depressions. These soils often are wet, and wetness delays tillage.

In cultivated areas surface runoff is rapid and erosion is a severe hazard. The soil tends to be droughty when it is used for crops. Major limitations to its use for crops include the need to control erosion, improve tilth, restore organic-matter content, and increase the level of fertility.

Most areas of this soil are in crops, but some are in pasture. The principal crops are small grains and hay. (Capability unit IIIe–4 (1.5a); woodland suitability group B)

Nester sandy loam, 12 to 18 percent slopes (NmD).—This soil is moderately steep and is near other Nester soils and near the Ubly and Menominee soils. The surface layer is very dark grayish-brown sandy loam 6 to 14 inches thick. The second layer is clay loam or silty clay loam. Underlying this layer at a depth of 20 to 30 inches is limy clay loam or silty clay loam. Included in mapping this soil were small areas of Kawkawlin soils and of Sims soils in small depressions and drainageways. Slopes range outside the specified limits over short distances.

Rapid surface runoff, an erosion hazard, and wetness in the depressions and drainageways are the principal limitations to the use of this soil for crops.

Most areas of this soil are used for crops and pasture, but a few areas are in forest. The principal crops are small grains and hay. (Capability unit IVe–1 (1.5a); woodland suitability group B)

Nester sandy loam, 12 to 18 percent slopes, moderately eroded (NmD2).—This soil is moderately steep and is on uplands near other Nester soils and near the Ubly soils. The surface layer, 6 to 12 inches thick, is brown sandy loam in most areas but is brown loam in some places. In small areas the color is very dark grayish brown. The second layer is clay loam or silty clay loam. Underlying this layer, at a depth of about 25 inches, is limy clay loam or silty clay loam. Erosion and tillage have removed part of the original surface and subsurface layers of this soil and in most areas have mixed the remainder with the upper part of the subsoil. As a result, the level of fertility and the organic-matter content are lower and the tilth is poorer. The present surface layer is lighter colored, crusts more readily, and is a poorer seedbed than the former uneroded surface layer. Included in mapping most areas of this soil are Nester loams, Ubly sandy loams, and Menominee loamy sands in many small, wet depressions.

Major limitations to the use of this soil for crops are steepness of slope, rapid surface runoff, a moderate erosion hazard, reduced crop yields resulting from previous damage to the soil, and the presence of small, wet depressions.

Most areas of this soil are used for growing small grains, hay, and some corn. Some areas are in permanent pasture. (Capability unit IVe–1 (1.5a); woodland suitability group B)

Nester stony loam, 6 to 12 percent slopes (NnC).—This soil is sloping and is on uplands. It has a loam surface layer in most areas, but some areas have a sandy loam or fine sandy loam surface layer. Large, rounded stones, 1 to 4 feet in diameter, are 5 to 10 feet apart on the surface. In many areas the stones are present throughout the different layers of the soil. The subsurface layer is loam. There is a clay loam or silty clay loam subsoil at a depth of 8 to 14 inches. Underlying the subsoil, at a depth of about 30 inches, is limy clay loam or silty clay loam. Included in mapping this soil were small areas of Kawkawlin loam in narrow waterways and wet depressions.

Unless the stones are removed from the surface layer, it is extremely difficult to work this soil with ordinary farm machinery. Rapid surface runoff, and a severe erosion hazard are other principal limitations to the use of this soil for crops.

Most areas of this soil are in pasture or forest. (Capability unit IIIe–4 (1.5a); woodland suitability group B)

Nester stony sandy loam, 2 to 6 percent slopes (NoB).—This soil is gently sloping and is on uplands. The surface layer is sandy loam in most areas but in some areas is loam or fine sandy loam. Large, rounded stones, 1 to 4 feet in diameter, are 5 to 100 feet apart on the surface. In many areas the stones are present throughout the different soil layers. The subsurface layer is sandy loam or loam. There is a clay loam or clay subsoil layer at a depth of 8 to 14 inches. Underlying the subsoil is limy clay loam or silty clay loam at a depth of about 25 inches. Included in mapping this soil were small areas of Kawkawlin loams and Sims loams in narrow waterways and depressions.

Unless the stones are removed from the surface layer, it is extremely difficult to work this soil with ordinary farm machinery. Most areas are in pasture or forest. Capability unit IIe–1 (1.5a); woodland suitability group B)

Nester soils, 18 to 25 percent slopes (NrE).—This soil is steep and is on uplands near other Nester soils. The surface layer is very dark grayish-brown loam or sandy loam. The subsurface layer is loam and extends as tongues or fingers into the underlying clay loam to clay subsoil at a depth of 8 to 14 inches. Included in mapping many areas of this soil were small areas of Kawkawlin soils in narrow drainageways, and small areas of Sims soils in depressions. They often are wet, and the wetness delays tillage.

Rapid surface runoff and an erosion hazard are the principal limitations to the use of this soil for crops. Most areas of this soil are in forest or permanent pasture. A small acreage is in crops. Small grains and hay are the principal crops. (Capability unit VIe–1 (1.5a); woodland suitability group B)

Nester soils, 18 to 25 percent slopes, moderately eroded (NrE2).—This soil is steep and is on uplands near other Nester soils. The surface layer is brown loam or sandy loam in most areas, but in small areas it is very dark grayish brown. The surface layer rests directly on a clay loam or silty clay loam subsoil. Underlying the subsoil, at a depth of about 25 inches, is limy clay loam or silty clay loam. Erosion and tillage have removed part of the original surface and subsurface layers and mixed the remainder with the upper part of the subsoil. The present surface layer is lighter colored, crusts more readily, and is less absorbent of water than the former uneroded surface layer. The level of fertility and organic-matter content have been reduced. Slopes of this soil range outside the specified limits in some areas. Included in the mapping were some areas of wet soils in small depressions.

An erosion hazard, rapid surface runoff, and a reduction in crop yields resulting from erosion damage are the major limitations to the use of this soil for crops. The steep slopes also restrict use of farm machinery and tree planting equipment.

Most areas of this soil have been cultivated in the past, but at present most are in permanent pasture or are idle. A few areas are in small grains or hay. (Capability unit VIe–1 (1.5a); woodland suitability group B)

Nester soils, 25 to 45 percent slopes (NrF).—This soil is very steep and is on uplands. The surface layer is very dark grayish-brown loam. The subsurface layer is loam and extends as tongues or fingers into the clay loam or clay subsoil. Underlying the subsoil, at a depth of 20 to 30 inches, is limy clay loam or silty clay loam. Slopes range outside the specified limits in a few areas.

Steepness of slope, an erosion hazard when cultivated, and rapid surface runoff limit the use of this soil for crops. It is difficult to use machinery on these slopes. Most areas of this soil remain in forest. A few areas are in permanent pasture. (Capability unit VIIe–2 (1.5a); woodland suitability group B)

Newaygo Series

The soils of this series are gently sloping to moderately steep and are well drained. They are on outwash plains, valley trains, moraines, eskers, and kames. They formed in gravelly loam and sandy loam material, 24 to 42 inches thick, that overlies calcareous, stratified gravel and sand.

The surface layer is very dark grayish-brown sandy loam about 7 inches thick. It has weak granular structure and is friable.

The upper part of the subsoil is dark-brown or brown sandy loam about 9 inches thick. It has weak blocky structure and is friable. The lower part of the subsoil is dark yellowish-brown or reddish-brown heavy sandy loam or light gravelly clay loam and is about 17 inches thick. This material has weak or moderate blocky structure and is firm to friable.

Brown, stratified gravel and sand are below the subsoil at a depth of about 33 inches. This material is single grain, loose, and high in lime content.

The available moisture capacity and natural fertility of this soil are moderate. Permeability is moderately rapid throughout the upper part of the soil and very rapid throughout the lower sandy material. Surface runoff ranges from slow in gently sloping areas to medium in moderately steep areas. In some years these soils tend to be droughty in midsummer.

The gently sloping to sloping areas of these soils are used for small grains, corn, hay, and similar crops. The moderately steep areas are generally in permanent pasture or forest. Some areas have been used as a source of sand and gravel for commercial use. The native vegetation was mainly such hardwoods as sugar maple, elm, and yellow birch, but there was some white pine.

Typical profile of Newaygo sandy loam:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) sandy loam; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

Bir—7 to 12 inches, dark-brown (7.5YR 4/4) sandy loam; weak, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

A'2—12 to 16 inches, brown (10YR 5/3) sandy loam; weak, medium, subangular blocky structure; friable; slightly acid; abrupt, irregular boundary.

B'21t—16 to 21 inches, dark yellowish-brown (10YR 4/4) heavy sandy loam; weak, medium, subangular blocky structure; friable; thin coatings and crack fillings of brown (10YR 5/3) to grayish-brown (10YR 5/2), (A'2 horizon); neutral; clear, wavy boundary.

B'22t—21 to 33 inches, reddish-brown (5YR 4/4) light gravelly clay loam; moderate, coarse, subangular blocky structure; firm; neutral; abrupt, irregular boundary.

IIC—33 to 60 inches, brown (7.5YR 5/4), stratified gravel and sand; single grain; loose; calcareous.

In uncultivated areas the surface layer is very dark gray, is 1 to 3 inches thick, and is underlain by a light brownish-gray subsurface layer 2 to 5 inches thick. The subsurface layer is absent in many cultivated areas. The lower part of the subsoil is heavy sandy loam, loam, gravelly loam, gravelly sandy clay loam, or gravelly clay loam. In some areas large amounts of gravel are in the subsoil. Reaction of the surface layer and subsoil ranges from medium acid to neutral.

Newaygo soils have a finer textured subsoil than the Mancelona soils. They have a coarser textured subsoil and a higher content of gravel than Dighton soils.

Newaygo sandy loam, 2 to 6 percent slopes (NsB).—This soil is gently sloping or undulating and is on outwash plains. The surface layer is very dark grayish-brown sandy loam in most areas. In some areas of small extent the surface layer is brown, and in some other small areas it is cobbly and gravelly. Limy gravel and sand are at a depth of about 30 inches. Slopes range outside specified limits over short distances. Small areas of Mancelona loamy sands were included in mapping most areas of this soil.

This Newaygo soil absorbs water readily, and surface runoff is slow. A slight erosion hazard and periodic droughtiness are the principal limitations to its use for crops.

Most areas of this soil are in crops and pasture. The principal crops are small grains, hay, and corn. In some areas gravel is removed for commercial use, but its suitability for such use varies from area to area. (Capability unit IIe–3 (3a); woodland suitability group A)

Newaygo sandy loam, 6 to 18 percent slopes (NsD).—This soil is sloping or moderately steep and is on outwash plains. The surface layer is very dark grayish-brown sandy loam in most areas, but it is loam or gravelly loam in some areas of small extent. The color is brown in some areas, generally on the upper parts of slopes. Limy gravel and sand are at a depth of about 30 inches. Slopes range outside specified limits over short distances. Small areas of Mancelona loamy sands were included in mapping this soil.

Water moves into this soil readily, but much of it runs off because of the steepness of slope. As a result, soil moisture is insufficient for crop needs during dry periods.

Most areas of this soil are in pasture or crops. The principal crops are small grains, hay, and corn. Many areas are mined for sand and gravel, but the suitability of the gravel and sand for commercial use varies from area to area. (Capability unit IIIe–6 (3a); woodland suitability group A)

Ogemaw Series

The soils of this series are sandy, nearly level, and somewhat poorly drained and poorly drained. They are on till and outwash plains and low moraines and formed in medium and coarse sand 18 to 42 inches thick that overlies loam, clay loam, silty clay loam, or light clay.

The surface layer is black loamy sand about 4 inches thick. It has weak granular structure and is very friable.

The upper part of the subsoil is dark reddish-brown sand about 5 inches thick. This layer is strongly cemented and hard when dry. The lower part of the subsoil is dark-brown or light brownish-gray sand about 13 inches thick.

This layer is mottled with yellowish brown, is single grain, and is loose.

Below the subsoil, at a depth of about 30 inches, is grayish-brown clay. It is mottled with gray, lacks structure, and is very firm.

Available moisture capacity of these soils is moderately low, and natural fertility is low. Water moves rapidly through the upper sandy layers and slowly through the finer textured clay. Surface runoff is very slow, and water ponds in depressed areas. The cemented sand layer in the upper part of the subsoil restricts the movement of water through the profile and limits the development of plant roots. As a result, the soils are saturated during spring and after rains. This excess wetness and the cemented layer severely limit use of these soils for crops.

Only a small acreage of these soils has been cleared and planted to crops. Most areas are in pasture or in poorly stocked stands of trees. The native vegetation was mixed hardwoods and conifers.

Typical profile of Ogemaw loamy sand:

A1—0 to 4 inches, black (10YR 2/1) loamy sand; weak, fine, granular structure; very friable; very strongly acid; abrupt, smooth boundary.

A2—4 to 11 inches, gray (10YR 5/1) sand; single grain; loose; strongly acid; clear, wavy boundary.

B21hirm—11 to 16 inches, dark reddish-brown (5YR 3/4) sand; massive; strongly cemented ortstein; strongly acid; abrupt, wavy boundary.

B22hirm—16 to 19 inches, dark-brown (10YR 3/3) sand; few, fine, faint, yellowish-brown (10YR 5/4) mottles; massive; weakly cemented ortstein; strongly acid; abrupt, wavy boundary.

B3—19 to 29 inches, light brownish-gray (10YR 6/2) sand; few, fine, faint, yellowish-brown (10YR 5/4) mottles; single grain; loose; medium acid; abrupt, smooth boundary.

IIC1—29 to 30 inches, yellowish-brown (10YR 5/4) sandy loam; massive; firm; medium acid; abrupt, wavy boundary.

IIIC2—30 to 60 inches, grayish-brown (10YR 5/2) clay; many, medium, distinct, gray (N 6/0) mottles; massive; very firm; neutral.

The surface layer is very dark gray in some areas and is 3 to 5 inches thick. Reaction of the surface layer and subsoil ranges from medium acid to very strongly acid.

Ogemaw soils have finer textured underlying layers than Saugatuck soils. The cemented layer in the subsoil of Ogemaw soils is lacking in the Au Gres soils.

Ogemaw loamy sand, 0 to 2 percent slopes (OgA).—This soil is nearly level and is on plains. The surface layer is black and is predominantly loamy sand. Loam to clay lies at a depth of about 30 inches. The windthrow of trees has given many areas of this soil a microhummocky relief, commonly called cradle knolls. The soil on the hummocks has slightly better drainage than the soil on low areas between hummocks. There are areas of this soil of less than an acre where the subsoil is not cemented.

Wetness, the degree of acidity, low fertility, and the presence of the cemented layers restrict use of the soil for crops. Most areas of this soil are in trees or pasture or are idle. A few areas are in hay crops. (Capability unit IVw–2 (5b–h); woodland suitability group F)

Otisco Series

The soils of this series are sandy, nearly level or gently sloping, and somewhat poorly drained. They are on till or outwash plains and low moraines and are near Blue Lake soils. They formed in sand or loamy sand material.

The surface layer is very dark grayish-brown loamy sand about 8 inches thick. It has weak granular structure and is very friable. The subsurface layer is light brownish-gray loamy sand about 3 inches thick. It has weak granular structure and is very friable.

The upper part of the subsoil is brownish-yellow loamy sand about 6 inches thick. It has distinct, yellowish-brown mottles, has very weak blocky structure, and is very friable. The lower part of the subsoil consists of alternate layers of sand and heavy loamy sand. The sand layers are light brownish gray, are mottled with strong brown, and are from 2 to 6 inches thick. The heavy loamy sand layers are yellowish brown or strong brown and are from ⅛ inch to 3 inches thick. These layers have weak blocky structure and are friable.

Below the subsoil, at a depth of about 44 inches, is very pale brown loamy sand. This material lacks structure and is very friable.

Available moisture capacity and natural fertility of these soils are moderately low. Permeability is moderately rapid. Surface runoff is slow. Mottling of these soils indicates they are saturated for extended periods, especially in spring. After the water table recedes in spring, these soils tend to become droughty.

Most areas of these soils are in pasture or woods. The native vegetation was predominantly hardwoods, such as elm, ash, and swamp white oak, but there were some white and red pine trees.

Typical profile of Otisco loamy sand:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—8 to 11 inches, light brownish-gray (10YR 6/2) loamy sand; weak, fine, granular structure; very friable; medium acid; abrupt, wavy boundary.

Bir—11 to 17 inches, brownish-yellow (10YR 6/6) loamy sand; common, medium, distinct, yellowish-red (5YR 4/8) mottles; very weak, fine, subangular blocky structure; very friable; medium acid; clear, wavy boundary.

A'2—17 to 23 inches, light brownish-gray (10YR 6/2) sand; many, medium, distinct, strong-brown (7.5YR 5/6) mottles; very weak, medium, granular structure; very friable; medium acid; abrupt, irregular boundary.

B'2lt—23 to 28 inches, yellowish-brown (10YR 5/8) heavy loamy sand; weak, medium, subangular blocky structure; very friable; slightly acid; abrupt, wavy boundary.

A'2&B'22t—28 to 44 inches, light brownish-gray (10YR 6/2) sand (A'2) horizon); strong-brown (7.5YR 5/6) heavy loamy sand (B'22t horizon); A'2 is single grain; loose; B'22t horizon is massive; friable; A'2 horizon is 2 to 6 inches thick; B'22t horizon is 1/8 inch to 3 inches thick; slightly acid; abrupt, wavy boundary.

C—44 to 60 inches, very pale brown (10YR 7/4) loamy sand; massive; very friable; neutral.

In undisturbed areas the surface layer is black or very dark gray loamy sand 2 to 5 inches thick. The subsurface layer is gray, is mottled with yellowish brown in some areas, and is from 2 to 8 inches thick. The upper part of the subsoil is yellowish brown or brown in a few places. The finest textured subsoil layers are sandy loam in some areas, and these have thin bands of light sandy clay loam in places. Between the upper and lower parts of the subsoil is light brownish-gray sand, mottled with strong brown. This layer is about 6 inches thick and has very weak granular structure. Depth to mottling ranges from 6 to about 16 inches. Reaction of the surface layer and upper part of the subsoil ranges from strongly acid to slightly acid. Reaction of the lower part of the subsoil ranges from medium acid to neutral.

Otisco soils are more poorly drained than Montcalm soils. The Otisco soils have coarser textured subsoil layers than Coral soils but have finer textured underlying material than Au Gres soils.

Otisco loamy sand, 0 to 2 percent slopes (OsA).—This soil is nearly level and is on uplands. The surface layer is very dark grayish-brown loamy sand. In some areas there are thin layers of loam, clay, or silt at a depth of about 40 inches. In some areas there are gravel layers at a depth greater than 42 inches.

This soil has slightly lower fertility and organic-matter content and is more subject to wind erosion than the Otisco sandy loams. Because of its sandiness, this soil dries quickly when drained and soil moisture is low during dry summer months.

Wetness, moderately low available moisture capacity when drained, and moderately low fertility limit use of the soil for crops. Most areas of this soil are in forest or pasture. (Capability unit IIIw–5 (4b); woodland suitability group G)

Otisco loamy sand, 2 to 6 percent slopes (OsB).—This soil is gently sloping or undulating and is on uplands. The surface layer is very dark grayish-brown loamy sand. In some areas there are thin layers of loam, clay, or silt at a depth of about 40 inches. Gravel layers lie at a depth greater than 42 inches in some areas, and there are some pebbles and stones on the surface in a few areas. Slopes exceed 6 percent in a few areas.

Wetness, moderately low fertility, moderately low available moisture capacity, and droughtiness when drained primarily limit the use of this soil for crops. Most areas of this soil are in forest or pasture. (Capability unit IIIw–5 (4b); woodland suitability group G)

Otisco sandy loam, 0 to 2 percent slopes (OtA).—This soil is nearly level and is on uplands. The surface layer is very dark grayish-brown sandy loam 8 to about 15 inches thick. The lower subsoil layers range to sandy loam in texture. In some areas there is a thin loam or silt layer at a depth of 20 to 40 inches. Thin layers of gravelly sand lie below a depth of 48 inches in a few areas. Slopes exceed 2 percent in some areas.

The soil has slightly greater fertility and organic-matter content and is less subject to wind erosion than the Otisco loamy sands. Wetness, moderately low fertility, and moderately low available moisture capacity when drained, primarily limit the use of this soil for crops. It dries quickly when drained and tends to become droughty in dry summer months.

Most areas of this soil are in forest or pasture. (Capability unit IIIw–5 (4b); woodland suitability group G)

Otisco sandy loam, 2 to 6 percent slopes (OtB).—This soil is gently sloping or undulating and is on uplands. The surface layer is very dark grayish-brown sandy loam ranging from 8 to about 15 inches in thickness. The lower subsoil layers are sandy loam in some areas. In a few areas thin layers of loam or silt lie at a depth of 20 to 40 inches. There are thin gravelly sand layers below a depth of 48 inches in a few areas. Slopes exceed 6 percent in some areas.

The soil has slightly greater fertility and organic-matter content and is less subject to wind erosion than the Otisco loamy sands. After drainage, it tends to become droughty during dry periods. Wetness, moderately low fertility, and moderately low available moisture capacity when drained, primarily limit the use of this soil for crops.

Most areas of this soil are in forest or pasture. (Capability unit IIIw–5 (4b); woodland suitability group G)

Pickford Series

The soils of this series are poorly drained and are nearly level or are in depressed areas. They are on lake and till plains and formed in clayey material.

The surface layer is very dark gray or dark grayish-brown silty clay loam about 8 inches thick. It has moderate granular structure and is firm.

The subsoil is dark grayish-brown or dark yellowish-brown silty clay about 11 inches thick. This layer is mottled with strong brown or gray. It has moderate blocky structure and is very firm.

Below the subsoil, at a depth of about 19 inches, is pinkish-gray silty clay. This material has weak blocky structure, is very firm, and is high in lime content.

Available moisture capacity and natural fertility of these soils are high. Permeability is very slow. Surface runoff is very slow, and water often ponds in depressions and other low areas. The gray color of the subsoil indicates that these soils are saturated for long periods. The water table is at or near the surface unless these soils are artificially drained. The major limitations to the use of these soils for crops are the high water table, the clayey texture, and a frost hazard. These soils dry slowly in spring.

Many areas of these soils are in trees or permanent pasture. Areas that have been drained are used for crops. The crops commonly grown are hay and small grains. The native vegetation was mixed hardwoods and conifers. Dominant trees were soft maple, elm, hemlock, white-cedar, and spruce.

Typical profile of Pickford silty clay loam:

A1—0 to 5 inches, very dark gray (10YR 3/1) silty clay loam; moderate, medium, granular structure; firm; neutral; clear, wavy boundary.

A3—5 to 8 inches, dark grayish-brown (10YR 4/2) silty clay loam; moderate, medium, granular structure; firm; neutral; abrupt, irregular boundary.

B21g—8 to 14 inches, dark grayish-brown (10YR 4/2) silty clay; many, fine, distinct, strong-brown (7.5YR 5/8) mottles; moderate, medium, angular blocky structure; very firm; mildly alkaline; gradual, irregular boundary.

B22—14 to 19 inches, dark yellowish-brown (10YR 4/4) silty clay; few, fine, distinct, gray (10YR 6/1) mottles; moderate, fine, angular blocky structure; very firm; mildly alkaline; abrupt, irregular boundary.

Cg—19 to 60 inches, pinkish-gray (7.5YR 6/2) silty clay; weak, coarse, angular blocky structure; very firm; calcareous.

The surface layer is black in some areas and is 4 to 8 inches thick. It ranges from fine sandy loam to silty clay loam. The basic color of the subsoil is gray or pinkish gray in some areas. Both the subsoil and underlying material are clay in some places. Combined thickness of the surface layer and subsoil ranges from 14 to 24 inches. Reaction of these layers ranges from slightly acid to mildly alkaline.

Pickford soils are not so poorly drained as Bergland soils and have a thinner surface layer than Bergland soils. Pickford soils have a finer textured profile than Sims soils.

Pickford fine sandy loam (Pc).—This soil is nearly level and is in drainageways and depressions on till and lake plains. The surface layer is very dark gray fine sandy loam in most areas but is loam in areas of limited extent. The fine sandy loam layer is 8 to 14 inches thick. A few sand lenses are in the soil profile in some areas. Included

in mapping some areas of this soil were small spots of very poorly drained Bergland loams and somewhat poorly drained Selkirk loams.

This soil has very slow permeability and requires drainage. It has slightly better tilth than Pickford silty clay loam.

Most areas of this soil are in pasture or trees. A few areas that have been artificially drained are planted to small grains and hay. (Capability unit IIIw–2 (1c); woodland suitability group P)

Pickford silty clay loam (Pk).—This soil is nearly level or undulating and is in drainageways and depressions on till and lake plains. The surface layer is very dark gray, is predominantly silty clay loam, and is 8 to 14 inches thick. Small spots of very poorly drained Bergland and somewhat poorly drained Selkirk soils were included in mapping this soil. Slopes range to 4 percent in some areas.

This soil has very slow permeability and tends to compact during cultivation. It has poorer tilth than Pickford fine sandy loam. Most areas of this soil are in pasture or trees. A few areas that have been artificially drained are planted to small grains and hay. (Capability unit IIIw–2 (1c); woodland suitability group P)

Pinconning Series

Soils of this series are poorly drained and very poorly drained. They are in nearly level or depressed areas and on till or lake plains. They formed in loamy sand or sand, 18 to 42 inches thick, that overlies clay or silty clay.

The surface layer is very dark brown loamy sand about 7 inches thick. It has very weak granular structure and is very friable. Below the surface layer and down to a depth of about 25 inches is light brownish-gray or gray sand. This material has distinct yellowish-brown mottles, has very weak granular or single grain structure, and is very friable or loose.

There is dark-brown silty clay, mottled with gray, at a depth of about 25 inches. It extends to a depth of about 42 inches or more. This layer has moderate blocky structure, is very firm, and is high in lime content.

Available moisture capacity and natural fertility of these soils are moderately low. Permeability is rapid throughout the sandy upper layers but is slow throughout the clayey underlying material. Surface runoff is very slow to ponded. The water table is at or near the surface. Unless these soils are drained, wetness severely restricts their use for crops. Crops also are subject to a frost hazard.

Only a few areas of these soils have been cleared and drained for crops or pasture. Many areas remain in woods because it is difficult to drain these soils. The native vegetation was swamp forest, mixed hardwoods, and conifers.

Typical profile of Pinconning loamy sand:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loamy sand; very weak, fine, granular structure; very friable; neutral; abrupt, smooth boundary.

C1—7 to 16 inches, light brownish-gray (10YR 6/2) sand; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; very weak, medium, granular structure; very friable; neutral; gradual, wavy boundary.

C2g—16 to 25 inches, gray (10YR 5/1) sand; single grain; loose; mildly alkaline; abrupt, wavy boundary.

IIC3—25 to 60 inches, dark-brown (10YR 4/3) silty clay; many, medium, prominent, gray (5YR 5/1) mottles; moderate, fine, angular blocky structure; very firm; calcareous.

The surface layer is black and is 4 to about 10 inches thick in some areas. A layer of muck, 1 to 12 inches thick, is at the surface in a few areas. A few thin lenses of loamy fine sand or sandy loam, 1 to 4 inches thick, are present in a few areas above a depth of 42 inches. Reaction throughout the surface layer and subsoil ranges from medium acid to mildly alkaline.

Pinconning soils have coarser textured upper layers than Munuscong soils and finer textured lower layers than Brevort soils. Pinconning soils are more poorly drained than Allendale soils.

Pinconning loamy sand (Pn).—This soil is nearly level and is in depressed areas along drainageways and also in depressions on uplands and plains. The surface layer is very dark brown or black. It is predominantly loamy sand but is sand or fine sand in areas of limited extent. A layer of muck, 1 to 12 inches thick, is at the surface in a few areas. There are thin layers of sandy loam in the upper sandy part of the soil in places. Thickness of the sandy part of the soil profile is variable over short distances, and in some places this part is more than 25 inches thick.

Wetness, very slow permeability in the lower part of the soil profile, and moderately low available moisture capacity after drainage are major limitations to the use of this soil for crops.

Most areas of the soil are in forest. Some areas have been cut over or are in pasture. A few areas are planted to crops, primarily small grains and hay. (Capability unit IIIw–10 (4/1c); woodland suitability group W)

Richter Series

Soils of this series are somewhat poorly drained and are stratified. They are undulating and gently sloping and are on till and lake plains and moraines. These soils formed in layers of fine sandy loam, sandy loam, loamy fine sand, loamy sand, and occasional layers of gravelly sand.

The surface layer is very dark brown sandy loam about 2 inches thick. It has moderate granular structure and is very friable. The subsurface layer is pale-brown loamy sand about 5 inches thick. It has single grain structure and is loose.

The subsoil consists of alternate layers of sandy loam and sandy clay loam. These are dark brown and are mottled with light reddish brown and light brownish gray. The upper part of the subsoil has weak blocky structure, and the lower part has moderate blocky structure. This material is very friable to firm.

Below the subsoil, at a depth of about 28 inches, is stratified loamy sand and sandy loam mottled with grayish brown. This material is single grain, loose, and high in lime content.

Available moisture capacity of these soils is moderately high, and natural fertility is moderate. Permeability is moderately rapid. Surface runoff is slow, and water ponds in depressed areas or on nearly level flats. The water table is at or near the surface unless these soils are artificially drained. Excess wetness limits the use of these soils for crops.

Some of the better drained areas of these soils have been cleared of trees and are planted to crops or are in pasture. Undrained or poorly drained areas remain in woods. The native vegetation was swamp oak, mixed hardwoods, alder, willow, shrubs, and grasses.

Typical profile of Richter sandy loam, 2 to 6 percent slopes:

O1—1 inch to 0, very dark brown (10YR 2/2) organic matter; some undecomposed plant tissue; medium acid; abrupt, smooth boundary.

A1—0 to 2 inches, very dark brown (10YR 2/2) sandy loam; moderate, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—2 to 7 inches, pale-brown (10YR 6/3) loamy sand; single grain; loose; slightly acid; abrupt, wavy boundary.

Bir—7 to 13 inches, dark-brown (10YR 4/3) sandy loam; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; very friable; slightly acid; abrupt, wavy boundary.

B't—13 to 28 inches, dark-brown (10YR 4/3), stratified sandy loam and sandy clay loam; many, medium, prominent, light reddish-brown (2.5YR 6/4) and light brownish-gray (10YR 6/2) mottles; moderate, medium, subangular blocky structure; firm; neutral; abrupt, smooth boundary.

C—28 to 60 inches, light-brown (7.5YR 6/4) stratified loamy sand and sandy loam; many, medium, prominent, grayish-brown (10YR 5/2) mottles; sandy loam is massive and firm; loamy sand is single grain and loose; calcareous.

The surface layer is very dark gray in some areas and is 1 to 4 inches thick. Light-gray or light brownish-gray sandy loam lies between the upper and lower part of the subsoil in some areas. Thickness and sequence of the layers of the soil profile vary greatly within short distances. Thickness of the individual layers ranges from 2 to 12 inches. Combined thickness of the surface layer and subsoil ranges from 20 to 40 inches.

Richter soils have a coarser textured profile than the Brimley soils but have a finer textured profile than the Au Gres soils.

Richter sandy loam, 2 to 6 percent slopes (RcB).—This soil is gently sloping or undulating and is on plains and uplands. The surface layer is very dark brown and is predominantly sandy loam. The layers beneath the surface layer are predominantly loamy sand and sandy loam, but thin lenses of sand and clay loam are present in many areas. Included in mapping some areas of this soil were small areas of Tonkey, Coral, and Otisco soils. Slopes are less than 2 percent in some areas of this soil.

Excess wetness in spring is the main limitation to the use of this soil for crops. Most of the soil is pastured or is planted to crops. Some areas are in forest. Crops grown include corn, small grains, hay, and in small acreages, potatoes. (Capability unit IIw–7 (2.5b); woodland suitability group G)

Rifle Series

The soils of this series are very poorly drained organic soils and are in depressed areas on till, outwash, and lake plains and moraines. They formed in material derived from coniferous and deciduous woody and fibrous material. The organic material is more than 42 inches thick.

The surface layer is dark-brown peat about 14 inches thick. The upper part of this layer has moderate granular structure and is friable. The lower part contains woody fragments, has weak platy structure, and is friable.

Below the surface layer, to a depth of 50 inches or more, is brown or yellowish-brown peat. This material has fine fibrous structure and is friable. Plant stems and leaves are in the lower part of this layer.

Available moisture capacity of these soils is high, and natural fertility is low. Movement of water through the soil is variable but is generally moderately rapid. Surface runoff is very slow, and water ponds in the lowest areas, especially during spring and after rains. The soils usually are low in content of phosphorus and potassium and of many micronutrients.

A high water table and low fertility limit the use of these soils for crops. Frost and wind erosion are a hazard to crops, even when the soils are drained. Most areas of Rifle soils are in trees or brush. A few areas have been cleared and are in crops. The native vegetation was elm, ash, tamarack, spruce, cedar, aspen, and willow.

Typical profile of Rifle peat:

1—0 to 4 inches, dark-brown (7.5YR 3/2) peat; moderate, medium, granular structure; nonsticky when wet, friable when moist; very strongly acid; gradual, wavy boundary.

2—4 to 14 inches, dark-brown (7.5YR 3/2) peat; layers of woody fragments; weak, medium, platy structure; nonsticky when wet; very strongly acid; clear, wavy boundary.

3—14 to 36 inches, brown (7.5YR 5/4) peat; fine, fibrous; nonsticky when wet; medium acid; clear, wavy boundary.

4—36 to 50 inches +, yellowish-brown (10YR 5/6) peat; fine, fibrous; numerous distinguishable plant stems and leaves; nonsticky when wet; medium acid.

In some areas the surface layer is brown or yellowish brown. Color of the material below the surface layer is yellowish brown or reddish brown in a few areas. Thickness of the organic material ranges from 42 inches to 10 feet or more. The amount of woody material in the profile varies. The size of the fragments of woody material ranges from small to very large, and there are partially decomposed logs in some places.

Rifle soils are less acid than Greenwood soils but are more acid than Carbondale, Lupton, or Houghton soils. The Rifle soils have a thicker layer of organic material than either the Tawas or Adrian soils.

Rifle loam, overwash (Re).—This soil is nearly level and is in depressed areas. The surface layer is very dark brown loam or silt loam 6 to 14 inches thick. It is underlain by peat. Small areas of this soil have a muck or peat surface layer. Organic soils, underlain by sand or loam at a depth of 30 to 42 inches, were included in mapping some areas of this soil.

The soil is saturated most of the year because of a high water table. Even when drained it remains cold and dries slowly. Excess wetness and low fertility limit its use for crops, and frost is a hazard in most years. Most areas of this soil are in forest or in native grasses and sedges. (Capability unit Vwc–1 (Mc); woodland suitability group J)

Rifle muck (Rf).—This soil is nearly level and is in depressed areas. The surface layer is black muck 6 to about 14 inches thick. It is underlain by peat. Small areas with a peat surface layer, and small areas of Tawas soils, were included in the mapping in many areas of this soil.

This soil is saturated most of the year because of a high water table. It dries slowly, even when drained. Low fertility and a frost hazard also limit its use for crops. Most areas of this soil are in trees or in native grasses and sedges. (Capability unit Vwc–1 (Mc); woodland suitability group J)

Rifle peat (Rl).—This soil is nearly level and is in depressed areas. The surface layer is dark-brown peat. Peat also lies below the surface layer. Small areas of Tawas muck, underlain by sand at a depth of less than 42 inches, are at the outer edges of many areas of this soil and were included in mapping.

This soil is saturated most of the year because of a high water table. It remains cold and dries slowly, even when drained. Low fertility and a frost hazard also limit its use

for crops. Most areas of this soil are in trees or in native grasses and sedges. (Capability unit Vwc–1 (Mc); woodland suitability group J)

Roscommon Series

Soils of this series are poorly drained and very poorly drained and are sandy. They are nearly level or in depressed areas and are on outwash plains and in drainageways left by glacial action. These soils formed in medium and coarse sands more than 60 inches thick.

The surface layer is black mucky sand about 4 inches thick. It has very weak granular structure and is very friable.

Below the surface layer, to a depth of about 32 inches, is light browish-gray or grayish-brown sand. It has single grain structure and is loose. It has distinct, dark grayish-brown mottles in the lower part.

The material below a depth of 32 inches and down to a depth of 42 inches or more is grayish-brown sand mottled with pale brown. It has single grain structure, is loose, and is high in lime content.

Available moisture capacity and natural fertility of these soils are low. Water moves very rapidly through the profile in the absence of a high water table. Surface runoff is very slow, and water ponds in depressed areas. The water table is at or near the surface unless the soils are artificially drained.

Use of these soils for crops is limited by excess wetness, low fertility, and sandiness. Most areas of these soils are in second-growth aspen, willow, black spruce, and white-cedar. A small acreage is in permanent pasture. The native vegetation was principally elm, hemlock, ash, aspen, black spruce, and white-cedar.

Typical profile of Roscommon mucky sand:

A1—0 to 4 inches, black (10YR 2/1) mucky sand; very weak, fine, granular structure; very friable; slightly acid; abrupt, wavy boundary.

C1—4 to 14 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; slightly acid; gradual, wavy boundary.

C2—14 to 32 inches, grayish-brown (10YR 5/2) sand; common, coarse, distinct, dark grayish-brown (10YR 4/2) mottles; single grain; loose; neutral; gradual, wavy boundary.

C3—32 to 60 inches, grayish-brown (10YR 5/2) sand; common, coarse, faint, pale-brown (10YR 6/3) mottles; single grain; loose; calcareous.

A layer of muck or peat, 2 to 10 inches thick, is at the surface in some areas. In cultivated areas the surface layer is grayish brown to dark grayish brown. Reaction to a depth of 30 inches ranges from slightly acid to mildly alkaline.

Roscommon soils are coarser textured than Tonkey soils and are more poorly drained and grayer than Au Gres soils. Their drainage is similar to that of Kinross soils, but they are less acid.

Roscommon mucky sand and sand (Rm).—This soil is nearly level and is in depressed areas on plains and drainageways. The surface layer is black mucky sand or sand 2 to 8 inches thick. The layers beneath the surface layer are commonly gray. In some places small areas of less than 1 acre of Tawas muck were included in mapping this soil. Slopes exceed 3 percent in a few areas.

This soil is saturated. Low available moisture capacity, low fertility, wetness, and a wind-erosion hazard severely limit its use for crops.

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Most areas of this soil are in trees or are covered by willow and tag alder thickets. Some areas have been cleared and are in pasture. (Capability unit IIIw–11 (5c); woodland suitability group Q)

Rousseau Series

The soils of this series are well drained and sandy and are gently sloping to moderately steep. They are on outwash and till plains, moraines, and deltas. These soils formed in fine and very fine sands and in loamy sands.

The surface layer is very dark grayish-brown fine sand about 8 inches thick. It has very weak granular structure and is very friable. The subsurface layer is light brownish-gray fine sand about 3 inches thick. It has very weak platy structure and is very friable.

The upper part of the subsoil is reddish-brown loamy fine sand about 2 inches thick. It has very weak blocky structure and is very friable. The lower part is dark yellowish-brown fine sand about 11 inches thick. It has very weak blocky structure and is very friable.

Below the subsoil, at a depth of about 24 inches, is brown or pale-brown stratified fine sand and very fine sand. This material is single grain and loose.

Available moisture capacity and natural fertility of these soils are moderately low. Water moves rapidly through the soil layers. Surface runoff ranges from slow in gently sloping areas to medium in moderately steep areas.

Sandiness and a moderately low available moisture capacity severely limit the use of these soils for crops. Wind erosion is a hazard if large areas are cultivated.

Most areas of these soils are in a cutover state, are in pasture, or have been planted to trees. A small acreage is in crops and is planted to wheat, oats, hay, or corn. The native vegetation was mixed hardwoods and pines.

Typical profile of Rousseau fine sand:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) fine sand; very weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—8 to 11 inches, light brownish-gray (10YR 6/2) fine sand; very weak, thick, platy structure; very friable; medium acid; abrupt, wavy boundary.

B21hir—11 to 13 inches, reddish-brown (5YR 4/3) loamy fine sand; very weak, fine, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

B22ir—13 to 24 inches, dark yellowish-brown (10YR 4/4) fine sand; very weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.

C1—24 to 60 inches, brown (10YR 5/3), stratified fine sand and very fine sand; single grain; loose; medium acid; gradual, wavy boundary.

C2—60 inches +, pale-brown (10YR 6/3), stratified fine sand and very fine sand; single grain; loose; neutral.

The plow layer is dark grayish brown in some areas and is 6 to 10 inches thick. In undisturbed areas the surface layer is very dark gray and is 1 to 4 inches thick. The subsurface layer is absent in some cultivated areas. Thin layers of silt and fine sandy loam are in the subsoil in some areas. The material below the subsoil is generally fine sand or very fine sand but ranges to stratified fine and very fine sand and loamy sand. Reaction of the surface layer and subsoil ranges from strongly acid to slightly acid.

Rousseau soils formed in finer textured sands than either Rubicon or Grayling soils. They are finer textured than Grayling soils.

Rousseau fine sand, 2 to 6 percent slopes (RnB).—This soil is gently sloping or undulating and is on uplands and plains. The surface layer is very dark grayish brown and is predominantly fine sand or loamy fine sand. In a few areas the surface layer is brown. The underlying layers are predominantly fine sand stratified with very fine sand and loamy fine sand. In a few areas there are thin layers of coarse and medium sand.

The sandiness and moderately low fertility of this soil moderately limit its use for crops. It is subject to wind erosion if large areas are exposed by cultivation. Runoff is slow, and water erosion is seldom a hazard on the gentle slopes.

Some areas of this soil are idle, some are in permanent pasture, and some are in crops. Crops grown include corn, small grains, and hay. (Capability unit IIIs–4 (4a) ; woodland suitability group C)

Rousseau fine sand, 6 to 12 percent slopes (RnC).—This soil is sloping and is on uplands and plains. The surface layer is very dark grayish brown and is predominantly loamy fine sand or fine sand. In some places, particularly on the upper parts of the slopes, the surface layer is brown. Spots of loamy sand, very fine sand, and sand are on the surface in a few places. There are seep spots on some of the lower slopes, but these dry during summer. Some layers of coarse and medium sand are present in the soil profile.

A hazard of wind and water erosion and a shortage of available soil moisture moderately limit the use of this soil for crops.

Most areas of this soil are idle or in pasture, but a few areas are in trees. Small acreages are in crops and are planted to corn, small grains, and hay. (Capability unit IIIe–9 (4a) ; woodland suitability group C)

Rousseau fine sand, 12 to 18 percent slopes (RnD).—This soil is moderately steep and is on uplands and plains. The surface layer is very dark grayish brown and is predominantly loamy fine sand or fine sand. In some areas, particularly on the upper parts of slopes, the surface soil is brown. There are layers of coarse and medium sand in some areas. Spots of loamy sand, very fine sand, and sand are on the surface in a few areas. Seep spots occur on some of the lower slopes, but they usually dry during summer.

Moderately low available moisture capacity, moderately low fertility, and a hazard of wind and water erosion limit the use of this soil for crops.

Most areas of this soil are idle or in pasture. A few areas are in trees. A small acreage is in crops and is planted to small grains and hay. (Capability unit IVe–9 (4a) ; woodland suitability group C)

Rubicon Series[3]

Soils of this series are well drained and sandy and range from level to very steep. They are in till and outwash plains and moraines, and they formed in medium and coarse sands.

In undisturbed areas the surface layer is black sand about 2 inches thick. It has very weak granular structure and is very friable. The subsurface layer is light brownish-gray sand about 4 inches thick. It is single grain and loose.

The subsoil is predominantly sand and is about 24 inches thick. The upper 8 inches is dark brown, has very weak blocky structure, and is very friable. The lower part is strong brown or yellowish brown, has single grain structure, and is loose. Below the subsoil, at a depth of about 30 inches, is pale-brown sand that is single grain and loose.

The loamy substratum phases of the Rubicon series are underlain by loam to clay material at depths ranging from 42 to 66 inches.

The available moisture capacity and natural fertility of Rubicon soils are low. Water moves very rapidly through the soil layers. Rate of surface runoff varies from slow in nearly level areas to medium in steep areas. The low available moisture capacity restricts plant growth during midsummer and seriously reduces crop yields in dry summers.

Because of the sandy and droughty condition of Rubicon soils, only a small acreage is used for crops. A wind erosion hazard also limits use of large areas for cultivated crops. Most areas that were once cleared of trees for crop use are now idle or have been reforested. A small acreage is used for small grains and hay crops. The native vegetation consisted mainly of red and white pine, aspen, red maple, and a ground cover of brambles, wintergreen, sweetfern, and bracken.

Typical profile of a Rubicon sand:

O1—1 inch to 0, partially decomposed leaves and leaf mold; strongly acid.
A1—0 to 2 inches, black (10YR 2/1) sand; very weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.
A2—2 to 6 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; medium acid; abrupt, irregular boundary.
B21hir—6 to 14 inches, dark-brown (7.5YR 4/4) sand; very weak, fine, subangular blocky structure; very friable; strongly acid; gradual, wavy boundary.
B22ir—14 to 26 inches, strong-brown (7.5YR 5/6) sand; single grain; loose; medium acid; gradual, wavy boundary.
B3—26 to 30 inches, yellowish-brown (10YR 5/6) sand; single grain; loose; medium acid; diffuse, wavy boundary.
C—30 to 60 inches, pale-brown (10YR 6/3) sand; single grain; loose; medium acid.

In cultivated areas the surface layer is very dark grayish brown and is about 9 inches thick. In some areas the surface layer of undisturbed soils is very dark gray and is 1 to 3 inches thick. The subsurface layer is light gray or pinkish gray in some areas and is 2 to 6 inches thick. Combined thickness of the surface layer and subsoil ranges from 20 to 36 inches. Reaction of these layers ranges from strongly acid to slightly acid.

Rubicon soils formed in coarser sands than the Rousseau soils. They are better drained than the Au Gres soils and slightly better drained than the Croswell soils, and they lack the mottles that are common to these two soils. Their subsoil layers are less well developed than those of the Kalkaska soils.

Rubicon sand, 0 to 6 percent slopes (RoB).—This soil is nearly level or gently sloping and is on plains and uplands. The surface layer is very dark gray or black in most areas and is predominantly sand. A few areas have a brown surface layer. Below the surface layer are layers of sand or coarse sand. In many places numerous thin loamy sand layers occur at depths below 6 feet. Included in mapping this soil were a few areas that have a fine sand or gravelly sand surface layer. Also included in many places were small areas of Croswell and Kalkaska soils. These

[3] The loamy substratum phases of the Rubicon series will continue to be classified as Melita soils by the Michigan Agricultural Experiment Station.

included soils are similar to this Rubicon soil and are similar in the use and management they need.

Low available moisture capacity, low fertility, and a wind erosion hazard limit the use of this soil for crops. It is droughty during dry summer months.

Most areas of this soil remain in forest. Some have been cleared and are now idle or are reforested. (Capability unit VIIs–1 (5.3a); woodland suitability group H)

Rubicon sand, 6 to 12 percent slopes (RoC).—This soil is sloping and is on plains and uplands. The surface layer is very dark gray and is predominantly sand. In small eroded areas the surface layer is brown or pale brown. Thin loamy sand layers lie below a depth of 6 feet in some areas. Included in mapping this soil were a few areas that have a fine sand or gravelly sand surface layer.

Low available moisture capacity, low fertility, and a hazard of wind and water erosion severely limit the use of this soil for crops.

Most areas of this soil are in forest. Some areas have been cleared but are now idle or have been reforested. (Capability unit VIIs–1 (5.3a); woodland suitability group H)

Rubicon sand, 12 to 18 percent slopes (RoD).—This soil is moderately steep and is on the edges of plains and on uplands. The surface layer is very dark grayish brown and is predominantly sand. In a few areas the surface layer is brown. Thin loamy sand layers are at a depth of 6 feet or more in some areas. Included in mapping this soil were a few areas having a fine sand or gravelly sand surface layer.

Low available moisture capacity, low fertility, and a hazard of wind and water erosion severely limit use of this soil for crops. Slope and sandiness of the soils limit the use of equipment.

Most areas of this soil are in forest. Some areas have been cleared but are now idle or have been replanted to pines. (Capability unit VIIs–1 (5.3a); woodland suitability group H)

Rubicon sand, 18 to 25 percent slopes (RoE).—This soil is steep and is on uplands and plains. The surface layer is very dark grayish-brown sand in most areas. In some areas it is brown, and in some areas the texture is fine sand. There are shallow gullies in some areas. Small areas of Chelsea soils were included in mapping a few areas of this soil.

Low fertility, low available moisture capacity, and a wind and water erosion hazard severely limit the use of this soil for crops. Steep slopes and the sandiness of the soil limit the use of farm machinery and tree-planting machinery.

Many areas of this soil are in forest. Some areas are idle, and others support a growth of briers, brush, and grass. (Capability unit VIIs–1 (5.3a); woodland suitability group H)

Rubicon sand, 25 to 55 percent slopes (RoF).—This soil is very steep and is on uplands. The surface layer is dark gray sand in most areas, but it is fine sand in a few areas. Color of the surface layer is brown in the small eroded areas. In some areas there are thin loamy sand layers at a depth of 6 feet or more. Shallow gullies occur in a few places, and there are some eroded spots that are the result of clear cutting and burning. Slopes range outside specified limits over short distances.

Low available moisture capacity, low fertility, and a hazard of wind and water erosion severely limit the use of this soil for crops. The very steep slopes severely limit the use of farm implements and tree-planting machinery.

Most areas of this soil are in trees. (Capability unit VIIs–1 (5.3a); woodland suitability group H)

Rubicon sand, loamy substratum, 0 to 6 percent slopes (RuB).—This soil is nearly level and is on uplands and plains. The surface soil is dark brown in a few areas and is loamy sand in some areas of limited extent. Thickness of the sandy part of the soil profile is variable over short distances and ranges from less than 42 to more than 66 inches. Small areas of Rubicon soils were included with this soil in mapping; in these areas the sandy material is more than 66 inches thick. These areas are more droughty than areas of this soil.

Sandiness, droughtiness, low fertility, and a wind erosion hazard limit the use of this soil for crops. Most areas are in trees or pasture. Small areas are in crops. Small grains and hay are grown. (Capability unit IVs–4 (5/2a); woodland suitability group C)

Rubicon sand, loamy substratum, 6 to 12 percent slopes (RuC).—This soil is sloping and is near areas of deep, sandy soils and of soils that developed in loam to clay till. The surface layer is very dark grayish brown in most areas but is brown or dark brown in some areas of limited extent. In cultivated areas the surface layer is mixed with the subsurface layer. The thickness of the sandy material is variable over short distances and ranges from less than 42 to more than 66 inches. Small areas of other Rubicon soils were included in mapping some areas of this soil.

A moderate erosion hazard, low available moisture capacity, and low fertility are the major limitations to the use of this soil for crops.

The soil is used for pasture, crops, and trees. Crops commonly grown are small grains and hay. (Capability unit VIs–1 (5/2a); woodland suitability group C)

Rubicon sand, loamy substratum, 12 to 18 percent slopes (RuD).—This soil is moderately steep and is near deep, sandy soils and near soils that developed in loam to clay till. The surface soil is very dark grayish brown in most areas, but in some areas it is brown or dark brown. Thickness of the sandy material is variable over short distances and ranges from less than 42 inches to more than 66 inches. Small areas of Rubicon soils were included in mapping most areas of this soil.

Moderately steep slopes, low available moisture capacity, moderately low fertility, and a severe hazard of wind and water erosion are the major limitations to use of this soil for crops.

Most areas of this soil are in pasture and crops, but some areas are in trees. Crops commonly grown are small grains and hay. (Capability unit VIIs–1 (5/2a); woodland suitability group C)

Rubicon sand, loamy substratum, 18 to 25 percent slopes (RuE).—This soil is steep and is near areas of deep, sandy soils and soils that developed in loam to clay till. The surface soil is very dark grayish brown in most areas but is brown or dark brown in areas of limited extent. Thickness of the sandy layers is variable over short distances and ranges from less than 42 to more than 66 inches. Small areas of other Rubicon soils and of Menominee and Manistee soils were included in mapping most areas of this soil.

Steep slopes, low available moisture capacity, moderately low fertility, and a severe hazard of wind and water erosion are major limitations to use of this soil for crops.

Most areas of this soil are in pasture and forest. Some areas are in crops. Crops commonly grown are small grains and hay. (Capability unit VIIs–1 (5/2a); woodland suitability group C)

Saranac Series

The soils of this series are poorly drained and very poorly drained and are level. They formed in stratified material deposited by floodwaters. The stratified material is mainly clay loam and silty clay loam.

The surface layer of these soils is very dark brown loam about 9 inches thick. It has moderate granular structure and is friable.

Dark-gray silty clay loam underlies the surface layer to a depth of about 24 inches. This material is mottled with reddish brown and dark brown, has weak blocky structure, and is firm.

Below 24 inches there is grayish-brown, stratified clay loam and silty clay loam mottled with dark brown. It is massive and firm.

Available moisture capacity and fertility of these soils are high. The water table is at or near the surface, and runoff is very slow. Water moves moderately slowly through these soils when they are drained, and they are subject to flooding, especially in spring.

Most areas of these soils are in pasture or in woods. The native vegetation was hardwood trees, grasses, and sedges.

Typical profile of Saranac loam:

A1—0 to 9 inches, very dark brown (10YR 2/2) loam; moderate, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

Bg—9 to 24 inches, dark-gray (10YR 4/1) silty clay loam; common, medium, distinct, reddish-brown (5YR 4/4) and dark-brown (7.5YR 4/4) mottles; weak, medium, subangular blocky structure; firm; neutral; gradual, wavy boundary.

C—24 to 60 inches, grayish-brown (2.5Y 5/2) stratified clay loam and silty clay loam; thin layers of sandy loam and sand; common, medium, distinct, dark-brown (7.5YR 4/4) mottles; massive; firm; mildly alkaline.

In the lowest areas a layer of muck or peat, 1 to 12 inches thick, lies on the surface. In other areas the surface layer is 7 to 12 inches thick. Thin layers of sand, sandy loam, and clay are in the soil profile in some areas. Reaction ranges from slightly acid to very strongly alkaline.

Saranac soils and Sloan soils are in similar positions. Both are poorly drained or very poorly drained, but Saranac soils are finer textured.

Saranac loam (Sa).—This soil is on narrow flats and depressions along streams and rivers. It is near numerous upland soils, which are on and above banks indicated by escarpment symbols on the soil map. The surface layer of this Saranac soil is black or very dark gray loam or silt loam 6 to 12 inches thick. Below this depth clay loam or silty clay loam dominates in the soil profile.

This soil is wet most of the time, and water is frequently ponded. The soil is subject to flooding during the growing season. Use of this soil for crops is severely limited by the flooding hazard, the high water table, and a frost hazard. (Capability unit Vw–3 (L–2c); woodland suitability group O)

Saugatuck Series

Soils of this series are somewhat poorly drained or poorly drained and are sandy. They are nearly level to gently sloping or are in depressions and are on outwash, lake, and till plains. These soils formed in medium and coarse sand.

The surface layer in undisturbed areas is black sand about 3 inches thick. It has very weak granular structure and is very friable. The subsurface layer is light brownish-gray sand about 12 inches thick. It has single grain structure and is loose.

The upper part of the subsoil is very dusky red sand about 9 inches thick. It is strongly cemented and very strongly acid. The middle part of the subsoil is reddish-brown sand about 7 inches thick. It has many dark-red mottles and is massive. The lower part of the subsoil is strong-brown sand about 6 inches thick. It is single grain and loose.

Very pale brown sand is at a depth of about 36 inches. It is single grain and loose.

Available moisture capacity and natural fertility of these soils are low. Water moves through the upper part of the profile very rapidly, but permeability of the cemented layer is moderately slow. Surface runoff is very slow to ponded. The water table is at or near the surface during spring but recedes in summer. During dry summer months these soils are droughty. In many areas the cemented layer in the upper part of the subsoil limits root growth.

Most areas of these soils are in second-growth forest, but some are in pasture. A few small areas have been planted to small grains or hay, but use of these soils for crops is severely limited by the excess wetness in spring, by their low available moisture capacity, and by their low natural fertility. The native vegetation was aspen, white-cedar, black spruce, and a few white pine, oak, elm, and maple trees. There was a ground cover of bracken fern and grasses.

Typical profile of Saugatuck sand:

O1—1 inch to 0, organic mat of partially decomposed leaves and twigs; mass of fine roots.

A1—0 to 3 inches, black (5YR 2/1) sand; very weak, fine, granular structure; very friable; mass of fine roots; strongly acid; abrupt, smooth boundary.

A2—3 to 15 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; very strongly acid; abrupt, wavy boundary.

B21hm—15 to 24 inches, very dusky red (2.5YR 2/2) sand; massive; strongly cemented (ortstein); very strongly acid; clear, irregular boundary.

B22hirm—24 to 31 inches, reddish-brown (5YR 4/4) sand; many, medium, distinct, dark-red (2.5YR 3/6) mottles; massive; strongly cemented in upper part; gradual change to weakly cemented in lower part; strongly acid; gradual, irregular boundary.

B3—31 to 37 inches, strong-brown (7.5YR 5/6) sand; single grain; loose; strongly acid; gradual, wavy boundary.

C—37 to 60 inches, very pale brown (10YR 7/4) sand; single grain; loose; strongly acid.

The surface layer is very dark gray in some areas and is 1 to 5 inches thick. In a few areas the subsurface layer is pinkish gray and is 2 to 15 inches thick. In cultivated areas the surface layer is very dark brown or dark gray and is 6 to 10 inches thick. The cemented part of the subsoil is 6 to 20 inches thick. Reaction of the surface layer and subsoil ranges from medium acid to extremely acid.

The cemented horizon in the subsoil of Saugatuck soils is absent in the Au Gres soils. The Saugatuck soils lack the finer

textured underlying material of the Ogemaw soils. Saugatuck soils are better drained and not so gray as Roscommon or Kinross soils.

Saugatuck sand, 0 to 6 percent slopes (ScB).—This soil is nearly level or gently sloping. It is in areas of acid sand near the edge of wet depressions where the water table is about 2 or 3 feet below the surface. The surface layer of this soil is black sand. Many areas have a microhummocky relief, commonly called cradle knolls. These knolls result when wind uproots shallow-rooted trees. Small spots of Au Gres sand and Kinross sand were included in mapping many areas of this soil.

Use of this soil for crops is severely limited by excess wetness in spring, low fertility, low available moisture capacity, and droughtiness.

Most areas of this soil are in forest, but a few areas are in permanent pasture. (Capability unit IVw–2 (5b–h); woodland suitability group F)

Selkirk Series

Soils of this series are somewhat poorly drained, are nearly level or gently sloping, and are on till plains. They formed in clay material.

In cultivated areas the surface layer is dark-gray loam about 7 inches thick. It has weak granular structure and is very friable. The subsurface layer is pale-brown loam about 4 inches thick. It has distinct, yellowish-brown mottles and weak platy structure, and it is friable.

The subsoil is reddish-brown silty clay about 11 inches thick. It has distinct, light-gray mottles and strong blocky structure, and it is very firm.

A dark reddish-brown silty clay underlies the subsoil at a depth of about 22 inches. This layer is mottled with light reddish brown and has moderate blocky structure. It is very firm and is high in lime content.

Available moisture capacity of these soils is high, and natural fertility is moderately high. Because of their clayey texture, water moves slowly through these soils. Surface runoff is slow and ponds in depressed areas. The mottled condition of the subsoil indicates that the soil is saturated for extended periods.

Excess wetness and poor surface drainage limit use of these soils for crops. Some areas of these soils have been cleared and are planted to crops. Most areas are in trees or pasture. Crops commonly grown are wheat, oats, hay, and to some extent, corn. The native vegetation was hardwoods, principally maple, elm, ash, beech, and ironwood. There was also some balsam fir, white-cedar, and hemlock.

Typical profile of Selkirk loam:

Ap—0 to 7 inches, dark-gray (10YR 4/1) loam; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—7 to 11 inches, pale-brown (10YR 6/3) loam; few, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, platy structure; friable; slightly acid; abrupt, irregular boundary.

B—11 to 22 inches, reddish-brown (5YR 5/3) silty clay; many, medium, distinct, light-gray (10YR 6/1) mottles; strong, medium, angular blocky structure; very firm; medium acid; abrupt, wavy boundary.

Cg—22 to 60 inches, dark reddish-brown (5YR 3/3) silty clay; many, coarse, distinct, light reddish-brown (5YR 6/3) mottles; moderate, medium, angular blocky structure; very firm; calcareous.

In undisturbed areas the surface layer is very dark gray loam 1 to 3 inches thick. In some cultivated areas the surface layer is very dark gray and is 6 to 9 inches thick. The subsurface layer is pinkish gray or light brownish gray in some areas and is 1 to 7 inches thick. Depth to mottling ranges from 7 to about 15 inches. Combined thickness of the surface layer and subsoil ranges from 14 to about 30 inches. Reaction of these layers ranges from slightly acid to medium acid. In a few areas the subsoil and material below the subsoil are clay.

Selkirk loam, 0 to 2 percent slopes (SeA). This soil is nearly level and is adjacent to shallow drainageways on the uplands. The surface layer is dark-gray loam 7 to about 12 inches thick. Small spots of Allendale loamy sand and of Pickford soils are in parts of the drainageways and are included in mapping this soil.

Excess wetness and poor surface drainage limit use of this soil for crops. Frost also is a hazard in low depressions.

Most areas of this soil remain in trees. Some areas are in pasture. A few areas have been drained and planted to small grains, hay, and corn. (Capability unit IIIw–2 (1b); woodland suitability group Z)

Selkirk loam, 2 to 6 percent slopes (SeB).—This soil is gently sloping and undulating and is on uplands. The surface layer is dark-gray loam 7 to about 12 inches thick. In some areas, particularly those forested, the surface soil is very dark gray. Limy silty clay underlies the surface layer at a depth of about 18 inches. Small spots of Allendale loamy sands and of Pickford soils were included in mapping many areas of this soil. Slopes range slightly outside the specified limits for short distances.

Excess wetness and poor surface drainage limit the use of this soil for crops. Frost also is a hazard in low depressions.

Most areas of this soil remain in trees. Some areas are in pasture, and a few have been drained and planted to small grains, hay, and corn. (Capability unit IIIw–2 (1b); woodland suitability group Z)

Shoals Series[4]

Soils of this series are somewhat poorly drained and are on level bottom lands along streams. They formed in stratified material, predominantly loam, silt loam, and sandy loam.

The surface layer is very dark gray loam about 8 inches thick. It has weak granular structure and is friable.

Below the surface layer is brown stratified loam, silt loam, and sandy loam mottled with dark reddish brown. This material lacks structure and is friable.

Available moisture capacity of these soils is moderate and fertility is high. Water moves through the soil at a moderate rate, and surface runoff is very slow. Because of a fluctuating high water table, these soils are excessively wet during spring and after a prolonged rain. They also are subject to flooding.

Most areas of Shoals soils are in woods and are used for recreation or as wildlife habitats. A few areas are in permanent pasture. The native vegetation consisted of hardwoods, including elm and alder.

Typical profile of Shoals loam:

A1—0 to 8 inches, very dark gray (10YR 3/1) loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

C—8 to 60 inches, brown (10YR 5/3), stratified loam, silt loam, and sandy loam; many, medium, distinct, dark red-

[4] The Michigan Agricultural Experiment Station will continue to name these soils Pennock.

dish-brown (5YR 3/3) mottles; massive; friable; individual strata range from 3 to 12 inches thick; calcareous.

The surface layer is black in some areas and is 4 to 9 inches thick. It ranges from loamy sand to loam. In a few areas there are thin layers of sand, clay loam, and silty clay loam below the surface. Reaction of the surface layer ranges from slightly acid to mildly alkaline. Reaction of the underlying material ranges from neutral to calcareous.

Shoals soils are in positions similar to those of the Algansee soils but are finer textured and less droughty. Shoals soils are better drained and the subsoil and underlying material are not so gray as that of the Sloan soils.

Shoals loam (Sh).—This soil is on nearly level bottom lands along streams. The surface layer is predominantly loam, but it is sandy loam or silt loam in some small areas. A few small areas have a loamy sand surface layer. Narrow bars of sand or gravel and narrow elongated areas of the poorly drained Sloan soils were included in mapping some areas of this soil.

Use of the soil for crops is severely limited by hazard of flooding and frost and by excess wetness resulting from a fluctuating high water table. Also, individual areas of this soil are small.

Most areas of the soil are in trees but some are in pasture. (Capability unit Vw–3 (L–2c); woodland suitability group O)

Shoals loamy sand (Sl).—This is a nearly level soil on bottom lands adjacent to streams and rivers. The surface layer is predominantly loamy sand, but in some small areas it ranges to sand. The surface layer rests directly on stratified loam, silt loam, or sandy loam at a depth of 6 to 10 inches. Narrow areas of sand or gravel and small areas of Sloan soils are in shallow elongated depressions and were included in mapping some areas of this soil. These depressions are wet most of the time, and water often ponds in them after floods. This soil is more droughty and less fertile than the Shoals loam.

Use of the soil for crops is severely limited by periodic flooding, excess wetness resulting from a fluctuating high water table, a frost hazard, and the small size and odd shape of individual areas.

Most areas of this soil are in forest, but some are in pasture. (Capability unit Vw–3 (L–2c); woodland suitability group O)

Sims Series

Soils of this series are poorly drained or very poorly drained. They are in level or depressed areas on till plains or low moraines. They formed in clay loam or silty clay loam material deposited by glaciers.

The surface layer in cultivated areas is black loam about 7 inches thick. It has moderate granular structure and is friable.

The subsoil is light brownish-gray clay loam about 25 inches thick. It is mottled with yellowish brown or strong brown. This layer has moderate blocky structure and is firm.

Below the subsoil, at a depth of about 32 inches, is light-gray clay loam mottled with yellowish brown. It has weak blocky structure, is firm, and is high in lime content.

Available moisture capacity and natural fertility of these soils are high. Water moves moderately slowly through the soil profile. Surface runoff is very slow, and water ponds in depressed areas. The subsoil is saturated for long periods.

Some areas of Sims soils have been cleared and drained and are now used for crops or pasture. Suitability of these soils for crops varies with their degree of drainage. Undrained areas are in swamp vegetation or are idle. The native vegetation was swamp hardwoods and conifers.

Typical profile of Sims loam:

Ap—0 to 7 inches, black (10YR 2/1) loam; moderate, medium, granular structure; friable; neutral; abrupt, smooth, boundary.

B21g—7 to 15 inches, light brownish-gray (10YR 6/2) clay loam; many, medium, distinct, yellowish-brown (10YR 5/4) mottles; moderate, medium, angular blocky structure; firm; neutral; gradual, wavy boundary.

B22g—15 to 32 inches, light brownish-gray (10YR 6/2) heavy clay loam; many, medium, distinct, yellowish-brown (10YR 5/4) and strong-brown (7.5YR 5/6) mottles; moderate, coarse, angular blocky structure; firm; mildly alkaline; abrupt, wavy boundary.

Cg—32 to 60 inches, light-gray (10YR 7/1) clay loam; many, medium, distinct, yellowish-brown (10YR 5/4) mottles; weak, coarse, angular blocky structure; firm; calcareous.

The surface layer is very dark gray in some areas and is 6 to 10 inches thick. It ranges from sandy loam to clay loam in texture. In a few areas a layer of muck, 1 to 4 inches thick, is at the surface. Texture of the subsoil is silty clay loam or light clay in a few areas. The underlying material is silty clay loam or clay loam and is at a depth of 20 to about 40 inches. It is limy. Reaction of the surface layer and subsoil ranges from slightly acid to mildly alkaline.

Sims soils and the Kawkawlin soils formed in similar material, but Sims soils are more poorly drained and grayer. They are finer textured than Ensley soils.

Sims clay loam (Sm).—This soil is in nearly level or depressed areas on uplands. The surface layer is black clay loam 6 to 10 inches thick. Below it is mottled clay loam or silty clay loam. A limy clay loam or silty clay loam underlying material is at a depth of 20 to 35 inches. Included in mapping this soil were small areas having a loam or silt loam surface layer. Also included in many areas were small spots of Kawkawlin loam and a few pockets filled with sand and gravel. Slopes range to 4 percent in a few areas.

This soil has poor tilth when wet, and the surface tends to crust when dry. The soil is saturated for long periods, especially during spring, and dries slowly. Water ponds in low areas. Frost damage is a hazard to crops.

Most areas of this soil remain in forest or are used for permanent pasture. A small acreage has been drained and is in crops, principally small grains, hay, and corn. (Capability unit IIw–2 (1.5c); woodland suitability group P)

Sims loam (Sn).—This soil is nearly level or is in depressed areas of the uplands. The surface layer is black or very dark gray loam that is 6 to 10 inches thick in most places but is silt loam in a few areas. Beneath the surface layer is mottled clay loam or silty clay loam. Below the second layer is a limy clay loam or silty clay loam material at a depth of 20 to 40 inches. Small spots of Sims sandy loam and Sims clay loam, and of Kawkawlin soils, are included in mapping of this soil. Slopes range up to 4 percent in a few areas.

This soil is saturated for long periods and dries slowly in the spring. Water ponds in low areas. Excess wetness and a frost hazard limit its use for crops.

Most areas of the soil remain in forest or permanent pasture. A small acreage has been drained and is in crops,

principally small grains, hay, and corn. (Capability unit IIw–2 (1.5c); woodland suitability group P)

Sims loam, overwash (So).—This soil is in nearly level or depressed areas of the uplands. From 6 to 18 inches of dark-gray or brown loam has been deposited on the original black surface soil. Thickness of loamy material in the combined surface layers ranges from 12 to 20 inches. Underlying the surface layer at a depth of 25 to 40 inches, is limy clay loam or silty clay loam. Small spots of Sims sandy loam, Sims loam, and Kawkawlin loams were included in mapping some areas of this soil. Slopes range up to 4 percent in a few areas.

This soil is saturated for long periods. Water ponds in low areas. Excess wetness limits use for crops, and frost is a hazard to crops in some years. The present surface layer of this soil is lower in organic-matter content than the surface layer of Sims loam.

Most areas of the soil remain in forest or permanent pasture. A small acreage has been drained and is in crops, principally small grains, hay, and corn. (Capability unit IIw–2 (1.5c); woodland suitability group P)

Sims sandy loam (Ss).—This soil is in nearly level or depressed areas of the uplands. The surface layer is black sandy loam, 6 to 12 inches thick, that overlies mottled clay loam or silty clay loam. Underlying these two layers is limy clay loam or silty clay loam material at a depth of 20 to 35 inches. Small spots of Sims loam and of Kawkawlin sandy loams were included in mapping many areas of this soil. The slopes range to 4 percent in some areas.

A high water table limits the use of this soil for crops. Even when drained, the soil dries slowly in spring. Nevertheless, it dries slightly faster than other Sims soils and is easier to work because its surface layer is sandy loam. Water ponds in low areas, and frost is a hazard to crops in some years.

Most areas of the soil are in forest or permanent pasture. A small acreage has been drained and is in crops, principally small grains, hay, and corn. (Capability unit IIw–2 (1.5c); woodland suitability group P)

Sloan Series[5]

The soils of this series are poorly drained and very poorly drained and are on bottom lands along streams. They formed in stratified loamy material deposited by floodwaters.

The surface layer is brown and very dark brown loam about 10 inches thick. It has moderate granular structure, is friable, and is mottled with dark reddish brown.

Below the surface layer, to a depth of about 27 inches, is gray loam mottled with dark brown. It has weak blocky structure and is friable.

Stratified loam, loamy sand, and sandy loam lie at a depth of 27 inches. This material is gray, massive, and friable.

Available moisture capacity and fertility of these soils are high. Water moves moderately to moderately slowly through the soil in the absence of a high water table. The gray color of the subsoil indicates that it remains wet for extended periods during spring and in other wet periods. The water table is within 12 inches of the surface, and the soil is saturated. These soils also are subject to frequent flooding, especially in spring.

Most areas of these soils are in woods and wildlife habitats or are used for recreation. The native vegetation was hardwood trees, grasses, and sedges.

Typical profile of Sloan loam:

A11—0 to 7 inches, very dark brown (10YR 2/2) loam; moderate, medium, granular structure; friable; slightly acid; gradual, smooth boundary.

A12—7 to 10 inches, dark-brown (7.5YR 3/2) loam; few, fine, distinct, dark reddish-brown (5YR 3/3) mottles; moderate, medium, granular structure; friable; slightly acid; clear, smooth boundary.

B21g—10 to 14 inches, dark-gray (10YR 4/1) loam; common, coarse, distinct, dark-brown (7.5YR 4/4) mottles; weak, fine, subangular blocky structure; friable; mildly alkaline; gradual, wavy boundary.

B22g—14 to 27 inches, gray (10YR 5/1) loam; common, coarse, distinct, dark-brown (7.5YR 4/4) mottles; weak, fine, subangular blocky structure; friable; mildly alkaline; gradual, wavy boundary.

Cg—27 to 60 inches, gray (10YR 5/1), stratified loam, loamy sand, and sandy loam; loam and sandy loam are massive, friable; loamy sand is single grain, loose; calcareous.

In the lowest areas a layer of muck or peat, 1 to 12 inches thick, is on the surface. The thickness and sequence of the strata of different-textured materials in the soil profile vary within short distances. Thickness of these strata ranges from 3 to 14 inches. In some areas there are thin layers of loamy sand, sand, and clay loam. Reaction at a depth of less than 42 inches ranges from slightly acid to calcareous.

Sloan soils formed in material similiar to that underlying Shoals soils but are more poorly drained and have grayer subsoil and underlying material than Shoals soils. They are coarser textured than Saranac soils.

Sloan loam (Sl).—This soil is nearly level and is on depressed bottom lands along rivers and streams. Texture of the surface layer is predominantly sandy loam, fine sandy loam, silt loam, or loam. Small areas have a clay loam or sand surface layer 6 to about 14 inches thick. Underneath the surface layer are layers of sandy loam and loam. Narrow bars of sand or gravel and spots of shallow organic soils were included in mapping this soil.

This soil is wet most of the time, and water is ponded after every rain. The major limitations to its use for crops are excess wetness and the hazards of flooding and frost. Many areas of this soil are too small or inaccessible to be planted to crops.

Most areas of this soil are in lowland hardwoods. Some areas have been cleared and used for pasture. (Capability unit Vw–3 (L–2c); woodland suitability group O)

Tawas Series

The soils of this series are very poorly drained organic soils. They are level or on depressed areas or broad low flats on lake, outwash, and till plains. These soils formed in woody and fibrous organic material, 12 to 42 inches thick, that overlies sand and loamy sand. The organic material is the remains of deciduous and coniferous trees mixed with materials from sedges, reeds, and grasses.

The surface layer is black muck about 14 inches thick. This layer contains many woody fragments, has moderate granular structure, and is very friable. Below the surface layer, to a depth of about 22 inches, is very dark brown peaty muck. It has weak platy structure and is friable.

[5] The Michigan Agricultural Experiment Station will continue to name these soils Pinora.

A light-gray sand begins at a depth of about 22 inches and extends to a depth of 42 inches or more. This sand is single grain and loose.

Available moisture capacity of these soils is high, and natural fertility is low. Water moves moderately rapidly through the organic layers and rapidly through the sandy underlying material. Surface runoff is very slow, and water ponds in many depressed areas. These soils are low in content of phosphorus, potassium, and many micronutrients. Unless these soils are artificially drained, the water table is at or near the surface.

A high water table and the difficulty of draining the soil prevent intensive use of these soils for crops. Wind erosion and frost also are hazards when these soils are used for crops.

Most areas of these soils are in woods. Only a few areas have been cleared, and most of these are in pasture. The native vegetation was mixed lowland hardwoods and conifers. Common trees were elm, white-cedar, balsam fir, and black spruce.

Typical profile of Tawas muck:

1—0 to 14 inches, black (10YR 2/1) muck; remains of woody material; moderate, medium granular structure; very friable; slightly acid; gradual, wavy boundary.

2—14 to 22 inches, very dark brown (10YR 2/2) peaty muck; weak, thin, platy structure; friable; slightly acid; abrupt, wavy boundary.

IICg—22 to 60 inches, light-gray (10YR 7/1) sand; single grain; loose; neutral.

The degree of decomposition of the organic material in this soil varies, and the material ranges from muck to peat. The muck is well decomposed and contains few, if any, plant remains. Texture of the subsurface layer ranges from muck to peat. Texture of the mineral material below the organic layers ranges from loamy sand to sand or fine gravelly sand.

Tawas soils have a thinner layer of organic material than do either the Carbondale or Rifle soils. They have coarser textured underlying material than do either the Linwood or Willette soils. The content of woody material is higher in Tawas soils than in Adrian soils.

Tawas loam, overwash (Ta).—This soil is in nearly level or depressed areas. Dark-gray loam, sandy loam, or silt loam mineral material has been deposited on the original muck or peat surface layer to a depth of 8 to about 14 inches. Sand or loamy sand material underlies the organic material at a depth of about 38 inches. Small spots of Roscommon mucky sand and Carbondale muck were included in mapping some areas of this soil.

The soil is cold and wet and is low in fertility. Crops are subject to frost damage.

Few areas of this soil are in crops. (Capability unit Vwc–1 (M/4c); woodland suitability group J)

Tawas muck (Tc).—This soil is nearly level or is in depressed areas. The surface layer is black muck. The underlying material is sandy and is at a depth of 12 to 42 inches. In many areas small spots of Roscommon mucky sand and Carbondale muck were included in mapping this soil.

The soil is wet and is low in fertility. Frost is a hazard to crops. Because of its low position, this soil remains cold and dries slowly, even when drained. Few areas of Tawas muck are in crops. (Capability unit Vwc–1 (M/4c); woodland suitability group J)

Tawas peat (Tp).—This soil is nearly level or is in depressed areas. The surface layer is very dark brown peat, about 14 inches thick, and rests directly on dark-brown peat. Underlying the peat is sandy material at a depth of 12 to 42 inches. Small areas of Roscommon mucky sand and Carbondale peat were included in mapping most areas of this soil.

Few areas of this soil are farmed. The soil is wet, and its fertility level is low. Even when drained, this soil remains cold and dries slowly. Frost also is a hazard to crops. (Capability unit Vwc–1 (M/4c); woodland suitability group J)

Tonkey Series

The soils of this series are poorly drained or very poorly drained. They are nearly level or in depressed areas and are on outwash, till, and lake plains and on deltas and glacial drainageways. These soils formed in stratified sand, loamy sand, and sandy loam in which occur thin layers of gravel and silt and loam material. The Tonkey soils are not mapped alone but as part of units with the Ensley and Edmore soils. The mapping units are designated either as Ensley and Tonkey soils or as Edmore and Tonkey soils.

The surface layer is black loam about 7 inches thick. It has weak granular structure and is friable.

The upper part of the subsoil is light brownish-gray loamy sand about 6 inches thick. This layer has yellowish-brown mottles, has weak granular structure, and is very friable. The lower part of the subsoil is pale-brown light sandy clay loam about 20 inches thick. It has strong-brown mottles, has moderate blocky structure, and is firm.

Underlying the subsoil at a depth of about 33 inches is a gray, stratified sand, loamy sand, and sandy loam in which there are thin layers and lenses of gravel, silt, and loam. The sand and loamy sand layers are single grain and loose. The sandy loam layers are massive, friable, and high in lime content.

Available moisture capacity and natural fertility of these soils are moderately high. Water moves moderately rapidly through the different layers. In depressed areas surface runoff is very slow, and it becomes ponded, especially during spring and after rain. The water table is high, and these soils are saturated during spring.

Most areas of Tonkey soils are in woods, but a few areas have been cleared and are in pasture or hay crops. The major limitations to their use for crops are the high water table and poor surface drainage. The native vegetation was mixed hardwoods and conifers, mainly elm, soft maple, white-cedar, and small amounts of alder and willow. In some areas sedges and grasses are common.

Typical profile of Tonkey loam:

A1—0 to 7 inches, black (10YR 2/1) loam; weak, fine, granular structure; friable; neutral; relatively high organic-matter content; abrupt, smooth boundary.

B21—7 to 13 inches, light brownish-gray (10YR 6/2) loamy sand; few, medium, distinct, light yellowish-brown (10YR 6/4) mottles; weak, fine, granular structure; very friable; neutral; abrupt, wavy boundary.

B22—13 to 33 inches, pale-brown (10YR 6/3), light sandy clay loam; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; firm, mildly alkaline; abrupt, wavy boundary.

Cg—33 to 60 inches, gray (10YR 5/1), stratified sand, loamy sand, and sandy loam; thin layers and lenses of gravel, silt, and loam; sand and loamy sand are single grain and loose; sandy loam is massive and friable; calcareous.

In some areas there is a layer of muck or peat, 1 to 12 inches thick, at the surface. The surface layer in some areas is very dark gray and is 5 to 10 inches thick. In some areas thin layers of clay loam or clay, 1 to 3 inches thick, are present in the upper part of the soil. Texture of the subsoil ranges from sandy loam to light clay loam, loamy sand, or loam. It is usually stratified. Thickness of the various subsoil layers ranges from 1 to 12 inches. Reaction of the surface layer and subsoil is neutral to mildly alkaline.

Tonkey soils have coarser textured profiles than Ensley soils. They are more poorly drained and are grayer than Richter soils.

Traverse Series

The soils of this series are well drained and moderately well drained bottom-land soils. They are in depressions and drainageways on moraines and till and outwash plains and are flooded periodically. These soils formed in sandy loam or loam material deposited by water.

The surface layer is very dark brown sandy loam about 7 inches thick. It has weak granular structure and is very friable.

The subsoil contains alternate layers of loamy sand and sandy loam. Color of these layers is very dark grayish brown, dark yellowish brown, or brown. Structure of the loamy sand layers is very weak blocky or single grain. The sandy loam layers have weak granular or blocky structure and are friable.

A pale brown sandy loam mottled with brownish yellow and yellowish brown is at a depth of about 66 inches. This layer lacks structure and is very friable.

Available moisture capacity and natural fertility of these soils are moderate. Water moves moderately rapidly through the different layers. Runoff is slow, and water ponds in closed depressions and broad flats. These soils flood during spring and following prolonged rainfall. New material often is deposited during floods.

Some areas of Traverse soils are in pasture or crops. The crops commonly grown are wheat and corn. A few areas remain in woods or are idle. The native vegetation was mainly northern hardwoods.

Typical profile of Traverse sandy loam:

Ap—0 to 7 inches, very dark brown (10YR 2/2) sandy loam; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

B2—7 to 20 inches, very dark grayish-brown (10YR 3/2) sandy loam; weak, fine, subangular blocky structure; very friable; medium acid; abrupt, wavy boundary.

A'1b—20 to 29 inches, black (10YR 2/1) sandy loam; weak, fine, granular structure; very friable; medium acid; abrupt, wavy boundary.

B'2—29 to 42 inches, dark yellowish-brown (10YR 3/4) loamy sand; very weak, fine, subangular blocky structure; very friable; medium acid; abrupt, irregular boundary.

A'2—42 to 44 inches, brown (10YR 5/3) loamy sand; massive; very friable; medium acid; abrupt, irregular boundary.

A'2&B'2—44 to 66 inches, brown (10YR 5/3) loamy sand; single grain; loose (A'2 horizon). Dark brown (7.5 YR 4/4) sandy loam; weak, fine, subangular blocky structure; friable (B'2 horizon). The B'2 horizon occurs as thin and often discontinuous bands separated by A'2 horizons; medium acid; abrupt, wavy boundary.

C—66 inches +, pale-brown (10YR 6/3) light sandy loam; many, common, faint, brownish-yellow (10YR 6/6) and yellowish-brown (10YR 5/6) mottles; massive; very friable; mildly alkaline.

The surface layer is dark yellowish-brown in some areas, particularly where new material has been recently deposited on the surface. In some areas the material below a depth of 20 inches is mottled. In a few areas there are layers of sandy clay loam, loam, or gravel in the subsoil. Reaction throughout the profile ranges from medium acid to mildly alkaline.

Traverse soils are more stratified than either the Montcalm or McBride soils. They lack the distinct subsoil layer of these two soils.

Traverse loam (Tr).—This soil is nearly level or gently sloping and is in lower parts of natural pits, depressions, and glacial drainageways. The surface layer is very dark brown sandy loam, fine sandy loam, loamy sand, or loam. Small areas of McBride and Montcalm soils were included in mapping this soil. They are near the edges of most areas of Traverse loam.

The soil receives considerable runoff from surrounding slopes. The major limitations to its use for crops are flooding and accumulation of soil material from adjoining sloping soils.

Most of this soil is in permanent pasture. A few areas are planted to crops, principally small grains, hay, and corn. (Capability unit IIe–3 (3a); woodland suitability group A)

Twining Series

Soils of this series are somewhat poorly drained and formed in sandy clay loam material deposited by glaciers. They are nearly level or gently sloping and are on till plains and moraines.

The surface layer is very dark grayish-brown sandy loam about 7 inches thick. It has weak granular structure and is friable.

The upper part of the subsoil is yellowish-brown sandy loam, about 9 inches thick, that has dark yellowish-brown and yellowish-brown mottles in its lower part. It has weak platy structure and is friable. The lower part of the subsoil is dark-brown sandy clay loam about 21 inches thick. It has light brownish-gray mottles, has moderate blocky structure, and is firm.

Below the subsoil, at a depth of about 37 inches, is brown sandy clay loam mottled with yellowish brown and light brownish gray. This material has weak blocky structure, is firm, and is high in lime content.

Available moisture capacity of these soils is high, and natural fertility is moderately high. Water moves moderately slowly through the profile. Surface runoff is slow, and water ponds in depressions and on broad flats. The mottles in the subsoil indicate that the soil is saturated for extended periods.

A few areas of these soils have been cleared and are planted to hay or small grain crops, but most areas are in pasture or woods. These soils dry slowly in the spring, and excess wetness is a severe limitation to their use for crops. The native vegetation was mainly hardwoods.

Typical profile of Twining sandy loam:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) sandy loam; weak, medium, granular structure; friable; medium acid; abrupt, smooth boundary.

Bir—7 to 13 inches, yellowish-brown (10YR 5/6) sandy loam; weak, fine, subangular blocky structure; friable; medium acid; clear, wavy boundary.

A'2—13 to 16 inches, pale-brown (10YR 6/3) sandy loam; common, medium, distinct, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) mottles; weak, medium, platy structure; friable; medium acid; clear, irregular boundary.

298–861—69——6

B'2t&A'2—16 to 25 inches, dark-brown (7.5YR 4/4) sandy clay loam; infiltration of A'2 material along cracks and cleavage planes; moderate, medium, subangular blocky structure; slightly brittle; weak fragipan; medium acid; clear, irregular boundary.

B'2t—25 to 37 inches, dark-brown (7.5YR 4/4) sandy clay loam; common, fine, distinct, light brownish-gray (10YR 6/2) mottles; moderate, medium, subangular blocky structure; firm; medium acid; abrupt, irregular boundary.

C—37 to 60 inches, brown (7.5YR 5/4) sandy clay loam; many, medium, faint, yellowish-brown (10YR 5/6) and distinct, light brownish-gray (10YR 6/2) mottles; weak, medium, angular blocky structure; firm; calcareous.

The surface layer is dark grayish brown in some areas, and it ranges from 6 to 10 inches in thickness. Undisturbed areas have a very dark gray surface layer 1 to 3 inches thick and a light brownish-gray subsurface layer 2 to 5 inches thick. Depth to limy material below the subsoil ranges from 30 to about 50 inches. Reaction of the surface layer and upper part of the subsoil ranges from strongly acid to slightly acid. Reaction of the lower part of the subsoil ranges from medium acid to slightly acid.

Twining sandy loam, 0 to 2 percent slopes (TwA).—This soil is nearly level and is in waterways and very low side slopes adjacent to depressions on the uplands. The surface layer is very dark gray or very dark grayish-brown sandy loam. Limy sandy clay loam underlying material is at a depth of 30 to 50 inches. Small areas of Isabella sandy loam in the higher positions and Sims soils in the depressions were included in mapping this soil. Slopes range above 2 percent for short distances.

Wet depressions are common in most areas and delay planting and cultivation during wet periods. Runoff is slow to ponded. Frost damage to crops also is a hazard in the lowest areas. If adequately drained, this soil is productive.

Most areas of this soil are in permanent pasture, but some areas are in hay and small grains. A few areas are in forest. (Capability unit IIw-2 (1.5b); woodland suitability group Z)

Twining sandy loam, 2 to 6 percent slopes (TwB).—This soil is gently sloping and undulating and is along waterways and low side slopes adjacent to depressions. The surface layer is very dark grayish-brown sandy loam. A limy sandy clay loam underlying material lies at a depth of 30 to 50 inches. Included in mapping this soil were areas of Isabella sandy loam in higher positions and Sims loam in depressions. Slopes range outside specified limits over short distances.

Wet depressions are common in most areas of this soil, and water ponds in many low areas. Frost is a hazard to crops. Most areas of this soil are in permanent pasture or trees, but some areas are in hay and small grains. (Capability unit IIw–3 (1.5b); woodland suitability group Z)

Ubly Series

Soils of this series are well drained and moderately well drained. They are gently sloping to moderately steep and are on till plains and moraines. These soils formed in 18 to about 42 inches of loamy fine sand, sandy loam, or fine sandy loam overlying loam, silty clay loam, sandy clay loam, or clay loam glacial till.

The surface layer is very dark grayish-brown sandy loam about 8 inches thick. It has weak granular structure and is friable. The next layer, about 3 inches thick, is pale-brown sandy loam.

The upper part of the subsoil is dark-brown sandy loam about 12 inches thick. It has weak granular structure and is friable. The lower part of the subsoil is predominantly pale-brown sandy loam or dark-brown sandy clay loam about 13 inches thick. This material has moderate blocky structure and is firm.

Underlying the subsoil at a depth of about 36 inches is brown light sandy clay loam. This material has weak blocky structure, is firm, and is high in lime content.

Available moisture capacity and natural fertility of these soils are moderately high. Water moves moderately rapidly through the upper part of the soil profile and moderately slowly through the lower part. Surface runoff is slow in gently sloping areas and medium in moderately steep areas.

Although soil moisture generally is adequate for crop growth, it is deficient for short dry periods in summer. Erosion is a serious hazard in sloping areas. Many of the gently sloping areas of these soils have been cleared and planted to crops, principally corn, wheat, oats, hay, and beans. Sloping and moderately steep areas are used mainly for pasture or woods. The native vegetation was mixed hardwood forest, including sugar maple, ash, beech, and some white pine.

Typical profile of Ubly sandy loam:

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

Bir—8 to 20 inches, dark-brown (7.5YR 4/4) sandy loam; weak, medium, granular structure; friable; medium acid; clear, wavy boundary.

A'2—20 to 23 inches, pale-brown (10YR 6/3) sandy loam; weak, coarse, granular structure; friable; medium acid; abrupt, irregular boundary.

A'2&B'2t—23 to 30 inches, pale-brown (10YR 6/3) sandy loam (A'2 horizon); dark-brown (7.5YR 4/4) clay loam (B'21t horizon); B'2t occurs as isolated peds, partially or wholly surrounded by A'2 in the upper part of the horizon; moderate, medium, subangular blocky structure; firm; medium acid; clear, irregular boundary.

IIB'2t—30 to 36 inches, dark-brown (7.5YR 4/4) sandy clay loam; moderate, medium, subangular blocky structure; firm; a few, thin, discontinuous clay films; slightly acid; abrupt, irregular boundary.

IIC—36 to 60 inches, brown (10YR 5/3) light sandy clay loam; weak, coarse, subangular blocky structure; firm; calcareous.

In some areas the surface layer is very dark gray or dark grayish-brown and is 6 to 10 inches thick. Undisturbed areas have a very dark gray surface layer 1 to 3 inches thick. It overlies a light brownish-gray or pinkish-gray subsurface layer 2 to 6 inches thick. In some places the upper part of the subsoil is reddish brown. In many areas a pale-brown sandy loam layer is present between the upper and lower part of the subsoil. Texture of the lower part of the subsoil and of the material below the subsoil is loam, clay loam, or silty clay loam in some areas. Reaction of the surface layer and the upper part of the subsoil ranges from slightly acid to strongly acid. Reaction of the lower part of the subsoil ranges from medium acid to neutral.

Ubly soils have coarser textured upper subsoil layers than Nester soils and have finer textured upper subsoil layers than Menominee soils.

Ubly sandy loam, 2 to 6 percent slopes (UbB).—This soil is undulating or gently sloping and is on the uplands. It is near areas of other Ubly soils and is near the Nester, Isabella, and McBride soils. The surface layer is very dark grayish-brown sandy loam in most areas, but it is fine sandy loam in a few areas. Small areas of Nester, Isabella,

and McBride soils were included in mapping many areas of this soil. In a few areas there are small, depressed areas of Belding soils, which remain wet in the spring and may delay planting and cultivation.

This Ubly soil is easy to till over a wide range of moisture content and is ready for use early in spring. Crusting of the surface seldom is a problem, especially if minimum tillage is practiced and organic matter is plowed under.

Most areas of the soil are in crops, principally corn, small grains, and hay. Beans are grown in some areas. (Capability unit IIe–3 (3/2a) ; woodland suitability group A)

Ubly sandy loam, 6 to 12 percent slopes (UbC).—This soil is sloping and is on uplands near other Ubly soils and near Nester soils and Isabella soils. The surface layer is very dark grayish-brown sandy loam. In many areas there are small areas of brown or dark-brown surface soil. Small areas of Nester and Isabella soils were included in mapping many areas of this soil. Also included were Belding soils in a few small depressions in some areas. The depressions remain wet during spring and occasionally delay planting of crops.

Major limitations of this Ubly soil for crops are an erosion hazard and a shortage of soil moisture during dry summer months. Water moves into the soil readily, but because of the degree of slope, much rain is lost by surface runoff. Slopes are complex and short in many areas.

Many areas of this soil are in crops. The principal crops are small grains, hay, and corn. Other areas are in permanent pasture or forest. (Capability unit IIIe–6 (3/2a) ; woodland suitability group A)

Ubly sandy loam, 12 to 18 percent slopes (UbD).—This soil is moderately steep and is on uplands near Ubly soils on milder slopes and near Nester soils and Isabella soils. The surface layer is very dark grayish-brown and is predominantly sandy loam. Small areas have a brown or dark-brown surface soil. Small areas of Nester or Isabella soils were included in mapping most areas of this soil.

Rapid runoff and an erosion hazard are the major limitations to the use of this soil for crops. Yields are low during dry years because little soil moisture is available. In many areas slopes are short and complex.

A few areas of this soil are planted to small grains and hay. Most areas are in permanent pasture. (Capability unit IVe–4 (3/2a) ; woodland suitability group A)

Ubly Series, Clay Subsoil Variant

The soils of this variant of the Ubly series are well drained and moderately well drained and are nearly level to sloping. They are on till plains, low moraines, and deltas. These soils formed in 18 to 42 inches of sandy loam over clay or silty clay.

The surface layer is very dark grayish-brown sandy loam about 9 inches thick. It has weak granular structure and is very friable.

The upper 9 inches of the subsoil is dark reddish-brown sandy loam. It has weak granular structure and is very friable. The lower part of the subsoil is dark-brown sandy clay loam about 13 inches thick. It has moderate blocky structure and is firm. Between the upper and lower part of the subsoil is reddish-gray sandy loam about 6 inches thick.

Reddish-brown silty clay is at a depth of about 37 inches. This material has weak blocky structure, is very firm, and is high in lime content.

Available moisture capacity of these soils is moderate, and fertility is moderately high. Water moves moderately through the upper part of the profile and slowly through the lower part. Surface runoff is slow in gently sloping areas and is medium in sloping areas. Soil moisture generally is adequate for crop growth, except for short periods during summer. Erosion is a hazard on sloping areas.

Most areas of these soils have been cleared and are planted to corn, wheat, oats, and hay. A few areas are in pasture or woods. The native vegetation was northern hardwoods, including beech, maple, and some hemlock.

Typical profile of Ubly sandy loam, clay subsoil variant:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) sandy loam; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

Bir—9 to 18 inches, dark reddish-brown (5YR 3/4) sandy loam; weak, fine, granular structure; very friable; medium acid; clear, irregular boundary.

A'21—18 to 20 inches, reddish-gray (5YR 5/2) sandy loam; weak, fine, subangular blocky structure; slightly compact and brittle when dry, friable when moist; medium acid; abrupt, irregular boundary.

A'22&B'21t—20 to 24 inches, reddish-gray (5YR 5/2) sandy loam (A'22 horizon) ; reddish-brown (5YR 4/3) sandy clay loam (B'21t horizon) ; peds of B'21t partially or wholly surrounded by A'22 horizon; A'22 horizon occurs as coatings around peds and as fillings in root channels and cracks; weak, coarse, subangular blocky structure; firm; medium acid; clear, irregular boundary.

B'22t—24 to 37 inches, dark-brown (7.5YR 4/4) sandy clay loam; moderate, coarse, subangular blocky structure; firm, medium acid in upper part; gradual change to slightly acid in lower part; abrupt, wavy boundary.

IIB'23—37 to 39 inches, reddish-gray (5YR 5/2) silty clay; white (5YR 8/1) and light brownish-gray (10YR 6/2) coatings and crack fillings; weak, coarse, angular blocky structure; very firm; mildly alkaline.

IIC—39 inches +, reddish-gray (5YR 5/2) silty clay; weak, coarse, angular blocky structure; very firm; calcareous.

Undisturbed areas have a very dark gray surface layer 2 to 5 inches thick and a grayish brown subsurface layer, 2 to 6 inches thick. Reaction of the surface, subsurface, and subsoil layers ranges from slightly acid to medium acid.

Ubly soils, clay subsoil variant, have finer textured underlying material than other Ubly soils. They are better drained than Belding soils, clay subsoil variant.

Ubly sandy loam, clay subsoil variant, 2 to 6 percent slopes (UlB).—This soil is gently sloping and undulating. The surface layer is very dark grayish brown in most areas, but there are spots of moderate erosion where the color is dark brown. In some areas the slopes range outside the limits of 2 to 6 percent. Included in mapping this soil were some areas of Munuscong soil in slight depressions and in drainageways.

This soil dries quickly in spring and is easily tilled over a wide range of soil moisture levels. Surface runoff is slow, and water erosion is seldom a serious hazard. The soil tends to be slightly droughty during extended dry periods.

Most areas of this soil are planted to corn, wheat, oats, and hay or are in pasture. Northern hardwoods predominate in the wooded areas. (Capability unit IIe–3 (3/2a) ; woodland suitability group A)

Ubly sandy loam, clay subsoil variant, 6 to 12 percent slopes (UlC).—This soil is sloping and rolling. The surface layer is very dark grayish brown in most areas, but it is

dark brown in a few areas. A few areas have a fine sandy loam surface layer. Small areas of McBride soils were included in mapping some areas of this soil. Some areas where slopes range outside specified limits and some areas where there are spots of moderate erosion also were included.

Water moves into the soil readily, but much surface water is lost through runoff. The major limitations to the use of this soil for crops are an erosion hazard and a shortage of soil moisture during dry summer months. Most areas of this soil are in crops or pasture. The principal crops are corn, wheat, oats, and hay. Northern hardwoods predominate in the wooded areas. (Capability unit IIIe–6 (3/2a) ; woodland suitability group A)

Wallace Series

Soils of this series are well drained and moderately well drained. They are level to moderately steep and are on outwash plains and moraines. These soils formed in sandy material more than 42 inches thick.

The surface layer is very dark brown sand about 2 inches thick. It has weak granular structure and is very friable. The subsurface layer is light-gray sand that is single grain, loose, and about 5 inches thick.

The upper part of the subsoil is dark reddish-brown or yellowish-red sand that is massive and cemented. The lower part is brownish-yellow sand. It is single grain and loose.

Pale-brown sand is at a depth of about 40 inches. It is single grain and loose.

Available moisture capacity and natural fertility of these soils are low. Water moves rapidly through most of the soil profile, but moves moderately slowly through the cemented upper part of the subsoil. Runoff is slow because of the sandiness of the soils, but these soils are droughty during dry summer months. Content of organic matter is low and is difficult to maintain in these sandy, well-aerated soils.

Sandiness, low fertility, and a cemented subsoil are limitations to the use of these soils for crops. Most areas of these soils remain in woods. The present vegetation consists of a sparse tree cover of red and white pine and aspen and a ground cover of sweetfern, brambles, and grasses.

Typical profile of Wallace sand:

O1—1 inch to 0, partially decomposed plant residue and raw, fibrous organic material; strongly acid; clear, smooth boundary.

A1—0 to 2 inches, very dark brown (10YR 2/2) sand; weak, fine, granular structure; very friable; strongly acid; clear, irregular boundary.

A2—2 to 7 inches, light-gray (10YR 7/2) sand; single grain; loose; strongly acid; abrupt, irregular boundary.

B21hirm—7 to 17 inches, dark reddish-brown (5YR 3/4) sand; massive; cemented; strongly acid; clear, irregular boundary.

B22irm—17 to 30 inches, yellowish-red (5YR 5/8) sand; massive; strongly cemented; strongly acid; clear, wavy boundary.

B3—30 to 40 inches, brownish-yellow (10YR 6/6) sand; single grain; loose; strongly acid; gradual, wavy boundary.

C—40 to 60 inches, pale-brown (10YR 6/3) sand; single grain; loose; medium acid.

Thickness of the subsurface layer ranges from 4 to 15 inches over short distances. Tongues of the subsurface layer extend to a depth of 24 inches. The degree of cementation of the upper part of the subsoil varies from moderate to strong. In moderately well drained areas, light grownish-gray or light-gray mottles are present in the lower part of the subsoil. The combined thickness of the surface layer and subsoil ranges from 30 to about 45 inches.

Wallace soils are better drained and lack the finer textured underlying material of the Ogemaw soils.

Wallace sand, 0 to 6 percent slopes (WaB).—This soil is nearly level or undulating and is on plains. The surface layer is very dark brown sand about 2 to 3 inches thick. The subsurface is light-gray sand. In areas that have been burned, the color of the surface soil is gray or light gray. Small, irregularly shaped areas of the Kalkaska, Croswell, and Rubicon soils, usually about ½ acre to 1 acre in size, were included in mapping almost all areas of this soil.

Low fertility, low available moisture capacity, droughtiness, a wind erosion hazard, and the presence of the cemented layers in the soil are the major limitations to the use of this soil for crops. Most areas of this soil are forested or are idle. Most areas are used for recreational purposes. (Capability unit VIIs–1 (5a–h) ; woodland suitability group H)

Wallace sand, 6 to 18 percent slopes (WaD).—This soil is sloping or moderately steep and is on plains and uplands. The surface layer is very dark brown sand 1 to 3 inches thick. The subsurface is light-gray sand. In small burned-over areas and in moderately eroded areas, the color of the surface layer is light gray. Included in mapping most areas of this soil were ½-acre to 2-acre areas of the Kalkaska and Rubicon soils. There are shallow blowouts in a few areas. Slopes range outside the specified limits over short distances.

Low fertility, low available moisture capacity, the hazard of wind and water erosion, and the degree of slope severely limit use of this soil for crops. Most areas of the soil are in forest or are idle. (Capability unit VIIs–1 (5a–h) ; woodland suitability group H)

Warners Series

The soils of this series are very poorly drained organic soils. They are in nearly level or depressed areas and are on lake margins and along drainageways between inland lakes. These soils formed in organic materials that are less than 12 inches thick over marl.

The surface layer is black muck about 7 inches thick. In it are variable amounts of gray marl and other mineral material. This layer has weak granular structure and is friable.

Below the surface layer is dark-gray or gray marl. Lenses or spots of black muck are in the upper part. Large numbers of shell fragments are in the marl. It is massive, friable, and high in lime content.

Available moisture capacity of these soils is high, and natural fertility is low. Permeability is moderately rapid through the organic material and moderately slow through the marl. Surface runoff is very slow and often ponds in depressions. The moderately slow permeability of the marl keeps the upper layer of these soils wet. Unless these soils are artificially drained, the water table is within 12 inches of the surface. These soils usually are low in content of plant nutrients, especially many of the micronutrients.

The high water table, low fertility, and moderately slow permeability of the marl limit the use of these soils for crops. Wind erosion and frost also are major hazards when

these soils are used for crops. Most areas of these soils remain in woods or pasture.

Typical profile of Warners muck:

1—0 to 7 inches, black (10YR 2/1) muck; variable amount of gray (10YR 6/1) marl and other mineral material; weak, fine, granular structure; friable; mildly alkaline; abrupt, wavy boundary.

IIC1—7 to 14 inches, dark-gray (10YR 4/1) marl; lenses or spots of black (10YR 2/1)) muck; massive; friable; calcareous; gradual, smooth boundary.

IIC2—14 to 42 inches, gray (10YR 6/1) marl; variable but in most places considerable numbers of shell fragments; massive; friable; calcareous.

In some areas the surface layer is very dark gray mucky loam, dark-gray loam, or sandy loam that contains marl. Thickness of the surface layer ranges from 4 to about 12 inches. Reaction is mildly alkaline to very strongly alkaline. The degree of purity of the marl varies in different areas, and the amount of mineral material in the upper few inches of the marl varies in different areas.

Warners soils are similar to the Edwards soils but have a thinner layer of organic material over the marl. They also have a thinner layer of organic material than either the Carbondale or Houghton soils. They lack the sandy underlying material of the Tawas or Adrian soils.

Warners muck and Marl (We).—This mapping unit consists of areas of Warners muck and also areas where the underlying marl extends to the surface. Some areas are predominantly Warners muck; others are predominantly marl. Some areas mapped contain both muck and marl interspersed closely. In some areas the surface soil is very dark gray mucky loam or sandy loam.

In some areas the marl has been mined for agricultural liming material. The calcium carbonate content of the marl is variable and should be determined before removing marl for commercial use. The high lime content of the surface layer and the underlying marl severely limit the use of this soil for crops. Almost all areas of this soil are in small trees and grass. (Capability unit Vwc–1 (M/mc); woodland suitability group J)

Wheatley Series

The soils of this series are sandy and gravelly and are poorly drained and very poorly drained. They are nearly level or in depressed areas and are on bottom lands along rivers. These soils formed in sand and loamy sand deposited by water. The sand and loamy sand overlie calcareous fine gravelly sand and coarse sand. Thickness of the sand and loamy sand material ranges from 10 to 42 inches.

The surface layer is black, mucky loamy sand about 7 inches thick. It has weak granular structure and is very friable.

Below the surface layer is light-gray sand to a depth of about 20 inches. The sand is single grain and is loose. A layer of light brownish-gray, stratified gravelly sand and coarse sand is below a depth of 20 inches. This material is single grain, loose, and high in lime content.

Available moisture capacity and natural fertility of these soils are low. A high water table is at or near the surface, but water moves very rapidly through these soils once they are drained. Runoff is slow, and water ponds in depressed areas and low flats.

Sandiness and a high water table are major limitations to the use of these Wheatley soils for crops. Most areas of this soil are in forest, but a few areas are in pasture or crops. Hay is the major crop. The native vegetation was white-cedar, black spruce, aspen, elm, ash, and soft maple.

Typical profile of Wheatley mucky loamy sand:

A1—0 to 7 inches, black (10YR 2/1) mucky loamy sand; very high organic-matter content; weak, medium, granular structure; very friable; neutral; abrupt, smooth boundary.

C1—7 to 20 inches, light-gray (10YR 7/2) sand; single grain; loose; mildly alkaline; abrupt, wavy boundary.

C2—20 to 60 inches, light brownish-gray (10YR 6/2), stratified gravel and coarse sand; single grain; loose; calcareous.

In some areas a layer of muck, 1 to 12 inches thick, is at the surface. The surface layer is a mucky sandy loam in some places. Thin layers of loam or sandy loam, 1 to 3 inches thick, are below a depth of 42 inches in some areas. Reaction of the upper part of the profile ranges from neutral to mildly alkaline.

Wheatley soils have a coarser textured and more variable underlying material than Roscommon soils. Wheatley soils and East Lake soils formed in similar material, but Wheatley soils are more poorly drained and grayer than either.

Wheatley mucky loamy sand (Wh).—This soil is nearly level or in depressed areas and is in drainageways and on plains. The surface layer is predominantly black mucky loamy sand. Some areas have a 1- to 12-inch surface layer of muck; others, a mucky gravelly sand surface layer. Small areas of Markey muck were included in mapping some areas of this soil.

Runoff is slow, and water ponds in low areas. The soil tends to be droughty after it is drained. Undrained areas are better suited to pasture or water-tolerant forage crops than to such crops as corn and small grains. Most areas of this soil are in trees or pasture. A few areas are in hay. (Capability unit IIIw–6 (4c); woodland suitability group W)

Wheatley mucky sandy loam (Wk).—This soil is nearly level or in depressed areas and is in drainageways and on plains. The surface layer is mucky sandy loam in most areas but is muck, 1 to 12 inches thick, in a few areas. Some stones and cobblestones are present on the surface in a few areas.

This soil is saturated because of a high water table, but it tends to be droughty when it is drained. Fertility is low, and wind erosion is a hazard if large areas are exposed by tillage. Most areas of the soil are in forest. A few areas are in pasture or are idle. (Capability unit IIIw–6 (4c); woodland suitability group W)

Willette Series

In this series are very poorly drained organic soils. These soils are nearly level or in depressed areas and are on outwash and till plains and moraines. These soils formed from woody material, 12 to 42 inches thick, underlain by heavy clay loam or light clay.

The surface layer is very dark brown muck, 15 inches thick, containing many fine roots and remains of woody material. This layer has moderate granular structure and is friable.

Below the surface layer, to a depth of about 25 inches, is dark-brown or dark reddish-brown peat. It has moderate or weak platy structure and is friable. Below a depth of 25 inches is light-gray light clay that lacks structure but is very firm and high in lime content.

Available moisture capacity of these soils is high, and natural fertility is low. Water moves rapidly through the

organic layers but moves slowly through the finer textured mineral material. Runoff is very slow to ponded. A high water table is at or near the surface, and these soils are saturated during wet periods unless they are drained.

The high water table and a frost hazard limit use of these soils for crops. Most areas of these soils are in cutover and idle land. Small areas have been drained and are used for pasture. The native vegetation was mixed hardwoods and some conifers.

Typical profile of Willette muck:

1—0 to 8 inches, very dark brown (10YR 2/2) muck; many fine roots and remains of woody material; moderate, fine, granular structure; very friable; slightly acid; clear, smooth boundary.
2—8 to 15 inches, very dark brown (10YR 2/2) muck; many partially disintegrated woody fragments; moderate, fine, granular structure; friable; medium acid; clear, wavy boundary.
3—15 to 20 inches, dark-brown (7.5YR 4/2) peat; moderate, thick, platy structure; friable; slightly acid; diffuse, wavy boundary.
4—20 to 25 inches, dark reddish-brown (5YR 3/4) peat; weak, thick, platy structure; friable; neutral; abrupt, smooth boundary.
IIC—25 to 60 inches, light-gray (10YR 7/2) light clay; massive; very firm; very sticky when wet; calcareous.

The amount of woody material in these soils varies considerably but is quite noticeable throughout the organic layers. Texture of the underlying mineral material ranges from heavy clay loam to heavy silty clay loam or light clay. In some areas thin layers of loam and sandy loam, 1 to 3 inches thick, lie below the organic material. Reaction of the organic material ranges from strongly acid to neutral.

Willette soils have a thinner layer of organic material than the Carbondale or Rifle soils. They have finer textured underlying material than the Tawas, Adrian, or Linwood soils.

Willette muck (Wl).—This soil is nearly level or in depressed areas and is on uplands and plains. The surface layer is very dark grayish-brown muck 10 to 30 inches thick. Thickness of the organic layers of this soil is variable and ranges from 12 to 60 inches over short distances. Included in mapping this soil were small areas of Sims soils and Bergland soils at the borders of areas of Willette muck. Also included were small areas of Carbondale muck near the centers of some areas of Willette muck. Included also were small areas where a very dark grayish-brown mineral surface layer, 4 to 12 inches thick, overlies the Willette muck.

A high water table and a frost hazard severely limit use of this soil for crops. The soil dries slowly and is cold even when drained. Most areas of this soil are in forest. A few areas are in permanent pasture. (Capability unit Vwc–1 (M/1c); woodland suitability group J)

Wind Eroded Land

Wind eroded land, sloping (WnC) is on slopes of 2 to 12 percent and is severely eroded. The surface material has been removed by wind to a depth of 20 to 30 inches or more. Underlying sands are exposed in large areas. Blowouts, where the wind has removed the sand to a depth of several feet, range from 10 to 100 feet or more in diameter. In many places the sand has been deposited on the leeward side of the blowouts.

The major needs on these wind eroded areas are control of wind erosion and the establishment of trees. Most of these areas are idle or support only a sparse growth of weeds, briers, and shrubs. (Capability unit VIIs–1 (5.7a); woodland suitability group N)

Wind eroded land, steep (WnF) is on slopes of 12 to 40 percent or more where severe wind erosion has removed the sand to a depth of 20 to 30 inches or more. Blowouts, where the wind has removed sand to a depth of several feet, are common. These blowouts range from 10 to 100 feet or more in diameter. In many areas the sand has been deposited on their leeward side.

The major needs on the steep slopes of these areas are control of erosion and establishment of trees. Most of these eroded areas support only a sparse growth of weeds, briers, and brush, but a few areas have been planted to pines. (Capability unit VIIs–1 (5.7a); woodland suitability group N)

Use and Management of the Soils

In this section the capability groupings used by the Soil Conservation Service are explained. Then, the capability units are discussed in detail and suggestions about use of the soils and management practices are given. Next, predicted yields of the principal crops are listed. Then, information about the use of the soils for woods and forests is given. The final part gives information about engineering tests, estimated engineering properties of the soils, and interpretations of soil properties that influence engineering work.

Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

In the capability system all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

Capability Classes, the broadest grouping, are designated by Roman numerals I through VIII; however, no soils in Osceola County are in class I. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined in the list that follows:

Class I. Soils have few limitations that restrict their use.
Class II. Soils have some limitations that reduce the choice of plants or require moderate conservation practices.
Class III. Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
Class IV. Soils have very severe limitations that restrict the choice of plants, require very careful management, or both.

Class V. Soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woods, or wildlife food and cover.

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

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

Class VIII. Soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

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

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

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–3 or IIIe–6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph. The Arabic numeral specifically identifies the capability unit within each subclass.

The names of soil series represented are mentioned in the description of each capability unit, but this does not mean that all the soils of a given series are in that particular capability unit. To find the names of all the soils in the county and the capability unit in which each one has been grouped, refer to the "Guide to Mapping Units" at the back of this survey. Omitted from the descriptions in the capability units is one variable land type, Gravel and sand pits (Gp).

The symbols in parentheses following each capability unit designation refer to Michigan management groups that make up the capability unit. All management groups that apply to soils present in the capability unit are listed. The management groups are used on a statewide basis for making recommendations about fertilizer and lime application, irrigation or drainage design, and cropping or conservation practices. For a more detailed explanation of the Michigan system of management grouping, see Michigan State University Agricultural Extension Bulletin E–550, "Fertilizer Recommendations for Michigan Vegetable and Field Crops" (*4*).[6] Because this bulletin was released in 1966, the numbering of management groups differs from that used in this survey. The management group for each mapping unit, except one, in Osceola County is listed after the capability unit symbol in the "Guide to Mapping Units" at the back of this survey. Omitted is the variable land type, Gravel and sand pits (Gp).

In the following pages the capability units in Osceola County are described and suggestions for use and management of the soils are given.

CAPABILITY UNIT IIe–1 (1.5a)

Soils of this unit are well drained or moderately well drained and are predominantly gently sloping. They are soils of the Nester series. The subsoil and underlying material are moderately fine textured. Stones are present on the surface of the Nester stony sandy loam soil.

Available moisture capacity of the soils is high, and soil moisture seldom is a limitation to plant growth. Fertility is moderate, and content of organic matter is low to medium. Water moves moderately slowly through the soil. Control of erosion and maintenance of tilth and organic-matter content are major management needs. These soils warm more slowly in spring than do coarser textured soils. A few wet spots are present in some areas, and these delay planting and harvesting.

Wheat, rye, hay, and corn are the principal crops grown on these soils. Yields are high if a sequence of crops is used that controls erosion and provides for the return of organic matter to the soil. Tilling these soils when they are wet results in a cloddy surface and poor tilth. Grazing the soils when they are wet causes compaction and increases runoff.

Fall plowing permits earlier planting the following spring, but erosion may be excessive if the soils are plowed in fall. Practices that improve tilth and reduce erosion are minimum tillage, terracing, use of grassed waterways, addition of green manure and fertilizers, and stripcropping (fig. 7). Layout and construction of terraces and contour strips is difficult in many areas because slopes are short and complex.

The stony soil of this unit is difficult to use for crops because there are stones on the surface and throughout the soil profile. The stones prevent or seriously hinder use of planting and harvesting equipment. This stony soil is suited to pasture.

CAPABILITY UNIT IIe–2 (2.5a)

The soils of this unit are well drained and moderately well drained and are gently sloping. They are soils of the Bohemian, Dighton, and Isabella series and have a moderately fine or medium-textured subsoil. The underlying material ranges from stratified silts and fine sands to sand or sandy clay loam. Most areas are uneroded or only slightly eroded, but a few areas are moderately eroded.

Available moisture capacity of these soils is high, and soil moisture seldom is a limitation to plant growth. Fertility is moderate to moderately high, and content of organic matter is low to medium. Water moves moder-

[6] Italic numbers in parentheses refer to Literature Cited, p. 137.

Figure 7.—**Field stripcropping on Nester sandy loam, 2 to 6 percent slopes, to control wind and water erosion.**

ately slowly through the soils, and runoff is medium. Small seep areas and wet depressions in some areas hinder planting and harvesting during wet years.

Crops commonly grown on these soils are corn, small grains, hay, and pasture. The major management needs are control of erosion and maintenance of tilth and fertility. Minimum tillage, terraces, and stripcropping help control erosion, but terracing and stripcropping are not feasible in some areas, because of short, complex slopes. Establishing grass in natural waterways reduces gullying and loss of soil. Use of shallow surface drains helps dry wet depressions and allows earlier tillage. Plowing under crop residues and green-manure crops reduces crusting of the surface and reduces runoff. Use of manure on the moderately eroded areas improves tilth and germination of seeds.

CAPABILITY UNIT IIe–3 (3a, 3/2a)

The soils of this unit are well drained and moderately well drained and are level or gently sloping. They are soils of the McBride, Newaygo, Traverse, and Ubly series and the Ubly series, clay subsoil variant. Most of the soils have a medium-textured or moderately coarse textured subsoil underlain by coarse- to medium-textured material.

Available moisture capacity is moderate to moderately high but is not adequate for crop growth during periods of extreme drought. Fertility is moderate or moderately high. Runoff is slow. Movement of water through the soil is generally moderate or moderately rapid, but it is moderately slow through the fragipan in the McBride soils.

Soils in this unit are easy to till over a wide range of moisture content. They are ready for tillage early in spring and dry quickly after rains. They warm earlier in spring than do finer textured soils. Crusting of the surface layer is seldom a problem, especially if minimum tillage is practiced and organic material is plowed under.

These soils are suited to most crops grown in the county. Corn, oats, wheat, hay, and potatoes are the crops commonly grown. Erosion control, maintenance of fertility and organic-matter content, and conservation of moisture are the major management needs. Terraces, stripcropping, and contour tillage control erosion. Minimum tillage helps to control erosion and also helps to maintain good tilth. Plowing under manure and crop residues improves tilth and the ability of the soils to absorb water. Winter cover crops control soil blowing and water erosion and provide organic matter for the soil.

Since the soils are acid, additions of lime help crop growth. Legumes benefit particularly.

CAPABILITY UNIT IIw–2 (1.5b, 1.5c)

The soils of this unit are somewhat poorly drained to very poorly drained and are members of the Kawkawlin, Sims, and Twining series. They are level to nearly level and in some areas are in shallow depressions. Their subsoil and the underlying material are moderately fine textured.

These soils warm and dry slowly in the spring in undrained areas. Available moisture capacity and natural fertility of these soils are high. Runoff is slow to ponded. Water moves through the soil moderately slowly, and the surface is saturated during wet periods. The water table is at or near the surface of these soils, unless they are artificially drained. Wet depressions are common in most areas and delay planting and cultivation during wet periods. If these soils are farmed when wet, they puddle readily, lose their tilth, dry cloddy and hard, and crust readily. The crust hinders seedling emergence and reduces plant population. Farm machinery readily bogs down in these soils when they are wet. Since the soils are in low positions, frost damage to crops is a hazard.

The major limitations to the use of these soils for crops are excessive wetness, a frost hazard, and the necessity to maintain good tilth.

These soils are among the most productive soils in the county if they are adequately drained. Unless they are drained, small grains grown on them often drown or else grow rank and lodge before harvest. Excess wetness also is a hazard to corn crops grown on these soils.

Natural outlets for drainage are lacking in many areas, and ditches are used instead. Drainage is impractical in some areas, because of the lack of suitable outlets and the low elevation of the soils. Tile drains are installed easily, and tile trenches generally do not fill in before tile is installed. Installation of diversion terraces in areas above these soils reduces runoff and reduces saturation of these soils.

Plowing under crop residues and green manure crops reduces crusting of these soils, improves their tilth, and increases crop yields. Fall plowing allows earlier planting of crops in the spring and in many instances is less destructive of tilth than spring plowing.

CAPABILITY UNIT IIw–3 (1.5b)

The soils of this unit are somewhat poorly drained and are gently sloping or undulating. They are soils of the Kawkawlin and Twining series. Their subsoil and underlying material are moderately fine textured. Stones are present on the surface and throughout the profile of the Kawkawlin stony loam soil that is included in this unit.

Available moisture capacity and fertility of these soils are high. Runoff is slow and ponds in the numerous depressions present in areas of these soils. Movement of water through the soils is moderately slow. The wet depressions often delay planting and tillage of crops. The soils of this unit have a fluctuating high water table, which is at or near the surface during spring. Many areas are too wet

in spring or after rain to permit operation of farm machinery. If the soils of this unit are tilled when wet, they puddle and lose tilth, dry cloddy and hard, and crust on drying. The hard crust hinders seedling emergence and reduces crop yields.

If these soils are drained, they are well suited to crops commonly grown in the county. The stony areas are generally too stony for use for crops but are suited to pasture. In the stony areas removal of the stones generally is not feasible.

Layout and installation of drainage systems on these soils are difficult or impractical in many areas, because these soils are undulating. Outlets for drainage are lacking in some areas. Drainage methods are limited to use of random tile and surface drains in many areas. The soils are stable, however, so ditchbanks and tile trenches require little maintenance.

Plowing under large amounts of crop residues and green manure improves the tilth of these soils and reduces crusting of the surface layer. The use of minimum tillage is suggested.

CAPABILITY UNIT IIw–7 (2.5b)

The soils of this unit are somewhat poorly drained and in most areas are gently sloping but in a few areas are nearly level or level. They are soils of the Brimley, Coral, and Richter series, and predominantly have a moderately coarse to medium-textured subsoil and medium-textured underlying material.

Available moisture capacity is moderately high or high, and fertility is moderate. Movement of water through the soil ranges from moderately rapid to moderately slow. Runoff is slow and ponds in depressed areas. These soils normally supply enough moisture for optimum plant growth. They are excessively wet during the spring and after rain because of a fluctuating high water table. Once the soils are drained and become dry, they can be worked easily and present no serious tilth problem.

Once these soils are drained, most crops commonly grown in the county can be grown on them. Because these soils are undulating, a complete drainage system is difficult to install. Random tile drains and surface drains can be used for drainage in many areas if adequate outlets are available. Installing tile drains is difficult in some areas because the silty and sandy material caves into the tile trenches readily. The Brimley soils of this unit are especially unstable when wet, and the Richter soils have sandy pockets. Backfilling of the trenches helps prevent the sandy and silty material from flowing into the tile and plugging it.

Selection of forage crops depends on the degree of drainage installed.

Additions of lime and fertilizer benefit most crops. Plowing under green manure and crop residues improves the content of organic matter.

CAPABILITY UNIT IIw–8 (3c, 3/2b, 3/1c)

The soils of this unit are somewhat poorly drained to very poorly drained and are in level areas or depressions or are gently sloping and undulating. They are in the Belding, Ensley, Munuscong, and Tonkey series. Generally, the soils of this unit have a medium-textured to moderately fine textured subsoil and moderately coarse to fine-textured underlying material. The exceptions are the Belding soils, in which the upper part of the subsoil is moderately coarse textured.

Unless the soils are drained, a seasonal high water table is at or near the surface during spring. Available moisture capacity and fertility are moderately high to high, except in the Belding soils, in which fertility is moderate. Movement of water through the soils is moderate or moderately slow. Runoff is very slow or slow, and water ponds in depressions. Frost is a hazard to crops in low areas.

Most crops grown in the county are suited to these soils once the soils are drained. Selection of crops depends on degree of drainage attained. Tile drains and surface drains help remove excess water and permit earlier tillage of the soils. The undulating soils are more difficult to drain than the level soils. Random tile and surface drains are suitable for removing excess water in undulating areas. Depth and spacing of tile depend on depth to finer textured material in the soil profile. Sand pockets cause caving in of tile trenches in some areas, and tile is installed most easily during dry periods.

CAPABILITY UNIT IIs–1 (1.5a)

The soils of this unit are well drained and moderately well drained, and are level or nearly level. They are soils of the Nester series and have a moderately fine textured subsoil and underlying material.

Available moisture capacity is high, and fertility is moderate. Runoff is slow, and water moves moderately slowly through the soil. Wet spots are present in many areas. These soils dry slowly in the spring, and planting of crops is delayed during some years because of wetness. Plowing or cultivating the soils when they are wet severely damages tilth and leaves the soils cloddy.

Crops commonly grown in the county are suited to these soils. Maintenance of tilth and organic-matter content are major management problems. Minimum tillage and the return of crop residues and green manure to the soil help maintain tilth and organic-matter content.

CAPABILITY UNIT IIIe–2 (1a)

The soils of this unit are well drained and moderately well drained and are sloping. They are in the Kent series. These soils are slightly eroded and moderately eroded. The subsoil and underlying material are clayey or moderately fine textured.

Available moisture capacity is high, and fertility is moderately high. Runoff is medium on the milder slopes and rapid on the steeper ones, but movement of water through the soil is slow. Erosion is a serious problem when the soils are cultivated. The moderately eroded areas have poor tilth and crust readily on drying. Runoff is greater from eroded areas than from uneroded areas, and the eroded areas are more droughty during midsummer. Content of organic matter is low, especially in the moderately eroded soils. Small seep spots remain wet late in the spring and prevent the soils from drying. The soils puddle and become cloddy if worked when too wet.

Because of the erosion hazard, these soils are better suited to close-growing crops rather than to row crops. A cropping system consisting mainly of small grains and hay reduces the risk of erosion.

Maintenance of tilth and control of erosion are the major management needs. Terraces, stripcropping, and contour farming reduce the risk of erosion if slopes are suitable

for these practices. In some areas the slopes are either too steep or too complex for practical layout of these practices. Plowing under green manure crops and crop residues helps maintain and improve tilth and thereby reduces runoff and erosion.

CAPABILITY UNIT IIIe–3 (1a, 1.5a)

The soils of this unit are well drained or moderately well drained and are gently sloping. They are soils of the Kent and Nester series. Most of the soils are moderately eroded, but one is uneroded or is slightly eroded. These soils have a fine textured or moderately fine textured subsoil and underlying material.

Available moisture capacity is high, and fertility is moderate to moderately high. In areas where erosion has removed part of the surface soil and where, as a result, the fine-textured subsoil is closer to the surface, tilth and workability of the surface layer are poor. Runoff is rapid in these areas because of poor tilth, and because erosion has reduced the content of organic matter in the soil. Elsewhere, it ranges from medium to rapid. Permeability is slow to moderately slow.

The soils of this unit puddle and become cloddy and hard when cultivated intensively. The surface crusts and hinders germination of seeds in many areas. Soils in the depressions and drainageways dry slowly in spring, and planting and harvesting of crops are delayed. Because of the poor tilth of the eroded soils and their loss of water by runoff, stands of plants often are uneven and yields are reduced during dry summers.

Small grains, hay, and corn are the crops commonly grown on these soils. Limiting the use of row crops in the cropping system helps reduce the erosion hazard. Plowing under green manure crops and crop residues and use of minimum tillage improve tilth and reduce runoff. Use of terraces and contour stripcropping to control erosion usually is not practical, because of the complex, short slopes in many areas.

CAPABILITY UNIT IIIe–4 (1.5a)

The soils of this unit are well drained and moderately well drained and are sloping. They are soils of the Nester series. They are uneroded or moderately eroded in most areas but are severely eroded in a few. In some areas they are gravelly or stony. These soils have a moderately fine textured subsoil and underlying material.

Available moisture capacity of these soils is high, and fertility is moderate. The degree of slope of these soils causes them to be subject to erosion and rapid runoff. Content of organic matter is low in both the uneroded and eroded soils. Tilth is poorer and runoff greater in areas of eroded soils than in areas of uneroded soils. Cropped areas tend to be droughty, as a result, in dry years. These soils puddle readily if worked when too wet. The surface crusts, especially on the eroded soils, and poor germination of seeds and uneven stands of plants result. Stones hinder tillage in some areas but removal of the stones generally is not practical.

Corn, small grains, and hay are crops commonly grown on these soils. The major management needs are control of erosion, improvement of tilth and content of organic matter, and renewal of fertility that has been removed by erosion and by crops. Cropping systems with a high proportion of close-growing crops protect the soils and allow their continued use. Planting row crops for more than 2 years in succession permits excessive erosion and runoff of water. Short, complex slopes make contour stripcropping and the layout and construction of terraces difficult, but contour farming is possible in a few areas. Occasional wet spots in low areas and on steep slopes can be dried by use of random tile drains.

CAPABILITY UNIT IIIe–5 (2.5a)

In this unit are well drained and moderately well drained, sloping soils of the uplands. They are soils of the Bohemian, Dighton, and Isabella series and have a medium-textured or moderately fine textured subsoil and coarse textured to moderately coarse textured underlying material. The underlying material is moderately fine textured in places. These soils are uneroded or moderately eroded.

Available moisture capacity of these soils is high, and fertility is moderate or moderately high. Water moves through the soil at a moderate to moderately slow rate. Runoff is rapid when the soils are farmed intensively. Uneroded areas have good tilth and are easy to work. Moderately eroded areas have poorer tilth and crust readily on drying. This results in uneven stands of crops and reduced yields. Runoff is more rapid in eroded areas than in uneroded areas, and less water moves into the soil to be used by plants.

Crops commonly grown in the county are suited to these soils if the soils are protected from serious erosion and excessive loss of moisture. Maintenance of tilth and fertility is a major management need if these soils are cropped. Cropping systems that include a large proportion of close-growing crops help to control erosion and reduce runoff. Minimum tillage improves tilth and helps reduce the risk of erosion. Plowing under large amounts of manure and of green-manure crops also helps improve tilth and fertility, especially on the moderately eroded soils. Because slopes are short and complex, use of terraces and stripcropping is seldom practical.

CAPABILITY UNIT IIIe–6 (3a, 3/2a)

In this unit are well drained and moderately well drained, sloping soils of the uplands. They are soils of the McBride, Newaygo, and Ubly series and of the Ubly series, clay subsoil variant. These soils have a medium-textured to moderately coarse textured subsoil over coarse-textured to medium-textured underlying material. A few soils are underlain by fine or moderately fine textured material. Most of the soils of this unit are uneroded or slightly eroded. Two of them are moderately eroded.

Available moisture capacity generally is moderately high. The Newaygo soil has moderate available moisture capacity and is the most droughty soil in the unit. Fertility of these soils ranges from moderate to moderately high. Water moves into most of the soils readily, but because of the slope, much of it runs off, and only moderate amounts soak into the soil. Water moves through the McBride and Newaygo soils moderately to moderately rapidly, and it moves through the Ubly soils moderately slowly or slowly. In general, runoff ranges from moderate to moderately rapid, but it is rapid if crops are planted up and down the slope.

The major limitations to the use of these soils for crops are an erosion hazard and a shortage of available soil moisture during dry summer months.

Crops commonly grown in the county are suited to these soils if the soils are protected from erosion. Minimum till-

age, return of crop residues to the soil, and use of cover crops reduce runoff and erosion. Establishing a grass cover in waterways provides for disposal of runoff and prevents gully formation. Terraces and stripcropping can protect the soils from erosion where the slopes are not too short and complex. In areas of such slopes, a cropping system with a large proportion of close-growing crops helps control erosion.

CAPABILITY UNIT IIIe–9 (4a, 4/2a)

Soils in this unit are well drained and moderately well drained, are sloping, and are on uplands. They are soils of the Blue Lake, Mancelona, Manistee, Menominee, Montcalm, and Rousseau series. Most of the soils have coarse-textured profiles. The Menominee and Manistee soils are underlain by moderately fine textured or fine textured material, and the Mancelona soils are underlain by stratified sand and gravel. The soils of this unit mostly are uneroded or only slightly eroded, but a few areas are moderately eroded or severely eroded.

Available moisture capacity and fertility of these soils are moderately low. The soils are droughty during dry summer months. Water moves rapidly or moderately rapidly through most of the soils but moves moderately slowly or slowly through the lower part of the Menominee and Manistee soils. Tillage of these soils is easy, but they erode readily when cultivated intensively. The Rousseau and Montcalm soils erode more readily than other soils in the unit. Runoff is rapid when crops are planted up and down the slope. The eroded soils of this unit have a lower content of organic matter than uneroded soils and tend to be more droughty. Wind erosion is a hazard where large areas of these soils are exposed by tillage.

Use of these soils for crops is limited mainly by an erosion hazard and a shortage of soil moisture. Shallow-rooted crops are not so well suited to these soils as are such deep-rooted crops as alfalfa. Small grains normally mature before soil moisture becomes inadequate. The soils warm early in spring and are ready for planting sooner than finer textured soils.

Minimum tillage, stubble mulching, and stripcropping control erosion and allow more intensive use of the soils (fig. 8). Some areas do not have continuous slopes, and stripcropping is difficult or impractical there. Grassed waterways are effective in carrying runoff along natural drainageways without erosion damage, but maintaining a grass cover in waterways is difficult on the coarsest textured soils of the unit.

Plowing under crop residues, use of green-manure crops, and spreading of barnyard manure are ways to improve the organic-matter content of these soils and reduce the risk of erosion and drought. Heavy additions of fertilizer are not profitable or beneficial during dry years when soil moisture is not sufficient to mature the crop.

CAPABILITY UNIT IIIw–2 (1b, 1c)

In this unit are somewhat poorly drained to very poorly drained soils that have a clayey subsoil and underlying material. They are soils of the Bergland, Pickford, and Selkirk series. Most of the soils are level or in depressed areas, but some are gently sloping.

Available moisture capacity of these soils is high, and fertility is moderately high or high. The soils have a seasonal high water table that is at or near the surface during part of the year, unless they are artificially drained. Water

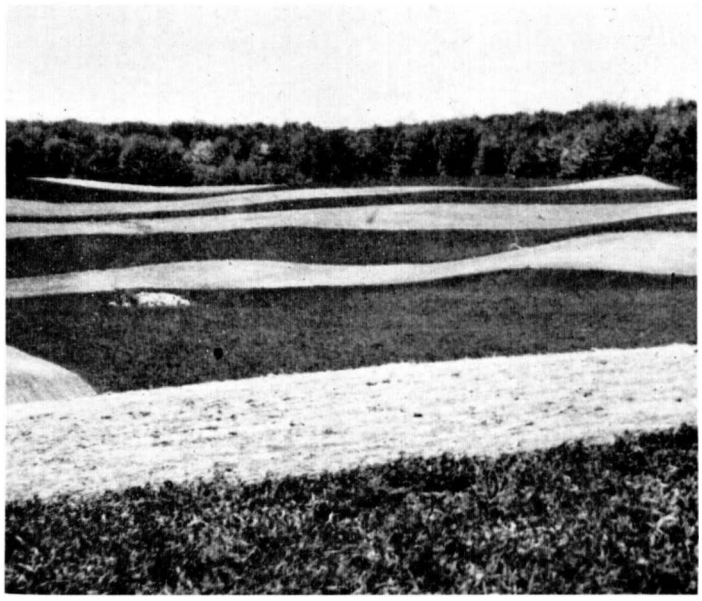

Figure 8.—**Stripcropping helps to control erosion on this field of Montcalm loamy sand.**

moves into these soils slowly or very slowly and stands on the surface in depressions and level areas for long periods. The gently sloping soils have better surface drainage than the level soils. The clayey subsoil and high water table restrict the root zone and reduce crop yields.

Unless the soils are drained, they are severely limited for crop use. Wetness hinders the use of farm machinery. Frost damage to crops also is a hazard, especially in the lowest areas.

Once these soils are drained, they produce good yields of crops commonly grown in the county. The Bergland soil, however, is seldom used for crops. Selection of crops depends on the degree of drainage and the frost hazard, but small grains tend to grow rank and lodge on these soils because of the moderate to high content of organic matter. Tile drains, surface drains, and bedding systems help remove excess water from the soil and permit earlier planting of crops.

Tilling these soils when they are wet tends to destroy the soil structure and results in poor tilth. Fall plowing, at the right moisture content, reduces damage to soil structure and allows earlier tillage of the soils the following spring. Plowing under organic materials improves movement of water into the soil and allows water to move more readily to the tile drains.

CAPABILITY UNIT IIIw–5 (4b)

The soils of this unit are somewhat poorly drained and are level or gently sloping. They are soils of the Gladwin and Otisco series and have coarse-textured profiles. The Gladwin soils are underlain by stratified sand and gravel, and the Otisco soils are underlain by sand.

All soils in this unit have a seasonal high water table, unless they are artificially drained. Because of their sandy texture, they dry quickly once the water table is lowered. Water moves moderately rapidly or rapidly through the soils in the absence of a high water table, and the soils tend to be droughty once they are drained. Natural fertility is moderately low, and the content of organic matter is low.

The use of these soils for crops is limited mainly by excess wetness, moderately low fertility, and shortage of available moisture during extreme dry periods. Wind erosion is a hazard in large areas.

Crops commonly grown in the county are suited to these soils once the soils are drained. Installing tile drains or surface drains helps increase yields and allows earlier tillage of the soils in spring and after rain. The sandy material readily caves into tile trenches and ditches, so tile drains are placed most easily during dry periods. In some areas a lack of outlets and uneven relief dictate the use of random surface drains or tile drains. The soils of this unit support farm machinery better than more clayey soils.

During dry periods yields of small grains are relatively better than those of corn because the small grains normally mature before soil moisture becomes inadequate. Light and frequent additions of fertilizer to these soils are sometimes more beneficial than heavy additions because of loss of nutrients through leaching.

CAPABILITY UNIT IIIw–6 (4c)

In this unit are poorly drained and very poorly drained soils that formed in coarse and moderately coarse textured material. They are soils of the Edmore, Tonkey, and Wheatley series and are level or are in depressed areas.

Available moisture capacity of these soils is low or moderately low, and fertility is low to moderate. These soils are saturated with water during spring because of a high water table. After the water table lowers, water moves rapidly to moderately rapidly through the soil. Runoff is very slow, and water ponds on the surface in depressions and on flats. Since the soils are sandy, they tend to be droughty after they are drained.

Corn, small grains, and hay are the crops commonly grown on these soils when they are drained. The selection of adapted crops depends on the degree of drainage. Undrained areas are suited to pasture or water-tolerant forage plants.

Tile drains and open ditches are effective in removing excess water from these soils. Ditchbanks and tile trenches cave in readily when the soils are wet, so installation of tile and ditches is best done during dry periods. Controlling the drainage flow helps regulate the amount of moisture available to plants.

Additions of fertilizer and organic material to these soils improve crop yields. The use of minimum tillage decreases the hazard of wind erosion.

CAPABILITY UNIT IIIw–9 (4/1b, 4/2b)

The soils of this unit are somewhat poorly drained and are nearly level to gently sloping. They are soils of the Allendale and Iosco series and have 18 to 42 inches of coarse-textured material over moderately fine textured or fine textured material.

These soils are saturated during spring and after rain because of a seasonal high water table and because of the slow or moderately slow permeability of the underlying material. Runoff is slow, and water ponds in the lowest depressions during wet periods. Available moisture capacity is moderately low, and fertility is low or moderately low. The soils are commonly droughty after they are drained. Water moves rapidly through the sandy upper layers and moderately slowly or slowly through the finer textured underlying material. Once the water table is lowered by drainage, the soils dry quickly and readily support farm machinery.

When large areas of these soils are exposed by tillage, wind erosion is a hazard. Stones are present on the surface in a few areas and hinder tillage of crops.

Crops commonly grown in the county are suited to these soils once they are drained. During dry years small grains yield relatively better than crops such as corn because the small grains mature before soil moisture becomes inadequate. Heavy fertilizer applications may not be profitable during dry years because crops lack the moisture needed to make use of the plant nutrients.

Tile drains and open ditches are effective in removing excess wetness. Installing tile drains and ditches is best done during dry periods because the sandy material tends to cave into the trenches and ditches when it is wet. In some areas drainage is impractical, because outlets are not available. Constructing diversion terraces on adjacent higher areas is effective in diverting runoff from these soils and allows them to dry more quickly after rain.

Stripcropping or windbreaks help control wind erosion where large areas of these soils are farmed. Returning large amounts of such organic materials as crop residues and green manure to these soils improves their tilth and ability to absorb moisture. Use of minimum tillage leaves the surface of the soil rough and resistant to wind erosion.

CAPABILITY UNIT IIIw–10 (4/1c, 4/2c)

The soils of this unit are poorly drained and very poorly drained and are level or are in depressed areas. They are soils of the Brevort and Pinconning series. The upper 18 to 42 inches of the soil profile is coarse textured, and the material below this depth is moderately fine textured or is fine textured.

Available moisture capacity and fertility of these soils are moderately low. Water moves rapidly through the sandy upper part of the soil and moderately slowly or slowly through the finer textured lower part. Runoff is very slow or ponded. These soils are saturated because of a high water table and the lack of permeability of the underlying material. They dry slowly in the spring, and tillage is delayed. In years of heavy rainfall, harvesting also is delayed. Once these soils are drained, they dry quickly and become droughty during extremely dry periods. Because of the low position of these soils, crops grown on them are subject to frost damage during spring and fall months. Frost prevents crops from maturing during some years.

Many areas of these soils have not been drained, because of a lack of suitable outlets for water or because the areas are not in farms. Many other areas remain wooded. Those areas that have been drained are in crops or pasture.

Tile drains and open ditches are effective in removing excess water. They are installed more easily during dry periods than during wet periods because the sandy soil material caves in readily when it is wet. Depth and spacing of tile drains depend on the depth of the finer textured underlying material. The Pinconning soil of this unit is more difficult to drain than the Brevort soils because of its clayey underlying material. The soils of this unit dry more quickly if runoff from adjacent higher areas is carried off by diversion terraces.

Since small grains normally mature before there is a lack of soil moisture during the growing season, small grain yields are more dependable than yields of crops that

mature late in summer. Additions of organic materials and fertilizer to these soils and use of minimum tillage conserve moisture during dry periods and improve yields.

CAPABILITY UNIT IIIw-11 (5c)

The two soils of this unit are poorly drained or very poorly drained and are nearly level or are in depressed areas. They formed in sandy material. The Kinross soil is very strongly acid, and the Roscommon soil is slightly acid to neutral.

Available moisture capacity and fertility of these soils are low. Water moves very rapidly through them in the absence of a high water table, but the water table is at or near the surface, unless the soils are artificially drained. When the soils are drained, available moisture is insufficient for crops during extreme droughts. Runoff is very slow and ponds in depressed areas.

Excess wetness, low fertility, low available moisture capacity when drained, and a wind erosion hazard severely limit the use of these soils for crops. A strongly acid reaction further limits use of the Kinross soil. Crops grown on these soils are subject to frost damage.

These soils are seldom planted to crops. Outlets for drainage are lacking in many areas, and ditches must be dug to provide outlets. The sandy material in the soils tends to clog tile drains and caves into tile trenches and ditches.

CAPABILITY UNIT IIIs-3 (4a, 4/2a)

The soils of this unit are well drained and moderately well drained and are level or nearly level. They are soils of the Blue Lake, Mancelona, and Menominee series. These soils have a coarse textured or moderately coarse textured subsoil that overlies coarse textured or moderately fine textured material.

Available moisture capacity and fertility of these soils are moderately low. Runoff is slow because the soils are level or nearly level. Available soil moisture is rarely adequate for optimum crop growth, especially during dry summer periods, and the content of organic matter and nitrogen is low. The Menominee soil has slightly higher available moisture capacity than other soils of this unit because of its underlying moderately fine textured material. Water erosion is seldom a problem, but wind erosion is a serious hazard if the soils of this group are intensively farmed.

These soils are easily farmed because of their friable surface layer and lack of slope. Most crops common to the county are suited to these soils. Corn, small grains, hay, potatoes, and beans are the major crops grown. Crops that resist drought and mature early in the season are best suited to these soils. Deep-rooted forage plants give better yields than many other kinds of plants.

Windbreaks, stripcropping, and minimum tillage help control erosion in cropped areas. Additions of organic material improve the content of organic matter and fertility, and additions of fertilizer help increase crop yields if soil moisture is adequate. Heavy additions of fertilizer may not be profitable in dry years, because the soils lack sufficient moisture to mature crops.

CAPABILITY UNIT IIIs-4 (4a, 4/2a)

Soils of this unit are well drained and moderately well drained, are level or gently sloping, and are on uplands. They are soils of the Blue Lake, Mancelona, Manistee, Menominee, Montcalm, and Rousseau series. All except the Manistee and Menominee soils are coarse textured to a depth of 5 feet or more. The Manistee soil has coarse-textured material, 18 to 42 inches thick, over fine-textured material. The Menominee soil is underlain by moderately fine textured material at a depth of 18 to 42 inches.

Available moisture capacity and fertility of these soils are moderately low. Normally, the soils have water available for the use of plants at the start of the growing season. As the season progresses, rainfall is not sufficient to replenish water used by plants. Crop yields are reduced during extreme drought. Water moves rapidly or moderately rapidly through these soils. The finer textured material in the Manistee and Menominee soils reduces permeability, and these soils are less droughty than others in this group. Runoff is slow, and water erosion is seldom a hazard, but the soils are subject to wind erosion if they are cultivated intensively. The Rousseau soil is more droughty and subject to wind erosion than other soils in the unit. Soils of this unit are easily worked throughout a wide range of moisture content without clodding or crusting.

Most crops common to the county are suited to these soils. Corn, small grains, hay, potatoes, and beans are the major crops grown. Crops that resist drought and mature early in the season do best on these soils.

Windbreaks, stripcropping, and minimum tillage help control wind erosion in cropped areas. Large additions of crop residues and manure, including green manure, increase fertility and the content of organic matter and make the soils more absorbent. Use of fertilizer increases yields if moisture is adequate. Heavy additions of fertilizer may not be profitable in dry years, when soil moisture is inadequate.

CAPABILITY UNIT IVe-1 (1a, 1.5a)

The soils of this unit are well drained and moderately well drained and are moderately steep or hilly. They are soils of the Kent and Nester series and range from uneroded to moderately eroded. These soils have fine textured or moderately fine textured subsoil and underlying material.

Available moisture capacity of these soils is high, and fertility is moderate. Water moves through the soil slowly or moderately slowly. Runoff is rapid and is greater on the moderately eroded soils than on the uneroded soils. The moderately eroded soils have poor tilth. During dry years soil moisture is inadequate for crop needs.

These soils generally are too steep to be used intensively for crops. Small grains and hay are the crops commonly grown. Such practices as minimum tillage, stripcropping, and use of long rotations reduce runoff and erosion. Addition of large amounts of organic matter to the soil improves tilth and reduces runoff. Establishment of grassed waterways in natural drainageways reduces erosion.

In many areas the slopes are too complex and short for installation of stripcropping. A cropping system that includes a large proportion of close-growing crops will reduce runoff and erosion in these areas.

CAPABILITY UNIT IVe-4 (2.5a, 3a, 3/2a)

In this unit are well drained and moderately well drained upland soils that are moderately steep or hilly. They are soils of the Bohemian, Dighton, Isabella, McBride, and Ubly series and range from uneroded to severely eroded. Predominantly, these soils have a medium-textured

to moderately fine textured subsoil over coarse-textured to moderately fine textured material.

Available moisture capacity is moderately high or high, and fertility is moderate to moderately high. Water moves through the soil moderately or moderately slowly. Runoff is rapid in areas that are in crops, and erosion is a serious hazard. Content of organic matter is low in the moderately eroded areas, and the surface layer tends to crust in these areas. Runoff and erosion are greater on the moderately eroded soils than on the uneroded soils. In dry years soil moisture is insufficient for crop needs.

These soils are too steep to be used intensively for crops. Small grains and hay are the crops commonly grown. Erosion is a serious hazard if row crops are planted for more than 1 year up and down the slopes. Such practices as minimum tillage, stripcropping, and use of long rotations reduce runoff and erosion. Plowing under large amounts of organic matter reduces runoff and improves movement of water into the soil. Establishment of grassed waterways helps move runoff safely downslope.

In many areas the slopes are too complex and short for stripcropping. A cropping system that includes a large proportion of close-growing crops will reduce runoff and erosion in these areas.

CAPABILITY UNIT IVe–9 (4a, 4/2a)

In this unit are well drained and moderately well drained upland soils that are moderately steep or hilly. They are soils of the Blue Lake, Mancelona, Manistee, Menominee, Montcalm, and Rousseau series. Most of the soils are coarse textured to a depth of 5 feet or more. The Menominee soils, however, are underlain by moderately fine textured material, and the Manistee soil is underlain by fine-textured material. The Mancelona soil is underlain by stratified sand and gravel. Most of the soils of this unit are uneroded or slightly eroded. A few areas are moderately eroded.

Available moisture capacity and fertility of these soils are moderately low. Runoff is rapid to medium, and the soils are droughty in summer. Water moves rapidly to moderately rapidly through most of these soils, but moderately slowly or slowly through the lower part of the Menominee and Manistee soils.

The soils in this capability unit are easy to till, but steepness of slope limits use of farm machinery in some areas. Erosion is a serious hazard in areas that are in crops. Organic-matter content and fertility are lower in the eroded soils than in the uneroded or slightly eroded soils, and the eroded soils tend to be more droughty. Wind erosion is a hazard if large areas are exposed by tillage.

Use of these soils for crops is severely limited by the erosion hazard and by droughtiness. Small grains mature before soil moisture becomes inadequate, but shallow-rooted crops suffer from lack of moisture during dry years.

Use of minimum tillage, stubble mulching, and stripcropping reduces runoff and erosion. In many areas slopes are not continuous and conservation practices are difficult to install. Maintaining a good grass cover on the soil effectively controls erosion, but overgrazing of the grass allows gullies to form. Addition of organic materials and fertilizer to the soil improves stands of plants and provides a better protective cover for the soils. Heavy additions of fertilizer may not be profitable or beneficial during dry years when soil moisture is inadequate for crop needs.

CAPABILITY UNIT IVw–2 (5b, 5/2b, 5b–h)

The soils of this unit are somewhat poorly drained, are level to gently sloping, and generally are coarse textured. They are members of the Au Gres, Ogemaw, and Saugatuck series. One soil, the loamy substratum phase of the Au Gres series, is underlain by medium- to fine-textured material at a depth ranging from 42 to 66 inches. There is a cemented hardpan in the subsoil of the Ogemaw and Saugatuck soils, and the Ogemaw soils are underlain by fine-textured material at a depth of 18 to 42 inches.

Available moisture capacity and fertility of the soils in this group are low. Because of a fluctuating high water table, these soils are excessively wet during spring. After these soils are drained, water moves rapidly through their sandy layers. The cemented layer in the Ogemaw and Saugatuck soils restricts the movement of water through the profile, and these soils are saturated during spring and after rains. Movement of water through the profile also is restricted by the finer textured material in the loamy substratum phase of the Au Gres soil, and in the Ogemaw soil. The cemented layer in the Saugatuck and Ogemaw soils also restricts the root zone. Runoff from these soils is slow and ponds in depressions. Wind erosion is a hazard if large areas are cleared and cropped.

Use of the soils for crops is severely limited by excess wetness, low fertility, low available moisture capacity, and a wind-erosion hazard.

Few areas of these soils are in crops. Most are in trees, and some are in pasture. Installation and maintenance of drainage systems are especially difficult because of the instability of the sandy material in the soils.

Once these soils are drained, they are easily tilled but become droughty. It is difficult to maintain organic-matter content and fertility because the soils are sandy. Additions of lime to these acid soils improve yields of some crops. Applying fertilizers also improves yields if the soils are drained, and if there is sufficient available soil moisture during the growing season for crop needs.

Use of stripcropping or windbreaks will reduce the risk of wind erosion if these soils are cultivated.

CAPABILITY UNIT IVs–4 (5a, 5/2a)

The soils of this unit are well drained or moderately well drained and are level to undulating or gently sloping. They are soils of the Chelsea, Croswell, East Lake, Kalkaska, and Rubicon series and are coarse textured to a depth of 42 inches or more. One soil, the Rubicon, is underlain by medium- to fine-textured material at a depth of 42 to 66 inches.

Available moisture capacity and fertility are low, and water moves through the soils rapidly or very rapidly. There is very little runoff. Available soil moisture is rarely adequate for good crop growth, especially during dry summer months, and these soils are among the most droughty in the county. During extremely dry years, such shallow-rooted crops as corn will not mature.

Hay, oats, and potatoes are grown in a few areas, but use of the soils for crops is severely limited by low fertility and available moisture capacity and by a wind erosion hazard. Crops that mature early in the season, before soil moisture is depleted, are best suited to these soils. Forage crops yield well early in the season, but their yield is

reduced in dry summer months. Additions of lime and fertilizer to the soil are needed for many crops, especially legumes. Large additions of fertilizer may not be profitable in dry years, because the soils lack sufficient moisture for crops to mature. The use of minimum tillage methods helps to reduce the loss of soil moisture.

CAPABILITY UNIT Vwc–1 (Mc, M/mc, M/1c, M/3c, M/4c)

Soils of this unit are very poorly drained and are in level or depressed areas. They are soils of the Adrian, Carbondale, Edwards, Houghton, Linwood, Lupton, Markey, Rifle, Tawas, Warners, and Willette series. These soils formed entirely or partly in organic material. The Rifle, Lupton, Houghton, and Carbondale soils formed in organic material more than 42 inches thick. The Edwards and Warners soils formed in organic material 12 to 42 inches thick over marl. In the Warners soil, the muck is less than 12 inches thick over marl. The remaining soils formed in 12 to 42 inches of organic material over mineral material of variable texture. The Adrian, Markey, and Tawas soils are underlain by sand. The Linwood soil is underlain by loam, and the Willette soil, by clay.

Available moisture capacity is high, but fertility is low or moderate. Water tends to pond in the low areas. The soils are high in organic-matter content but are low in content of phosphorus, potassium, and many of the micronutrients. Frost is a serious hazard to crops. Wind erosion not only is a hazard to soils and crops, but wind-driven material also fills ditches.

These soils are seldom used for crops. They are saturated during most of the year because of a high water table. Even when drained, they remain cold in spring and dry slowly. Suitable outlets for drainage systems are lacking.

CAPABILITY UNIT Vw–3 (L–2c, L–4a, L–4c)

The soils of this unit range from well drained to very poorly drained and are on level bottom lands that are subject to flooding. They are soils of the Abscota, Algansee, Evart, Kerston, Saranac, Shoals, and Sloan series. These soils formed in stratified, water-laid material. In general, their texture ranges from coarse to moderately fine, but the Kerston soils contain thin layers of organic material.

Use of these soils for crops is severely limited by a hazard of flooding, a high water table, and the hazard of damage by frost. Many areas of these soils are not suited to farming, because they are adjacent to meandering streams.

Some areas of these soils are suited to pasture when they are not flooded and when the soil dries.

CAPABILITY UNIT VIe–1 (1.5a, 2.5a)

In this unit are well drained and moderately well drained upland soils that are moderately steep or steep. They are soils of the Isabella and Nester series. The subsoil and underlying material are medium textured or moderately fine textured. The degree of erosion ranges from slight to severe.

Available moisture capacity is high, and natural fertility is predominantly moderately low or low. Fertility and content of organic matter are lower in the severely eroded soils than in the slightly eroded or moderately eroded soils. Runoff is rapid, especially on the severely eroded soils. Most of the eroded soils have poor tilth and crust readily when dry.

Use of these soils for crops is severely limited by steep slopes, poor tilth, and rapid runoff. The steepness limits the use of machinery. The soils are suited to use for pasture if a thick cover of grasses is maintained, but gullies form if pastures are overgrazed. Hay crops also are suited to these soils.

CAPABILITY UNIT VIe–2 (2.5a, 3a, 4a, 4/2a)

The soils of this unit are well drained and moderately well drained and are moderately steep or steep. They are soils of the Blue Lake, Isabella, Mancelona, McBride, Menominee, and Montcalm series and range from coarse textured to moderately fine textured. They are slightly to severely eroded.

Available moisture capacity of these soils ranges from moderately low to high, and fertility ranges from low to moderate. Severely eroded areas have poor tilth and crust readily when dry. Steepness of slope hinders use of farm machinery. Runoff is rapid, and gullies form readily.

Use of these soils for row crops and small grains is severely limited by steep slopes and a severe erosion hazard. The major management need is to maintain a cover of vegetation to protect the soils from erosion. The soils are suited to use for pasture and hay crops, but insufficient soil moisture reduces yields on the sandier soils during dry summer months. If pastures are overgrazed, they are subject to sheet and gully erosion. Harvesting of hay crops is difficult because of the steepness of slope.

CAPABILITY UNIT VIs–1 (5a, 5/2a)

The soils of this unit are well drained and moderately well drained. They are soils of the Chelsea, Croswell, East Lake, Kalkaska, and Rubicon series. They are sloping and have coarse-textured profiles. One of the soils, the Rubicon, is underlain by medium- to fine-textured material. The degree of erosion ranges from slight to severe.

Available moisture capacity and fertility of these soils are low. The content of organic matter is low and is quickly depleted by tillage. The soils are easily tilled but erode readily because of their loose structure. They dry quickly, and the soil moisture is deficient during dry summer months.

The major limitations of the soils for crop and pasture use are low fertility and soil moisture and an erosion hazard. Yields of shallow-rooted crops are low, and during extremely dry years, available soil moisture is not sufficient to mature crops. Maintaining a protective cover of vegetation reduces the risk of erosion. Pasture and forage plants grow well during the early part of the growing season but suffer from lack of moisture during the dry summer months.

Planting trees will control erosion and provide wildlife habitats.

CAPABILITY UNIT VIIe–2 (1.5a, 2.5a, 3a, 4a)

The soils of this unit are well drained to moderately well drained, are steep or very steep, and are on uplands. In the unit are soils of the Isabella, McBride, Montcalm, and Nester series and one land type, Gullied land, moderately fine textured. Their profiles range from coarse-textured to moderately fine textured.

Runoff is very rapid, and erosion is a serious problem if row crops are grown. Little water enters the soil for use by plants, and these soils tend to be droughty. Steepness of slope restricts the use of farm machinery. The severely eroded soils of this unit have poor tilth and are more sus-

ceptible to erosion than the uneroded soils. Gullied land is so cut up by erosion that tillage is impractical without major reclamation measures.

Keeping these soils in pasture or trees will help prevent erosion and formation of gullies. Pastures dry early and provide a source of forage only during spring months. Overgrazing of pastures leads to excessive runoff and formation of gullies.

CAPABILITY UNIT VIIs-1 (3a, 4a, 5a, 5a-h, 5/2a, 5.3a, 5.7a)

The soils of this unit are well drained and moderately well drained. They are soils of the Chelsea, East Lake, Grayling, Kalkaska, McBride, Montcalm, Rubicon, and Wallace series. The unit includes three land types, Gullied land, coarse textured; Wind eroded land, sloping; and Wind eroded land, steep. Profiles of these soils are mainly coarse textured. A few soils are stony or wind eroded, and some soils have been severely eroded by water. Slopes range from nearly level to very steep.

Available moisture capacity of these soils is mainly low, but it ranges to moderately high. Fertility is mainly low but ranges to moderately low. Content of organic matter is low, and the organic matter decomposes rapidly if the soils are tilled.

These soils are seldom suited to crop use because of low available moisture capacity and fertility, steepness of slope, a severe erosion hazard, stoniness, or a combination of these. Yields of crops are not dependable. Pastures dry quickly during the hot summer months and furnish only small amounts of forage for livestock. Stones are present on the surface in some areas and interfere with or prevent tillage. Steepness of slope of some soils restricts the use of farm machinery.

CAPABILITY UNIT VIIIw-1 (Mc-a)

In this unit are very poorly drained, extremely acid organic soils. They are soils of the Dawson, Greenwood, and Loxley series and consist of organic material that is generally more than 42 inches thick. The Dawson soil is underlain by coarse-textured mineral material at a depth ranging from 12 to 42 inches.

Available moisture capacity of these soils is high, but fertility is generally low. The soils are saturated with water most of the year because of a high water table.

These soils are ordinarily not suited to farm use, because they have a high water table, low fertility, and an extremely acid reaction. Artificial drainage is difficult to install because outlets are lacking and because the soils settle excessively. Wind erosion and frost damage are major hazards.

Predicted Yields

The predicted average acre yields of the principal crops grown in Osceola County are given in table 2 for each soil under two levels of management. The estimated yields are based on interviews with farmers, on data obtained from the staff of the Michigan Agricultural Experiment Station, and on observations made by Soil Conservation Service personnel and other agricultural workers who are familiar with the soils and crops of the county.

In columns A are average yields obtained under the management common in the county when the soil survey was made. Lime is applied, although in many places in minimum amounts. Some commercial fertilizer is applied but usually not enough to obtain maximum yields. Barnyard manure that is produced on the farm is returned to the soil. Some artificial drainage measures have been installed. Wetness is still a problem in low areas, and more drainage is needed. In most areas a crop rotation is used that includes some legume-grass mixtures. There is greater use of legume-grass mixtures in the crop rotations on steep or sandy soils than on more nearly level or finer textured soils.

In columns B are average yields obtained under improved management. Under improved management the amount of lime used is determined by soil tests. The amount of commercial fertilizer to apply is based on soil tests and the kind of crop to be grown. Where wetness is a problem, a complete drainage system is installed. Adapted and up-to-date varieties of plants and seeds of high quality are planted. Other conservation practices are used, where needed, to control erosion and to conserve moisture. The cropping systems used are adapted to the soils. Seeding, spraying, and cultivation of crops are timely.

Woodland[7]

Osceola County was covered almost entirely by forest at one time. Pines and northern hardwoods grew on the uplands, and swamp hardwoods and conifers grew on the lowlands and bottom lands. Cutting of the pines began about 1860 and continued until about 1900. Then the hardwoods were cut. Most of the cuttings were made for lumber.

Farmers and other individuals own most of the woodland in the county. Federal government holdings total 15,600 acres.

Forest cover types

The three major forest cover types in the county are (1) northern hardwoods, (2) aspen and white birch, and (3) pines. Swamp hardwoods and conifers are minor types in the county and occur on small tracts interspersed throughout the major forest types. The types of natural forest that develop depend on soil texture, drainage, and past management.

Northern hardwoods.—The northern hardwood forest type consists chiefly of sugar maples, but there are varying quantities of beech, elm, and basswood trees. Some red oak, white ash, and scattered yellow birch trees also are present. Northern hardwoods grow on the well-drained, moderately coarse textured to fine-textured soils. In some places hardwoods grow on the well-drained, coarse-textured soils. The northern hardwoods are important commercially. The sugar maple, one of the most common hardwoods, is valuable for saw logs and for maple sugar.

Aspen and white birch.—Predominant species in this type of forest cover are quaking (trembling) aspen and largetooth aspen or white birch. These species occur naturally in pure stands and also in a mixture with most of the native pines and hardwoods. This type is the most widespread of all the forest types in Osceola County and occurs throughout a wide range of soil conditions. Aspen stands are even aged and originated after extensive and severe logging and after fires. Aspen stands will be replaced by pines or hardwoods.

[7] RONALD WILSON, woodland conservationist, Soil Conservation Service, assisted in the preparation of this section.

TABLE 2.—*Predicted average yields per acre of crops under two levels of management*

[Yields in columns A are those to be expected under management common to the county; those in columns B are obtained under improved management. Dashes indicate that the soil is not suited to the crop or that the crop ordinarily is not grown on it]

Soil	Corn (grain)		Corn (silage)		Oats		Wheat		Alfalfa or alfalfa-brome hay	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Abscota sand										
Abscota loam										
Adrian muck										
Algansee sand										
Algansee loam										
Allendale loamy sand, 2 to 6 percent slopes	30	60	5	10	25	50	20	30	1.7	3.0
Allendale sandy loam, 2 to 6 percent slopes	30	60	5	10	25	50	20	30	1.7	3.0
Au Gres sand, 0 to 6 percent slopes	20	45	4	7	20	30	15	20	1.0	2.0
Au Gres sand, loamy substratum, 0 to 6 percent slopes	20	45	4	7	20	30	15	20	1.0	2.0
Belding sandy loam, 0 to 2 percent slopes	40	65	7	11	40	65	20	35	1.7	3.0
Belding sandy loam, 2 to 6 percent slopes	40	65	7	11	40	65	20	35	1.7	3.0
Belding sandy loam, clay subsoil variant, 2 to 6 percent slopes	45	65	7	11	40	65	20	35	1.7	3.0
Bergland mucky silt loam	45	75	10	15	30	65	15	30	1.0	3.0
Blue Lake loamy sand, 0 to 2 percent slopes	25	60	4	11	20	43	20	30	1.0	2.5
Blue Lake loamy sand, 2 to 6 percent slopes	25	60	4	11	20	43	20	30	1.0	2.5
Blue Lake loamy sand, 6 to 12 percent slopes	20	55	4	9	20	35	20	30	1.0	2.0
Blue Lake loamy sand, 12 to 18 percent slopes							15	20	1.0	2.0
Blue Lake loamy sand, 18 to 25 percent slopes									1.0	2.0
Bohemian fine sandy loam, 2 to 6 percent slopes	45	75	6	13	35	60	20	40	2.0	4.0
Bohemian fine sandy loam, 6 to 12 percent slopes	30	70	5	11	30	50	15	35	1.5	3.5
Bohemian fine sandy loam, 12 to 18 percent slopes					25	45	15	30	1.3	3.0
Brevort fine sandy loam	38	60	7	10	35	50	20	30	1.5	3.0
Brevort loamy sand	35	50	7	9	35	45	20	30	1.5	3.0
Brevort loamy sand, overwash	35	55	7	10	35	50	20	30	1.5	3.0
Brimley fine sandy loam, 2 to 6 percent slopes	50	75	10	14	45	60	30	40	2.3	3.5
Carbondale loam, 0 to 2 percent slopes, overwash										
Carbondale muck, 0 to 2 percent slopes										
Carbondale muck, 6 to 12 percent slopes										
Carbondale peat, 0 to 2 percent slopes										
Chelsea sand, 0 to 6 percent slopes	20	45	4	7	10	30	10	15	.5	1.2
Chelsea sand, 6 to 12 percent slopes	20	40	4	7	10	30	10	15	.5	1.4
Chelsea sand, 12 to 18 percent slopes					10	20	10	20	.5	1.2
Chelsea sand, 18 to 25 percent slopes										
Chelsea sand, 25 to 55 percent slopes										
Chelsea stony sand, 0 to 6 percent slopes										
Chelsea stony sand, 6 to 12 percent slopes										
Chelsea stony sand, 12 to 18 percent slopes										
Coral fine sandy loam, 0 to 2 percent slopes	50	75	10	14	40	65	20	30	2.0	3.5
Coral fine sandy loam, 2 to 6 percent slopes	50	75	10	14	40	65	20	30	2.0	3.5
Croswell sand, 0 to 6 percent slopes	20	40	4	7	20	30	15	25	.5	1.5
Croswell sand, 6 to 12 percent slopes	25	35	4	6	20	60	10	20	.5	1.5
Dawson peaty muck										
Dighton sandy loam, 2 to 6 percent slopes	45	80	9.6	16	36	62	30	44	2.5	4.0
Dighton sandy loam, 6 to 12 percent slopes	43	71	8.6	11	36	62	30	44	2.5	4.0
Dighton sandy loam, 12 to 18 percent slopes, moderately eroded							15	30	2.2	3.5
East Lake loamy sand, 0 to 6 percent slopes	10	45	4	7	20	30	10	20	1.2	.5
East Lake loamy sand, 6 to 12 percent slopes	10	35	4	6	15	25	10	20	.5	1.2
East Lake loamy sand, 12 to 18 percent slopes					10	25	10	20	.5	1.2
East Lake sandy loam, 0 to 2 percent slopes	10	45	4	7	20	35	10	25	.5	1.2
Edmore and Tonkey sandy loams	38	60	7	9	35	55	20	30	1.5	3.0
Edwards muck										
Ensley and Tonkey loams	50	75	8	14	40	65	20	35	1.5	3.0
Ensley and Tonkey loams, overwash	50	75	8	14	40	65	20	35	1.5	3.0
Evart loam										
Evart sand										
Gladwin loamy sand, 0 to 2 percent slopes	35	65	5	11	35	55	20	30	1.5	2.8
Gladwin loamy sand, 2 to 6 percent slopes	35	65	5	11	35	55	20	30	1.5	2.8
Gladwin sandy loam, 0 to 2 percent slopes	35	65	5	11	35	55	20	30	1.5	2.8
Gladwin sandy loam, 2 to 6 percent slopes	35	65	5	11	35	55	20	30	1.5	2.8
Gravel and sand pits										
Grayling sand, 0 to 6 percent slopes										
Grayling sand, 6 to 12 percent slopes										
Grayling sand, 18 to 25 percent slopes										
Greenwood peat										
Gullied land, coarse textured										

TABLE 2.—*Predicted average yields per acre of crops under two levels of management*—Continued

Soil	Corn (grain)		Corn (silage)		Oats		Wheat		Alfalfa or alfalfa-brome hay	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Gullied land, moderately fine textured										
Houghton muck										
Iosco loamy sand, 0 to 2 percent slopes	40	60	6	8	30	50	20	30	1. 5	3. 0
Iosco loamy sand, 2 to 6 percent slopes	40	60	6	8	30	50	20	30	1. 5	3. 0
Iosco sandy loam, 0 to 2 percent slopes	40	60	6	8	30	50	20	30	1. 5	3. 0
Iosco sandy loam, 2 to 6 percent slopes	40	60	6	8	30	50	20	30	1. 5	3. 0
Isabella loam, 2 to 6 percent slopes	50	80	9	14	35	62	30	45	2. 2	4. 0
Isabella loam, 6 to 12 percent slopes	40	70	7	13	30	55	25	40	2. 2	4. 0
Isabella loam, 6 to 12 percent slopes, moderately eroded	35	65	6	11	25	50	20	35	1. 5	4. 0
Isabella loam, 12 to 18 percent slopes					25	50	20	35	2. 0	4. 0
Isabella loam, 12 to 18 percent slopes, moderately eroded					20	45	15	30	1. 5	4. 0
Isabella loamy sand, 2 to 6 percent slopes	45	75	8	13	35	50	25	40	2. 2	4. 0
Isabella loamy sand, 6 to 12 percent slopes	40	70	7	12	30	45	25	35	2. 2	4. 0
Isabella loamy sand, 6 to 12 percent slopes, moderately eroded	35	60	7	10	25	40	20	30	1. 7	4. 0
Isabella loamy sand, 12 to 18 percent slopes					25	40	20	30	2. 2	4. 0
Isabella loamy sand, 12 to 18 percent slopes, moderately eroded							15	25	1. 7	4. 0
Isabella sandy clay loam, 12 to 18 percent slopes, severely eroded										
Isabella sandy clay loam, 18 to 25 percent slopes, severely eroded										
Isabella sandy loam, 2 to 6 percent slopes	45	75	8	13	30	55	30	40	2. 2	4. 0
Isabella sandy loam, 2 to 6 percent slopes, moderately eroded	35	70	6	13	25	50	20	35	1. 7	4. 0
Isabella sandy loam, 6 to 12 percent slopes	40	70	7	13	25	50	20	35	2. 2	4. 0
Isabella sandy loam, 6 to 12 percent slopes, moderately eroded	30	65	6	12	20	45	15	30	1. 7	4. 0
Isabella sandy loam, 12 to 18 percent slopes					20	45	15	30	1. 7	3. 5
Isabella sandy loam, 12 to 18 percent slopes, moderately eroded							15	20	1. 7	3. 7
Isabella sandy loam, 18 to 25 percent slopes									1. 7	3. 5
Kalkaska gravelly sand, 2 to 6 percent slopes	20	45	4	7	20	30	15	20	. 5	1. 2
Kalkaska sand, 0 to 6 percent slopes	20	45	4	7	15	25	15	20	. 5	1. 2
Kalkaska sand, 6 to 12 percent slopes	15	35	3	6	15	25	15	20	. 5	1. 0
Kalkaska sand, 6 to 12 percent slopes, severely eroded										
Kalkaska sand, 12 to 18 percent slopes										
Kalkaska sand, 12 to 18 percent slopes, severely eroded										
Kalkaska sand, 18 to 25 percent slopes										
Kalkaska sand, 18 to 25 percent slopes, severely eroded										
Kalkaska sand, 25 to 55 percent slopes										
Kalkaska stony sand, 0 to 6 percent slopes										
Kalkaska stony sand, 6 to 12 percent slopes										
Kalkaska stony sand, 12 to 25 percent slopes										
Kawkawlin loam, 0 to 2 percent slopes	50	80	8	14	45	65	34	45	2. 3	3. 5
Kawkawlin loam, 2 to 6 percent slopes	50	80	8	14	45	65	34	45	2. 3	3. 5
Kawkawlin loam, overwash, 0 to 2 percent slopes	50	80	8	14	45	65	34	45	2. 3	3. 5
Kawkawlin loam, overwash, 2 to 6 percent slopes	30	50	8	14	45	65	34	45	2. 3	3. 5
Kawkawlin sandy loam, 0 to 2 percent slopes	45	75	8	13	45	60	30	40	2. 3	3. 5
Kawkawlin sandy loam, 2 to 6 percent slopes	45	75	8	13	45	60	30	40	2. 3	3. 5
Kawkawlin stony loam, 2 to 6 percent slopes										
Kent loam, 2 to 6 percent slopes	35	65	6	12	35	55	23	35	2. 1	3. 0
Kent loam, 6 to 12 percent slopes	30	60	5	11	20	50	18	30	2. 1	3. 0
Kent loam, 6 to 12 percent slopes, moderately eroded	25	55	4	10	25	45	18	30	2. 1	3. 0
Kent loam, 12 to 18 percent slopes					20	40	18	25	2. 1	3. 0
Kent loam, 12 to 18 percent slopes, moderately eroded					15	35	15	20	2. 1	3. 0
Kerston loam										
Kerston muck										
Kinross sand	20	45	4	7	20	30	15	20	. 5	1. 7
Linwood muck										
Loxley muck										
Lupton muck										
Mancelona loamy sand, 0 to 2 percent slopes	35	65	6	12	35	55	20	30	1. 5	2. 8
Mancelona loamy sand, 2 to 6 percent slopes	35	65	6	12	35	55	20	30	1. 5	2. 8
Mancelona loamy sand, 6 to 12 percent slopes	30	60	5	11	30	50	15	25	1. 5	2. 8
Mancelona loamy sand, 12 to 18 percent slopes					20	40	15	20	1. 5	2. 8
Mancelona loamy sand, 18 to 25 percent slopes									1. 0	2. 8
Mancelona sandy loam, 0 to 2 percent slopes	35	65	6	12	35	55	20	30	1. 5	2. 8
Manistee loamy sand, 2 to 6 percent slopes	40	60	6	10	30	50	20	30	1. 5	3. 0
Manistee loamy sand, 6 to 12 percent slopes	35	50	6	9	25	45	15	25	1. 5	3. 0
Manistee loamy sand, 12 to 18 percent slopes					20	40	15	20	1. 5	3. 0
Markey muck										

TABLE 2.—*Predicted average yields per acre of crops under two levels of management*—Continued

Soil	Corn (grain)		Corn (silage)		Oats		Wheat		Alfalfa or alfalfa-brome hay	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
McBride gravelly sandy loam, 6 to 12 percent slopes	40	70	5	13	35	55	15	35	1. 4	2. 8
McBride loamy sand, 2 to 6 percent slopes	35	75	6	14	40	60	20	35	1. 4	2. 8
McBride loamy sand, 6 to 12 percent slopes	35	70	6	13	40	55	20	30	1. 4	2. 8
McBride loamy sand, 6 to 12 percent slopes, moderately eroded	35	65	6	12	30	50	15	30	1. 4	2. 8
McBride loamy sand, 12 to 18 percent slopes					25	45	15	30	1. 4	2. 8
McBride loamy sand, 12 to 18 percent slopes, moderately eroded							15	20	1. 4	2. 8
McBride loamy sand, 18 to 25 percent slopes									1. 4	2. 8
McBride sandy loam, 0 to 2 percent slopes	35	80	6	15	40	65	25	40	1. 4	2. 8
McBride sandy loam, 2 to 6 percent slopes	35	75	6	14	35	60	20	35	1. 4	2. 8
McBride sandy loam, 2 to 6 percent slopes, moderately eroded	30	70	6	13	30	55	20	30	1. 4	2. 8
McBride sandy loam, 6 to 12 percent slopes	30	70	6	13	30	55	20	30	1. 4	2. 8
McBride sandy loam, 6 to 12 percent slopes, moderately eroded	30	65	6	12	30	50	20	30	1. 4	2. 8
McBride sandy loam, 12 to 18 percent slopes					25	45	20	25	1. 4	2. 8
McBride sandy loam, 12 to 18 percent slopes, moderately eroded							15	20	1. 0	2. 5
McBride sandy loam, 12 to 18 percent slopes, severely eroded										
McBride sandy loam, 18 to 25 percent slopes									1. 0	1. 9
McBride sandy loam, 18 to 25 percent slopes, moderately eroded										
McBride sandy loam, 18 to 25 percent slopes, severely eroded										
McBride stony sandy loam, 2 to 6 percent slopes										
McBride stony sandy loam, 6 to 12 percent slopes										
McBride soils, 25 to 45 percent slopes										
Menominee loamy sand, 0 to 2 percent slopes	40	60	7	10	30	50	20	30	1. 5	3. 0
Menominee loamy sand, 2 to 6 percent slopes	40	60	7	10	30	50	20	30	1. 5	3. 0
Menominee loamy sand, 6 to 12 percent slopes	35	55	6	9	30	45	20	25	1. 5	3. 0
Menominee loamy sand, 6 to 12 percent slopes, moderately eroded	30	50	5	9	25	40	15	20	1. 3	2. 5
Menominee loamy sand, 12 to 18 percent slopes					20	35	12	18	1. 5	3. 0
Menominee loamy sand, 12 to 18 percent slopes, moderately eroded					20	30	10	15	1. 3	2. 5
Menominee loamy sand, 18 to 25 percent slopes							10	15	1. 5	3. 0
Montcalm gravelly loamy sand, 0 to 6 percent slopes	35	65	6	11	35	55	20	30	1. 5	2. 8
Montcalm gravelly loamy sand, 6 to 12 percent slopes	30	60	5	10	30	50	15	25	1. 5	2. 8
Montcalm gravelly loamy sand, 12 to 18 percent slopes					20	40	10	15	1. 3	2. 5
Montcalm gravelly loamy sand, 18 to 25 percent slopes									1. 5	2. 0
Montcalm loamy sand, 0 to 6 percent slopes	35	65	6	11	35	55	20	30	1. 5	2. 8
Montcalm loamy sand, 6 to 12 percent slopes	30	60	5	10	30	50	15	25	1. 5	2. 8
Montcalm loamy sand, 6 to 12 percent slopes, moderately eroded	25	55	5	9	25	45	15	20	1. 5	2. 8
Montcalm loamy sand, 6 to 12 percent slopes, severely eroded									1. 2	2. 0
Montcalm loamy sand, 12 to 18 percent slopes					25	40	15	20	1. 5	2. 8
Montcalm loamy sand, 12 to 18 percent slopes, moderately eroded					25	40	15	20	1. 5	2. 8
Montcalm loamy sand, 12 to 18 percent slopes, severely eroded										
Montcalm loamy sand, 18 to 25 percent slopes									1. 5	2. 0
Montcalm sandy loam, 0 to 6 percent slopes	35	65	6	11	35	55	20	30	1. 5	2. 8
Montcalm sandy loam, 6 to 12 percent slopes	30	60	5	10	30	50	15	25	1. 5	2. 8
Montcalm sandy loam, 12 to 18 percent slopes					25	40	15	20	1. 5	2. 8
Montcalm stony loamy sand, 2 to 6 percent slopes										
Montcalm stony loamy sand, 6 to 12 percent slopes										
Montcalm stony loamy sand, 12 to 18 percent slopes										
Montcalm stony loamy sand, 18 to 25 percent slopes										
Montcalm soils, 25 to 45 percent slopes										
Munuscong fine sandy loam	30	65	5	11	30	55	20	30	1. 8	3. 0
Nester clay loam, 6 to 12 percent slopes, severely eroded	25	45	4	5	15	30	10	20	1. 0	2. 0
Nester clay loam, 12 to 18 percent slopes, severely eroded									1. 0	2. 0
Nester clay loam, 18 to 25 percent slopes, severely eroded										
Nester gravelly loam 6 to 12, percent slopes	35	60	6	11	25	40	20	30	2. 2	4. 0
Nester loam, 0 to 2 percent slopes	50	80	8	14	35	60	30	45	2. 2	4. 0
Nester loam, 2 to 6 percent slopes	50	80	9	14	35	60	30	45	2. 2	4. 0
Nester loam, 2 to 6 percent slopes, moderately eroded	35	70	6	12	25	50	25	40	1. 7	3. 5
Nester loam, 6 to 12 percent slopes	45	70	7	12	35	50	30	40	2. 2	4. 0
Nester loam, 6 to 12 percent slopes, moderately eroded	35	60	6	11	30	45	25	35	1. 7	3. 5
Nester loam, 12 to 18 percent slopes					25	40	20	30	2. 2	4. 0
Nester loam, 12 to 18 percent slopes, moderately eroded					20	35	15	25	1. 7	3. 5
Nester loamy sand, 2 to 6 percent slopes	40	70	7	12	30	50	25	37	2. 2	4. 0
Nester loamy sand, 6 to 12 percent slopes	35	60	6	11	25	40	20	30	2. 2	4. 0
Nester loamy sand, 12 to 18 percent slopes					25	40	20	30	2. 2	4. 0
Nester sandy loam, 0 to 2 percent slopes	45	75	8	13	35	55	30	42	2. 0	3. 7
Nester sandy loam, 2 to 6 percent slopes	45	75	8	13	35	55	30	42	2. 0	3. 7

TABLE 2.—*Predicted average yields per acre of crops under two levels of management*—Continued

Soil	Corn (grain)		Corn (silage)		Oats		Wheat		Alfalfa or alfalfa-brome hay	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Nester sandy loam, 2 to 6 percent slopes, moderately eroded	38	67	7	12	30	50	25	37	1. 7	3. 5
Nester sandy loam, 6 to 12 percent slopes	40	70	7	12	35	50	30	37	2. 0	3. 7
Nester sandy loam, 6 to 12 percent slopes, moderately eroded	30	60	5	11	30	45	25	30	1. 7	3. 5
Nester sandy loam, 12 to 18 percent slopes					30	45	25	30	2. 0	3. 7
Nester sandy loam, 12 to 18 percent slopes, moderately eroded					25	35	20	25	1. 5	3. 0
Nester stony loam, 6 to 12 percent slopes										
Nester stony sandy loam, 2 to 6 percent slopes										
Nester soils, 18 to 25 percent slopes									2. 0	3. 5
Nester soils, 18 to 25 percent slopes, moderately eroded									1. 7	3. 0
Nester soils, 25 to 45 percent slopes										
Newaygo sandy loam, 2 to 6 percent slopes	35	75	6	13	35	60	25	35	1. 4	2. 8
Newaygo sandy loam, 6 to 18 percent slopes	30	70	5	12	30	55	20	30	1. 4	2. 8
Ogemaw loamy sand, 0 to 2 percent slopes										
Otisco loamy sand, 0 to 2 percent slopes	35	65	6	12	35	55	20	30	1. 5	2. 8
Otisco loamy sand, 2 to 6 percent slopes	35	65	6	12	35	55	20	30	1. 5	2. 8
Otisco sandy loam, 0 to 2 percent slopes	35	65	6	12	35	55	20	30	1. 5	2. 8
Otisco sandy loam, 2 to 6 percent slopes	35	65	6	12	35	55	20	30	1. 5	2. 8
Pickford fine sandy loam	45	75	8	14	30	65	15	30	1. 0	3. 0
Pickford silty clay loam	45	75	8	14	30	65	15	30	1. 0	3. 0
Pinconning loamy sand	38	60	7	10	35	50	20	30	1. 5	3. 0
Richter sandy loam, 2 to 6 percent slopes	50	75	8	14	40	65	20	35	2. 5	3. 5
Rifle loam, overwash										
Rifle muck										
Rifle peat										
Roscommon mucky sand and sand	20	45	4	8	20	30	15	20	. 5	1. 7
Rousseau fine sand, 2 to 6 percent slopes	35	65	6	11	25	55	20	30	1. 5	2. 8
Rousseau fine sand, 6 to 12 percent slopes	30	55	5	10	20	45	15	25	1. 5	2. 8
Rousseau fine sand, 12 to 18 percent slopes					20	40	15	25	1. 5	2. 8
Rubicon sand, 0 to 6 percent slopes										
Rubicon sand, 6 to 12 percent slopes										
Rubicon sand, 12 to 18 percent slopes										
Rubicon sand, 18 to 25 percent slopes										
Rubicon sand, 25 to 55 percent slopes										
Rubicon sand, loamy substratum, 0 to 6 percent slopes	20	40	3	7	20	30	15	20	1. 0	1. 7
Rubicon sand, loamy substratum, 6 to 12 percent slopes	20	35	3	6	20	25	15	20	1. 0	1. 7
Rubicon sand, loamy substratum, 12 to 18 percent slopes					15	20	10	15	1. 0	1. 7
Rubicon sand, loamy substratum, 18 to 25 percent slopes									. 9	1. 2
Saranac loam										
Saugatuck sand, 0 to 6 percent slopes										
Selkirk loam, 0 to 2 percent slopes	35	65	6	12	35	55	25	38	2. 2	3. 1
Selkirk loam, 2 to 6 percent slopes	35	65	6	12	35	55	25	38	2. 2	3. 1
Shoals loam										
Shoals loamy sand										
Sims clay loam	55	75	10	14	35	65	15	35	2. 0	4. 0
Sims loam	55	75	10	14	35	65	15	35	2. 0	4. 0
Sims loam, overwash	55	75	10	14	35	65	15	35	2. 0	4. 0
Sims sandy loam	55	75	10	14	35	65	15	35	2. 0	4. 0
Sloan loam										
Tawas loam, overwash										
Tawas muck										
Tawas peat										
Traverse loam	50	75	8	14	40	65	30	45	2. 3	3. 5
Twining sandy loam, 0 to 2 percent slopes	50	80	9	14	40	65	30	45	2. 3	3. 5
Twining sandy loam, 2 to 6 percent slopes	50	80	9	14	40	65	30	45	2. 3	3. 5
Ubly sandy loam, 2 to 6 percent slopes	35	65	6	11	40	65	20	35	1. 7	3. 2
Ubly sandy loam, 6 to 12 percent slopes	30	60	5	10	35	55	15	30	1. 7	3. 2
Ubly sandy loam, 12 to 18 percent slopes					25	45	15	20	1. 5	3. 0
Ubly sandy loam, clay subsoil variant, 2 to 6 percent slopes	50	70	7	13	40	65	20	35	1. 7	3. 2
Ubly sandy loam, clay subsoil variant, 6 to 12 percent slopes	50	65	7	11	35	60	20	35	1. 7	3. 2
Wallace sand, 0 to 6 percent slopes										
Wallace sand, 6 to 18 percent slopes										
Warners muck and Marl										
Wheatley mucky loamy sand	40	60	7	9	35	55	20	30	1. 5	3. 0
Wheatley mucky sandy loam	40	60	7	9	35	55	20	30	1. 5	3. 0
Willette muck										
Wind eroded land, sloping										
Wind eroded land, steep										

Pines.—The pine type of forest cover consists of pure or mixed stands of jack, red, or white pine. Most of these stands are in plantations. Natural jack and red pine stands are predominant on some of the well-drained sands and loamy sands. White pines are mixed with hardwoods on the well-drained sandy loam to clay loam soils. Pines are the most valuable trees for plantations because of their use for Christmas trees, posts, poles, sawtimber, and pulp.

Woodland suitability groupings

To provide a guide for woodland planning, the soils of Osceola County have been placed in 16 woodland suitability groups. Woodland groups are established on a statewide basis, and some Michigan groups are not present in Osceola County. Each group described in this survey consists of soils that are similar in productivity, in management problems and response to management, and in requirements for conservation practices. Information is given for individual groups about their potential productivity for pine, spruce and fir, aspen and white birch, and hardwoods. Species priority, major limitations, and degree of the limitations are given for each group.

Productivity.—The information in this survey on potential productivity of a particular group of soils for a given species of tree is based on the average annual growth rate of fully stocked, well-managed stands that have not been affected by special practices, such as artificial drainage or fertilization. Fully stocked stands have the amount of good growing stock required to produce maximum growth per acre. The number of trees in a fully stocked stand depends on the tree species and on the sizes and ages of the trees. Well-managed stands will sustain production and maintain full stocking. They are improved and harvested by timely and orderly cuttings and are protected from fire and livestock. Many of the stands in Osceola County are overstocked with undesirable species, but sufficient quantities of desirable species are usually present to make management of the stands feasible.

Table 3 translates the terms used to indicate potential productivity into averages of annual growth in board feet and cords per acre. The productivity ratings reflect, in part, the effects of soil, climate (particularly drought), insects, or diseases that are associated with particular soils or are common to the area. They also reflect genetic influences and other common factors that affect the development of a stand of trees, even under good management.

TABLE 3.—*Potential productivity ratings per acre per year for woodland types*

[<=less than]

Rating	Board feet	Cords
Very high	325–350	1. 5–1. 7
High	270–325	1. 0–1. 5
Medium	200–270	6–1. 0
Low	125–200	1– . 6
Very low	<125	< . 1

Species priority.—The information given on species priority for the different woodland suitability groups is based on the adaptability or tolerance, productivity, and commercial value of the predominant species of trees that grow on the soils of a particular group. The species are named in order of priority, the first species named having the highest priority. The first species named for each of the woodland suitability groups should be given the most consideration when new plantings or improvement cuttings are made. The information given on species priorities does not reflect damages from diseases or insect infestations that have plagued certain localities.

Seedling mortality.—Unfavorable soil characteristics prevent the survival of some healthy seedlings, whether natural or planted. A high water table, extreme acidity, droughtiness, and high soil temperature are some of the soil characteristics that cause seedlings to die. A seedling mortality rating of *slight* indicates that ordinary losses from these causes are not more than 25 percent of the planted stock. A rating of *moderate* indicates that losses are between 25 and 50 percent of the planted stock. A rating of *severe* indicates that more than 50 percent of the trees in a planting are likely to die.

Plant competition.—When a site has been disturbed by fire, cutting, or other factors, and the soil is fertile and moist, undesirable species of brush, trees, and other plants may invade the site. This vegetation competes with and hinders the establishment and growth of desirable kinds of trees. A plant competition rating of *slight* indicates that invasion by undesirable trees does not impede the establishment or growth of natural or planted stands of the preferred kinds of trees. No special management to control competition is needed. A rating of *moderate* indicates that competing plants do not ordinarily prevent the establishment of adequate stands of desirable kinds of trees. Development of fully stocked stands may take longer. Establishment of seedlings is delayed, and early growth is slow. Management practices that eliminate or retard competition will speed up establishment and growth of seedlings. A rating of *severe* indicates that natural reestablishment of stands cannot be relied upon. Establishment of stands by tree planting is poor, unless competing vegetation is controlled.

Equipment limitations.—Some soil characteristics and topographic features, such as drainage, slope, number or size of stones, or soil texture, restrict or make impossible the use of equipment commonly used in woodland management and harvesting. Special equipment, special methods of equipment operation, or the use of equipment in only certain seasons may be necessary on some soils. An equipment limitation rating of *slight* indicates that there is no special problem in the use of equipment. A rating of *moderate* indicates that not all types of equipment can be used; that there are short periods when equipment cannot be used, because of wetness or steep slopes; or that looseness of the soil makes hand planting and use of special logging techniques necessary. A rating of *severe* indicates that the type of equipment that can be used is very limited. Either the soil is so wet that equipment cannot be used for long periods of time, or the soil is so extremely steep or loose that the use of motorized equipment is dangerous and difficult. In some areas saw logs must be hauled from the slopes by a winch.

Erosion hazard.—It is possible to protect woodland from erosion and to prevent excessive surface runoff by growing adapted species of trees, by adjusting the rotation age and cutting cycles, by laying out new plantings on the contour, and by careful construction and maintenance of

roads, trails, and landings. When runoff is diverted from cultivated fields into wooded areas, the erosion hazard, the slope, and the ground cover in the woods should be such that gullies will not form. An erosion hazard rating of *slight* indicates that little or no erosion has taken place and that erosion can be prevented by normal management practices. A rating of *moderate* indicates that the soils are subject to some water or wind erosion or both and that excessive disturbance or removal of the forest litter should be avoided. A rating of *severe* indicates that the hazard of erosion is severe to very severe and that applicable erosion control measures, such as those already mentioned, should be used.

Windthrow hazard.—Certain soil characteristics, such as the presence of a high water table or a cemented subsoil layer, affect the development of tree roots and, in turn, determine the resistance of trees to the force of the wind. The degree of windthrow hazard is important in the choice of tree species for planting and in the planning of release or harvest cuttings. A windthrow hazard rating of *slight* indicates that the roots of trees of adapted species develop normally and that windthrow is not a problem. A rating of *moderate* indicates that the trees remain standing, unless the wind velocity is high during the time the soil is excessively wet. A rating of *severe* indicates that the soil does not allow adequate rooting for stability of the trees or that the trees lack root firmness.

WOODLAND SUITABILITY GROUP A

Soils in this group are well drained or moderately well drained and range from nearly level to steep. They are soils of the Bohemian, McBride, Newaygo, Traverse, and Ubly series and of the Ubly series, clay subsoil variant. Generally, water moves through these soils moderately rapidly to moderately slowly, and available moisture capacity is moderate or moderately high. Natural fertility is moderate to moderately high.

Northern hardwoods are best suited to this group of soils. Pines are next best suited. Fully stocked, well-managed stands of northern hardwoods normally grow more than 325 board feet per acre annually. Red pine is an excellent producer, but white pine was a more common component of the native vegetation. Aspen is well suited to the soils and responds well to management in well-stocked natural stands. Harvesting the aspen and converting the stands to northern hardwoods or to pines generally is the most profitable plan of management in the long run.

White pine, red pine, and white spruce are the preferred species for planting. The preferred species in natural stands are sugar maple, basswood, red pine, and white pine.

Seedling mortality is slight, plant competition is moderate, erosion hazard is slight or moderate, and windthrow hazard is slight.

For most of the soils, equipment limitations are slight, but machine planting is neither possible nor practical on the steep or stony soils. Hand planting is necessary in these areas. Where machine planting is possible, planting on the contour helps retard erosion. Slopes of some soils exceed 12 percent. Locating roads and skid trails on these steeper soils requires special care to avoid erosion.

WOODLAND SUITABILITY GROUP B

Soils of this group are well drained or moderately well drained and are nearly level to very steep. They are soils of the Dighton, Kent, and Nester series, and the group includes a land type, Gullied land, moderately fine textured. Most of the soils have a moderately fine textured subsoil and underlying material, but the Dighton soils are underlain by sandy material at a depth ranging from 18 to 42 inches. Water moves through the soil at a moderately slow or slow rate. Available moisture capacity is high, and natural fertility ranges from medium to moderately high. A few soils are stony or severely gullied. Many of the soils have been cultivated in the past, and the degree of erosion ranges from slight to severe on these soils.

Northern hardwoods normally give the greatest yields. Fully stocked, well-managed hardwoods normally have high or very high productivity. Aspen and white birch also have high or very high productivity, but pines have low productivity. Pines generally are not suited to this group of soils, and spruce trees do not grow naturally on them.

Conifers are the best trees for planting in open fields and for reestablishing a forest cover. Preferred species for planting are white spruce, Norway spruce, white pine, white-cedar, and Austrian pine. Preferred species for natural stands are sugar maple, basswood, white spruce, and yellow birch.

Seedling mortality is slight in native stands and moderate in planted stands, plant competition is moderate, equipment limitation is slight, erosion hazard is slight, and windthrow hazard is slight.

When planting seedlings or transplants, extra care is needed to pack the soil around the roots to eliminate air pockets, especially when planting by machine. Plant competition generally will not prevent reestablishment of good hardwood stands, but the competition may retard early growth.

On steep and stony soils, hand planting is necessary. Gullied areas are difficult to plant unless the gullies are filled and the slopes stabilized. When trees are planted by machine, contour planting will help prevent erosion. Locating roads and skid trails on the contour in sloping areas also helps to prevent erosion. In sloping to steep areas, excessive disturbance or removal of ground cover increases the erosion hazard. Logging is difficult on the steep and stony soils.

WOODLAND SUITABILITY GROUP C

Soils in this group are well drained or moderately well drained and range from nearly level to very steep. They are soils of the Blue Lake, Mancelona, Manistee, Menominee, Montcalm, Rubicon, and Rousseau series, and the group includes a land type, Gullied land, coarse textured. Most of the soils have a coarse or moderately coarse textured profile, but the Manistee soils are underlain by clay, and the Menominee soils, by moderately fine textured material. Water moves through the soil at a moderately rapid or rapid rate, but movement of water is restricted in the Menominee and Manistee soils by the finer textured underlying material. Available moisture capacity and natural fertility of the soils are moderately low. Stones are present on the surface in a few areas, and some areas are gullied.

The productivity of pines and aspen growing on these soils is high or very high. Productivity of nothern hardwoods is medium to high. An annual growth of approximately 300 board feet per acre can be expected in fully

stocked, well-managed stands of red pine. Aspen is less valuable than pines or hardwoods.

Red pine has the highest priority for this group of soils. The preferred species in natural stands are red pine, sugar maple, and white pine. Preferred species for planting are white pine, red pine, and white spruce. Jack pine is preferred in areas that are severely eroded or gullied, or where erosion is a serious hazard.

Seedling mortality is slight in native or planted stands, plant competition is slight or moderate, erosion hazard is moderate, and windthrow hazard is slight.

For most of the soils, equipment limitation is slight. Use of equipment is limited in the steep, stony, or gullied areas, however, and the use of machine planters is not practical in such areas. Hand planting is a means of establishing trees in these areas. Since the erosion hazard is moderate to severe on steep soils, planting trees on the contour and locating logging and skid trails on the contour are advisable.

WOODLAND SUITABILITY GROUP D

Soils of this group are well drained or moderately well drained and are gently sloping to steep. They are soils of the Isabella series and have a moderately coarse textured to moderately fine textured subsoil and underlying material. Water moves down through the soil at a moderately slow rate. Available moisture capacity is high, and natural fertility is moderate to moderately low. Most of the soils have been cultivated in the past and are slightly eroded or moderately eroded. Some areas are severely eroded.

Northern hardwoods are the dominant trees growing on these soils, but the eroded soils do not support natural stands. Productivity of hardwoods, aspen, spruce, and fir is high or very high. Productivity of pines is low.

Preferred species for planting are white spruce and Norway spruce, but white pine and Austrian pine are also commonly planted. Preferred species in natural stands are sugar maple, basswood, and yellow birch.

Seedling mortality is slight in native stands and moderate in planted stands, plant competition is moderate, erosion hazard is slight or moderate, and windthrow hazard is slight.

When the overstory is removed, competition from undesirable plants becomes moderate. This competition slows the initial growth rate and delays establishment of a fully stocked stand. Some replanting is necessary when establishing plantations.

For many of the soils, equipment limitations are slight, but use of equipment on the moderately steep and steep soils is somewhat limited, especially during wet periods. Erosion is a problem if ground cover is removed from the sloping to steep areas. Placing roads and skid trails on the contour helps retard erosion.

WOODLAND SUITABILITY GROUP E

Soils in this group are well drained or moderately well drained and have a coarse-textured profile. They are soils of the Chelsea, Croswell, East Lake, and Kalkaska series. Slopes are nearly level to steep. Water moves through the soils rapidly or very rapidly. Available moisture capacity and fertility are low. Soils in this group are among the most droughty and sandy in the county. Some areas are stony or gravelly. Areas that have been farmed in the past are slightly to severely eroded and do not support natural stands of trees.

Productivity of hardwoods is low. Productivity of aspen, white birch, and pine is high.

Preferred species for planting are red pine, white pine, and jack pine. Preferred species in natural stands are white pine, red pine, and aspen.

Seedling mortality is slight in native and planted stands, plant competition is slight, erosion hazard is slight to moderate, and windthrow hazard is slight.

For most of the soils, equipment limitations are slight, but use of equipment is restricted in some areas by steep slopes and by the loose, sandy condition of the soils. Building roads and trails on the contour helps to control erosion and makes it easier to operate equipment. Although erosion generally is slight to moderate, it may become severe on slopes exceeding 18 percent.

WOODLAND SUITABILITY GROUP F

Soils in this group are somewhat poorly drained and are nearly level to gently sloping or undulating. They are soils of the Au Gres, Ogemaw, and Saugatuck series and generally have a coarse-textured surface layer and subsoil. The Au Gres, loamy substratum, soil is underlain by medium- to fine-textured material at a depth ranging from 42 to 66 inches. The Saugatuck and Ogemaw soils have a hardpan below the surface layer, and the Ogemaw soil is underlain by medium- to fine-textured material at a depth ranging from 18 to 42 inches. Water moves rapidly or very rapidly through the upper part of these soils but moderately slowly or slowly through the finer textured material below. The hardpan of the Saugatuck or Ogemaw soils limits the root zone and the movement of water through the profile. Soils in this group formed under conditions of a fluctuating high water table. They are saturated during the spring and other wet periods. Available moisture capacity and fertility are low.

Productivity of fully stocked, well-managed stands of pines and hardwoods on these soils is low or very low. Productivity of aspen, white birch, spruce, and fir is low or medium.

Tree plantings normally are not made on these soils. Plantings require special techniques, and considerable replanting is necessary. Preferred species for natural stands are aspen and spruce.

Seedling mortality is severe in native and planted stands, plant competition is severe, equipment limitation is severe, erosion hazard is slight, and windthrow hazard is moderate.

Natural regeneration will not always result in adequate restocking on these soils, and use of chemicals or girdling often is necessary to control the growth of undesired trees and brush. Plant competition often is severe. It slows the initial growth rate of desired species.

Aspen is severely affected by hypoxylon canker on the Au Gres soils.

Use of equipment generally is restricted for about 3 months each year by excessive wetness during spring and other wet periods. Tree roots are damaged in some areas by use of heavy equipment. Windthrow is a problem on the Ogemaw and Saugatuck soils, especially when the removal of trees leaves openings in the tree canopy.

WOODLAND SUITABILITY GROUP G

This group consists of somewhat poorly drained soils that have slopes ranging from 0 to 6 percent. They are soils of the Allendale, Belding, Brimley, Coral, Gladwin, Iosco, Otisco, and Richter series, and they have a coarse or moderately coarse textured surface layer and subsoil. The Iosco, Belding, and Allendale soils are underlain by moderately fine or fine textured material. Water moves through the upper part of the soil profile moderately or moderately rapidly but moves slowly through the finer textured material that underlies the Iosco, Belding, and Allendale soils. Available moisture capacity ranges from moderately low for the Allendale, Gladwin, Iosco, and Otisco soils to high for the Brimley soil. The soils in this group formed under conditions of a fluctuating water table and are saturated during spring and other wet periods. Fertility ranges from moderate to low.

Productivity of fully stocked and well-managed stands of pines and hardwoods is low. Productivity of aspen and white birch ranges from low to high, and productivity of spruce and fir ranges from medium to high.

Preferred species for planting and in natural stands are white spruce, white pine, and yellow birch. If the site is drained, the preferred species for planting are white spruce, Norway spruce, white-cedar, and white pine.

Seedling mortality is slight to moderate in native stands and moderate to severe in planted stands; plant competition is moderate to severe; equipment limitation is slight to moderate; and the erosion hazard is slight.

Removal of the overstory may prevent adequate stand establishment because of resulting competition from brush and other plants. On some soils the competition may be so severe that natural regeneration will not provide adequate restocking. On planted sites maintenance planting is required because of moderate to severe seedling mortality.

Use of heavy equipment is severely restricted by wetness for about 3 months each year. Erosion is seldom a hazard. The windthrow hazard is generally slight to moderate, but it is severe if large openings are left by harvesting. Controlled thinning in harvesting helps preclude large openings and decreases the windthrow hazard.

WOODLAND SUITABILITY GROUP H

In this group are well drained and moderately well drained soils that have slopes ranging from nearly level to very steep. They are soils of the Rubicon and Wallace series, have a coarse-textured profile, and are among the most droughty and sandy soils in the county. Water moves through the soils rapidly or very rapidly. Movement of water through the cemented layer in the Wallace soils is moderately slow. Available moisture capacity and fertility are low.

Productivity of pines is medium on these soils, productivity of hardwoods is very low, and productivity of aspen is low. Annual growth of fully stocked, well-managed red pine stands is about 240 board feet per acre. Annual growth of hardwoods commonly is less than 125 board feet per acre, and the quality is low. Aspen is better suited to these soils than hardwoods and has an annual growth of about 0.3 cord per acre.

Species priority of hardwoods and aspen is very low. If the soils are used for growing wood products, conversion of stands from hardwoods to aspen or pines eventually improves economic returns. Preferred species in natural stands and for plantings are red pine, white pine, and jack pine.

Seedling mortality, plant competition, equipment limitation, erosion hazard, and windthrow hazard generally are slight.

High soil temperatures, droughtiness, and cutting action of wind hinder establishment of seedlings, but loss of seedlings is less than 25 percent in most areas, and establishment is generally successful.

Use of equipment is restricted if the slope exceeds 18 percent. Placing roads and skid trails on the contour helps prevent erosion on the steeper slopes. Wind erosion is a hazard if the surface cover is removed from large areas of these soils.

WOODLAND SUITABILITY GROUP J

In this group are poorly drained or very poorly drained soils of the Adrian, Carbondale, Edwards, Houghton, Kerston, Linwood, Lupton, Markey, Rifle, Tawas, Warners, and Willette series. In most areas they are level, but in a few areas they are gently sloping or sloping. They consist of organic material to a depth of 12 inches or more. Some of the soils are underlain by mineral material of various textures at depths ranging from 12 to 42 inches. Available moisture capacity is high, and fertility is low. These soils are saturated most of the year.

No productivity ratings are available for these soils, and timber production on them is extremely variable. Growth and species priority are governed mainly by depth of soil to the water table and by the degree of saturation of the soil. Existing trees are lowland hardwoods and swamp conifers.

Seedling mortality is moderate in native stands and severe in planted stands; plant competition and equipment limitation are severe; erosion hazard is slight; and windthrow hazard is severe.

Harvesting is limited to winter months when the soils are frozen.

WOODLAND SUITABILITY GROUP L

Soils of this group are poorly drained or very poorly drained and are nearly level or in depressed areas. They are soils of the Dawson, Greenwood, and Loxley series and formed in strongly acid to extremely acid organic material. Greenwood and Loxley soils consist of organic material more than 42 inches thick. The Dawson soil consists of organic material 12 to 42 inches thick over sandy material. Available moisture capacity is high, and natural fertility is low. Water moves rapidly through the soil profile. The soils are subject to wind erosion if large areas are exposed.

Productivity of all tree species is very low, and forestry management of any kind generally is not practical. An occasional spruce, tamarack, or white pine tree grows on the soils.

Seedling mortality, plant competition, and equipment limitation all are severe, erosion hazard is slight, and windthrow hazard is severe.

WOODLAND SUITABILITY GROUP N

Soils in this group are well drained and range from nearly level to steep. The soils are those of the Grayling series, but the group also includes two mapping units of Wind eroded land. The Grayling soils and the areas of Wind eroded land are sandy, and water moves through

them rapidly or very rapidly. Available moisture capacity and fertility are low or very low. This group includes the most droughty and sandy areas in the county.

Productivity of all tree species is very low because of high soil temperatures and low or very low fertility and available moisture capacity. An annual growth of 0.1 cord of pine or aspen per acre and less than 125 board feet of pine per acre is typical for this group of soils and for the areas of Wind eroded land. Jack pine and red pine seedlings have been planted successfully. Red pines are more thrifty than jack pines until they are 30 years old, but jack pines are more thrifty after 30 years.

Seedling mortality is severe. Plant competition, equipment limitation, erosion hazard, and windthrow hazard all are slight, except that use of equipment is restricted on slopes exceeding 18 percent. Disturbance of the surface litter by logging equipment can result in wind erosion.

WOODLAND SUITABILITY GROUP O

This group of soils is well drained to very poorly drained and occupies bottom lands along rivers. They are soils of the Abscota, Algansee, Evart, Saranac, Shoals, and Sloan series. All of these soils are subject to flooding for varying periods during spring and after prolonged rain. They formed in stratified material that ranges from sand to clay loam. Water moves through the soil at a very rapid to moderately slow rate. Available moisture capacity and fertility are extremely variable and range from low in the Abscota, Algansee, and Evart soils to high in the Saranac soil. Some of the soils have a high water table, are saturated most of the year, and are subject to flooding.

Productivity ratings are not available for this group of soils. Lowland hardwoods and swamp conifers commonly grow on the bottom lands in most areas.

Seedling mortality in native stands is moderate and in planted stands is severe. Equipment limitation is moderate to severe, erosion hazard is slight, and windthrow hazard is severe.

Plant competition from brush and other plants is generally severe and is a moderate to severe limitation to regeneration of a stand if the overstory is removed. Natural regeneration is variable and sometimes results in establishment of scattered groups of trees. The severity and duration of flooding are major factors determining whether new stands can be established.

Use of equipment is limited mainly by the hazard of flooding and by excessive wetness during wet periods. The use of equipment during wet periods damages tree roots.

WOODLAND SUITABILITY GROUP P

In this group are poorly drained or very poorly drained soils of the Bergland, Munuscong, Pickford, and Sims series. They are level or are in depressed areas. In most places these soils have a fine textured or moderately fine textured subsoil and underlying material, but the upper part of the subsoil in the Munuscong soil is moderately coarse textured. Water moves through the soil at a moderately slow to very slow rate. Available moisture capacity is high, and fertility ranges from moderately high to high. These soils are saturated during much of the year because of a high water table. In some areas the water table has been lowered by artificial drainage, and the soils have better internal drainage as a result.

298-861—69——7

Productivity of fully stocked hardwood stands is low or very low. The annual growth rate is 160 board feet or less per acre. Production of aspen, white birch, spruce, and fir ranges from low to medium. The annual growth of aspen and spruce is about 0.3 to 0.8 cord per acre.

Trees generally are not planted on these soils. Species priority in natural stands is spruce, white-cedar, and balsam fir.

Seedling mortality, plant competition, equipment limitation, and windthrow hazards all are severe. The hazard of erosion is slight.

Plant competition prevents adequate immediate restocking of desired species by natural regeneration. Mortality of natural seedlings is severe, but they are produced in large enough numbers to assure ultimate restocking.

Logging should be done during dry seasons or when the soil is frozen.

WOODLAND SUITABILITY GROUP Q

Soils of this group are poorly drained and very poorly drained and are in level areas or depressions. They are soils of the Kinross and Roscommon series. They formed in sandy material. Water moves very rapidly through the soils, and they have low available moisture capacity and fertility. Because of a high water table, the soils are saturated for long periods of time.

Productivity of fully stocked, well-managed pines and hardwoods is very low. Annual growth is less than 125 board feet per acre. The annual growth of spruce, fir, and aspen is 0.1 cord per acre.

Preferred species in natural stands are spruce, aspen, and red maple.

Seedling mortality is severe in native and planted stands, plant competition is moderate, equipment limitation is severe, erosion hazard is slight, and windthrow hazard is severe.

Few tree plantings are made on these soils, but any plantings do best at the highest elevations or in areas that have been artificially drained. In undrained areas the root zone is limited and the windthrow hazard is severe.

Wetness of the soil restricts use of logging equipment, especially during spring and after heavy rain. Tree harvest is most practical during the driest periods or when the soil is frozen.

WOODLAND SUITABILITY GROUP W

This group consists of poorly drained or very poorly drained soils. These soils are in the Brevort, Edmore, Ensley, Pinconning, Tonkey, and Wheatley series. The subsoil and underlying material are generally coarse textured or moderately coarse textured, but the Brevort and Pinconning soils are underlain by moderately fine textured material at a depth of 18 to 42 inches. Water moves very rapidly to moderately rapidly through most of these soils. It moves moderately slowly or slowly through the finer textured material of the Brevort and Pinconning soils and moderately through the Ensley and Tonkey soils. Available moisture capacity ranges from moderately low to moderately high but is low for the Wheatley soils. Fertility of most of the soils is low or moderately low but ranges to moderately high in the Ensley and Tonkey soils.

Trees are seldom planted on these soils. Pines are not suited to them, and figures on productivity are not available. Productivity of hardwoods and aspen is very low or

low, and annual growth is less than 125 board feet per acre. Aspen yields an average of 0.1 cord per acre per year. Swamp conifers, spruce, and white-cedar have low productivity ratings. White-cedar and spruce are species to favor in natural stands.

Seedling mortality, plant competition, equipment limitation, and windthrow hazard all are severe. The erosion hazard is slight.

Extensive site preparation is required before trees are planted on these soils. This includes drainage and control of plant competition. A high water table restricts use of equipment in most areas and also restricts the root zone.

WOODLAND SUITABILITY GROUP Z

Soils in this group are somewhat poorly drained and are nearly level or gently sloping. They are soils of the Kawkawlin, Selkirk, and Twining series and have a medium-textured to fine-textured subsoil and underlying material. They are stony in some areas. Water moves through the soil moderately slowly or slowly. Available moisture capacity is high, and fertility is moderately high or high. There is a fluctuating high water table, and these soils are saturated during spring and other wet periods.

Generally only aspen and hardwood trees grow on these soils and productivity of both kinds is medium. Aspen has a very low species priority because of competition from hardwoods. Fully stocked, well-managed northern hardwood stands have an annual growth rate of about 240 board feet per year.

Planting of trees on these soils generally is not recommended. White or Norway spruce generally are given first priority for any plantings. Preferred priority in natural stands is spruce and sugar maple.

Seedling mortality is moderate in native and planted stands, plant competition is severe, equipment limitation is moderate, erosion hazard is slight, and windthrow hazard is moderate.

Because of a fluctuating high water table, special site preparation is needed for plantings. Chemical and mechanical control of undesired plants is necessary to insure adequate stands. Use of heavy equipment is restricted during wet seasons. Windthrow is a hazard if large areas are opened by logging operations.

Engineering Uses of the Soils

This section describes the properties of the soils that are important to engineering, especially those that affect the construction and maintenance of roads, airports, pipelines, foundations for buildings, facilities for storing water, erosion control structures, drainage systems, and sewage disposal systems.

This section contains information that engineers can use to—

1. Make soil and land use studies that will aid in selecting and developing sites for industrial, business, residential, and recreational uses.
2. Estimate runoff and erosion characteristics of soils for use in planning drainage structures and planning dams and other structures for conserving soil and water, locating suitable routes for underground conduits and cables, and locating sites for sewage disposal fields.
3. Make preliminary evaluations of soil conditions that will aid in selecting locations for highways, airports, pipelines, and sewage disposal fields and in planning detailed surveys of the soils at the selected locations.
4. Locate sources of sand, gravel, and other material for use in construction.
5. Correlate performance of pavements with the soil mapping units and thus develop information that will be useful in designing and maintaining pavements.
6. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
7. Determine suitability of soils for movement of vehicles and construction equipment.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

This survey does not eliminate the need for on-site sampling and testing of soils for design and construction of specific engineering works. It is useful, however, in planning more detailed field investigations to be made at the proposed site for engineering work to determine the condition of soil material in place at the site.

Some of the terms used by soil scientists may be unfamiliar to engineers, and some words, for example, soil, clay, silt, sand, and gravel, have different meanings for soil scientists than for engineers. These and other special terms that are used are defined in the Glossary at the back of the survey. Other information useful to engineers can be obtained from the soil map and from other parts of the survey, such as the sections "General Soil Map," "How This Survey Was Made," and "Descriptions of the Soils."

Data in tables 4, 5, and 6, and the soil maps at the back of this survey, provide preliminary information on the engineering properties of the soils in a specific part of the county. At many construction sites, however, major variations in the soil are present within the area of proposed excavations. Also, soils of several series can occur in a small area. Therefore, specific laboratory data should be determined for the soil or soils at a site before any engineering work is planned in detail.

Engineering classification systems

The U.S. Department of Agriculture (USDA) system of classifying soil texture is used by agricultural scientists. In this system the textural class of a soil is based on the proportions of sand, silt, and clay in the soil. In some ways this system is comparable to the systems engineers use in classifying soils.

Two systems of classification of soils are in general use among engineers. Most highway engineers classify soil materials according to the system used by the American Association of State Highway Officials (AASHO). Some engineers prefer to use the Unified soil classification system. Both classification systems are used in this survey in tables 4 and 5 and are briefly described here.

AASHO classification.—The American Association of State Highway Officials has developed a classification based on the field performance of soil materials (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1, consisting of gravelly

materials of high bearing capacity, to A–7, consisting of clay soils having low strength when wet.

Unified classification.—In the Unified soil classification system (*9*), soil materials are classified in 15 categories. Eight classes are for coarse-grained material and are designated GW, GP, GM, GC, SW, SP, SM, and SC; six are for fine-grained material and are designated ML, CL, OL, MH, CH, and OH; and one is for highly organic material and is designated Pt.

Engineering test data

Test data for four Osceola County soils are given in table 4. Samples of soils of three series were taken from six locations in the county. Only selected layers of each soil were sampled. The samples were tested by standard procedures in laboratories of the Bureau of Public Roads to help evaluate the soils for engineering uses. The samples do not represent the entire range of properties of soils in Osceola County or the full range within the three soil series that were sampled.

Both the AASHO and Unified classifications of the samples are listed in table 4. They are based on data obtained by mechanical analysis and from tests to determine liquid and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

The names for the various sizes of sand, silt, and clay as used by engineers are not equivalent to the names used by soil scientists. To soil scientists, for example, clay refers to mineral grains less than 0.002 millimeter in diameter, whereas engineers frequently define clay as the grains less than 0.005 millimeter in diameter. These and other terms used by soil scientists are defined in the "Soil Survey Manual" (*7*).

The tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material. As the moisture content of a clayey soil is increased from a very dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The *plastic limit* is the moisture content at which the soil material passes from a semisolid to a plastic state. The *liquid limit* is the moisture content at which the material passes from a plastic to a liquid state. The *plasticity index* is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

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

Engineering descriptions of the soils

In table 5 the soil series and most of the land types in the county are listed, the map symbol for each soil is indicated, and estimates of the properties of the soils are given. One variable land type, Gravel and sand pits (Gp), is omitted. Since tests were made only for those soils listed in table 4, it was necessary to estimate the engineering properties of the other soils. This was done by comparing them with those soils that were sampled and tested, based upon experience gained from working with and observing similarly classified soils in other areas. The estimates provide information about the soils that an engineer would otherwise have to obtain for himself. The estimates, however, are not a substitute for the detailed tests needed at a specific site selected for construction. In general, the information in the table applies to a depth of 5 feet or less. A brief explanation of the data in the columns of table 5 follows.

In the column "Depth from surface," normally, only the depths of major horizons are listed. Special horizons are listed if they have engineering properties significantly different from those of adjacent horizons.

The USDA textural classification of soil materials is based on the relative amounts of sand, silt, and clay in a horizon, and uses such basic soil textural class names as sand, sandy loam, and clay (*7*).

The figures on the percentages of material passing through sieves are estimates and are rounded off to the nearest 5 percent. Where there is little material present of gravel size (held on No. 4 and No. 10 sieves), the percentage of material passing the No. 200 sieve approximates the combined amount of silt and clay in a soil.

The rate of movement of water downward through undisturbed soil material indicates the permeability of the material. The figures given are estimates and are based mainly on the texture, structure, and consistence of the soils.

The approximate amount of water in a soil when it is wet to field capacity, expressed as inches of water per inch of soil depth, indicates the available water capacity of the soil. When the moisture in the soil is at the point at which common crops wilt, this amount of water will wet the soil material described to a depth of 1 inch without deeper penetration.

The estimated range in pH values for each major horizon of the soils as determined in the field is given. It indicates the acidity or alkalinity of the soils. A pH of 7, for example, indicates a neutral soil, a lower pH value indicates acidity, and a higher value indicates alkalinity.

The change in volume of the soil that results from a change in moisture content is known as the shrink-swell potential. The figures given are estimates and are based mainly on the amount and kind of clay in the soil.

Engineering interpretations

Table 6 lists the suitability ratings of soils and the features that affect the suitability of soils for engineering uses. The data in the table apply to the representative profile of the soil series that is described in the section "Descriptions of the Soils." Omitted from table 6 is a variable land type, Gravel and sand pits (Gp).

Some features of a soil can be of help in one kind of engineering work but a hindrance in another. For example, a highly permeable substratum would make a soil unsuitable as a site for a farm pond, but it might make it favorable for the location of a highway. The properties of a soil that are important to the engineer are permeability to water, shear strength, compaction characteristics, shrink-swell potential, compressibility, drainage, grain

TABLE 4.—*Engineering test data* [1] *for soil*

Soil and location	Parent material	Bureau of Public Roads report No.	Depth	Horizon	Mechanical analysis [2]		
					Percentage passing sieve—		
					3 in.	¾ in.	No. 4 (4.7 mm.)
			Inches				
Isabella loam:							
NW¼NW¼ sec. 22, T. 19 N., R. 8 W. (modal).	Glacial till.	S35733	0–8	Ap	--------	100	98
		S35731	8–10	Bhir	--------	100	98
		S35735	10–16	A2m	--------	100	98
		S35736	28–42	Bt	100	96	94
		S35737	42–66	C	100	99	97
McBride sandy loam:							
NW¼NW¼ sec. 11, T. 18 N., R. 8 W. (coarse textured).	Glacial till.	S35744	0–9	Ap	100	97	95
		S35745	9–17	Bhir	100	96	93
		S35746	17–28	A2m	100	99	97
		S35747	44–55	Bt	100	99	97
		S35748	55–90	C	100	98	95
SE¼NE¼ sec. 31, T. 19 N., R. 9 W. (fine textured).	Glacial till.	S35749	0–3	A1	--------	100	99
		S35750	3–4	A2	--------	--------	99
		S35751	4–17	Bhir	--------	--------	--------
		S35752	17–28	A2&Btm	--------	--------	--------
		S35753	44–56	C	--------	100	98
Nester loam:							
NE¼NE¼ sec. 30, T. 18 N., R. 7 W. (modal).	Glacial till.	S35754	0–7	Ap	--------	100	99
		S35755	7–14	A2bt	--------	--------	--------
		S35756	14–27	Bt	--------	--------	--------
		S35757	27	C	--------	--------	--------
SE¼SE¼ sec. 10, T. 19 N., R. 8 W. (fine textured).	Glacial till.	S35758	0–6	A1	--------	--------	--------
		S35759	6–8	A2	--------	--------	--------
		S35760	14–26	Bt	--------	--------	--------
		S35761	26	C	--------	--------	--------
Nester sandy loam:							
SW¼SE¼ sec. 36, T. 19 N., R. 10 W. (coarse textured).	Glacial till.	S35762	0–7	A&Bhir	100	93	90
		S35763	7–16	A2m	100	99	97
		S35764	25–48	Bt	--------	--------	--------
		S35765	48–60	C	--------	--------	--------

[1] Tests performed by the Bureau of Public Roads (BPR) in accordance with standard procedures of the American Association of State Highway Officials (AASHO).

[2] Mechanical analyses according to the American Association of State Highway Officials Designation T 88–57 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 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 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.

size, plasticity, and reaction. Depth to the water table and to bedrock and the kind of topography also are important. A brief explanation of the information in the columns of table 6 follows.

Topsoil refers to soil material, preferably high in content of organic matter, that is used as a topdressing for back slopes, embankments, lawns, gardens, and so on. The suitability ratings are based mainly on texture and organic-matter content. Unless otherwise indicated, only the surface of a mineral soil is considered in its rating.

The ratings of the suitability of the soils as sources of sand and gravel apply to soil material occurring within a depth of 5 feet. In some of the soils, sand and gravel are present at a depth of less than 5 feet and extend to a depth of more than 5 feet. In adjacent areas of the same soil, unsuitable material is just below a depth of 5 feet in some places. Some soils that are rated as unsuitable have sand and gravel at a depth of more than 5 feet. Where suitability is in question, test pits will be needed to determine the availability of sand and gravel.

The ratings of the suitability of the soils as sources of road fill are based on performance of soil material when used as borrow for subgrade fill. Both the subsoil and the substratum are rated if they are contrasting in character. The most desirable material for subgrade fill is sand, and the least desirable is clay.

The entire soil profile was evaluated in determining the overall performance of the soils as locations for highways.

samples taken from selected soil profiles

Mechanical analysis [2]—Continued							Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Con.			Percentage smaller than—						AASHO [3]	Unified [4]
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.				
							Percent			
97	88	37	33	24	16	10	19	3	A-4(0)	SM
97	88	34	31	24	16	10	14	2	A-2-4(0)	SM
97	87	36	33	27	18	12	12	2	A-4(0)	SM
93	86	44	42	39	32	27	26	12	A-6(2)	SC
96	88	45	43	36	29	23	25	12	A-6(3)	SC
93	83	24	21	16	8	5	[5] NP	NP	A-2-4(0)	SM
92	82	22	19	13	7	4	NP	NP	A-2-4(0)	SM
95	83	17	15	10	5	2	NP	NP	A-2-4(0)	SM
95	84	20	19	15	12	10	NP	NP	A-2-4(0)	SM
92	81	18	17	13	8	6	NP	NP	A-2-4(0)	SM
98	92	45	41	29	16	10	27	5	A-4(2)	SM-SC
98	91	40	37	30	20	13	19	4	A-4(1)	SM-SC
100	92	29	27	23	18	13	NP	NP	A-2-4(0)	SM
100	92	33	31	28	23	20	21	9	A-2-4(0)	SC
97	89	35	32	28	22	18	18	7	A-2-4(0)	SM-SC
99	93	48	44	34	22	15	21	6	A-4(3)	SM-SC
100	96	61	58	47	35	27	23	9	A-4(5)	CL
100	96	65	61	53	43	36	34	16	A-6(8)	CL
100	96	65	62	52	40	31	30	14	A-6(8)	CL
100	96	64	60	43	26	16	38	9	A-4(6)	ML
100	96	63	59	43	28	18	24	6	A-4(6)	ML-CL
100	97	73	71	63	53	44	42	21	A-7-6(12)	CL
100	97	75	72	62	48	38	36	18	A-6(11)	CL
89	84	36	32	20	9	5	NP	NP	A-4(0)	SM
95	88	38	34	26	17	10	12	2	A-4(1)	SM
100	94	56	54	48	40	33	29	14	A-6(6)	CL
100	94	55	53	47	39	32	28	13	A-6(5)	CL

[3] Based on "Standard Specifications for Highway Materials and Methods of Sampling and Testing" (Pt. 1, Ed. 7): "The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes," AASHO Designation M 145-49 (*1*).

[4] Based on the "Unified Soil Classification System," Technical Memorandum No. 3-357, v. 1, Waterways Experiment Station, Corps of Engineers, March 1953 (*9*). 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.

[5] NP = Nonplastic.

The ratings were based on undisturbed soils without artificial drainage. The State Highway Department of Michigan has rated the soils of the major soil series in the State with respect to their highway engineering properties (*3*).

Features and qualities of the substratum of naturally occurring, undisturbed soils were evaluated in determining the suitability of the soils for foundations of low buildings, up to three stories high. It is the substratum that usually provides the base for foundations.

The ratings of the suitability of the soils for reservoir areas are based primarily on features of the undisturbed soils that affect the seepage rate or permeability.

The features of disturbed soil material were considered in rating the suitability of the soils for use in constructing dikes, levees, and embankments to impound or contain surface water.

Permeability or percolation rate, depth to the water table or to bedrock, the hazard of flooding, and topography were considered in rating the suitability of the soils for septic tank disposal fields.

Considered in rating the suitability of the soils for agricultural drainage were factors that affect the installation and performance of surface and subsurface drainage systems, such as texture, permeability, topography, restricting layers, and depth to the water table.

The ratings of the suitability of the soils for irrigation are based on the water-holding capacity and the water intake rate of the soils and also on the depth to the water

TABLE 5.—*Estimated*

Soil series and map symbol	Depth to water table [1]	Depth from surface [2]	Classification: USDA texture
	Feet	*Inches*	
Abscota (Ab, Ac)	3–10	0–6	Sand, loamy sand, sandy loam, or loam
		6–60	Sand or loamy sand
Adrian (Ad)	0–2	0–26	Muck and peat
		26–60	Sand or loamy sand
Algansee (Ae, Ag)	2–8	0–7	Sand or loamy sand
		7–60	Sandy loam or loam
			Sand or loamy sand
Allendale (AlB, AmB)	[5] 2–8	0–7	Loamy sand or sandy loam
		7–30	Sand or loamy sand
		30–60	Silty clay or clay
Au Gres:			
Normal (ArB)	[5] 2–8	0–14	Sand or loamy sand
		14–60	Sand
Loamy substratum (AuB)	[5] 2–8	0–42	Sand or loamy sand
		42–60	Loam, clay loam, silty clay loam, silty clay, or clay
Belding:			
Normal (BdA, BdB)	[5] 2–10	0–18	Fine sandy loam or loamy fine sand
		18–60	Loam, clay loam, or silty clay loam
Clay subsoil variant (BeB)	2–8	0–22	Sandy loam
		22–30	Sandy loam or sandy clay loam
		30–60	Silty clay or clay
Bergland (Bg)	0–3	0–9	Silt loam
		9–22	Silty clay to clay
		22–60	Silty clay or clay
Blue Lake (BlA, BlB, BlC, BlD, BlE)	5–30	0–18	Loamy sand
		18–60	Sand layers 2 to 7 inches thick; bands of light sandy loam about ⅛ inch to 1 inch thick.
Bohemian (BoB, BoC, BoD)	4–20	0–15	Loamy fine sand or very fine sandy loam
		15–30	Silt loam or silty clay loam
		30–60	Stratified silt, very fine sand, and fine sand
Brevort (Br, Bt, Bv)	0–3	0–10	Fine sandy loam, loamy sand, or sand
		10–28	Sand
		28–60	Loam, clay loam, or silty clay loam
Brimley (ByB)	2–8	0–15	Fine sandy loam
		15–36	Heavy silt loam or silty clay loam
		36–60	Stratified silt and very fine sand
Carbondale:			
(CaA)	0–2	0–13	Loam to sandy loam
		13–60	Muck or peat
(CbA, CbC, CdA)	0–2	0–60	Muck or peat
Chelsea (ChB, ChC, ChD, ChE, ChF, ClB, ClC, ClD)	5–30	0–10	Loamy sand or sand
		10–45	Sand
		45–60	Sand and several bands of loamy sand 1⅛ to ½ inch thick
Coral (CoA, CoB)	2–8	0–27	Fine sandy loam or sandy loam
		27–48	Sandy clay loam
		48–60	Sandy loam
Croswell (CrB, CrC)	3–10	0–8	Sand or loamy sand
		8–20	Sand
		20–60	Sand

See footnotes at end of table.

properties of the soils

Classification—Continued		Percentage passing sieve—			Permeability [3]	Available water capacity [4]	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH value*	
SP–SM or SM	A–2 or A–4	100	95–100	5–50	2. 5–10. 0	0. 12	5. 0–6. 5	Low.
SP or SM	A–2 or A–3	100	95–100	0–20	5. 0–10. 0+	. 05	5. 0–7. 0	Low.
Pt					5. 0–10. 0	. 50	5. 6–7. 0	Moderate.
SP, SW, or SM	A–3 or A–2	100	95–100	0–20	10. 0+	. 02	5. 6–7. 0	Low.
SP–SM or SM	A–2 or A–4	100	95–100	5–25	2. 5–5. 0	. 08	5. 5–7. 0	Low.
ML or SM	A–2 or A–4	100	95–100	30–65	0. 8–2. 5	. 14	5. 5–7. 0	Low.
SP–SM or SM	A–3 or A–2	100	95–100	5–25	5. 0–10. 0+	. 04	6. 0–7. 5	Low.
SM	A–2	100	95–100	15–25	5. 0–10. 0+	. 08	5. 5–7. 0	Low.
SP or SM	A–2 or A–3	100	95–100	2–15	5. 0–10. 0+	. 06	5. 5–7. 0	Low.
CH	A–7	95–100	95–100	70–90	0–0. 2	. 16	7. 0–8. 0	High.
SP or SM	A–2 or A–3	100	95–100	0–15	10. 0+	. 06	4. 5–6. 0	Low.
SP	A–3	100	95–100	0–5	10. 0+	. 04	5. 0–6. 5	Low.
SP or SM	A–3 or A–2	100	95–100	2–20	5. 0–10. 0+	. 04	5. 0–6. 0	Low.
ML, CL, or CH	A–6 or A–7	95–100	90–100	55–90	0–1. 5	. 17	7. 0–8. 0	Moderate or high.
SM	A–4	90–100	85–95	35–50	2. 5–5. 0	. 12	5. 0–6. 5	Low.
ML or CL	A–6	90–100	85–95	60–90	0. 05–1. 5	. 17	7. 0–8. 0	Moderate.
SM	A–4 or A–2	95–100	90–100	25–45	0. 8–2. 5	. 13	5. 0–6. 5	Low.
SM or SC	A–4 or A–2	95–100	90–100	25–45	0. 8–2. 5	. 14	5. 5–7. 0	Low.
CH	A–7	100	95–100	70–95	0–0. 2	. 16	7. 0–8. 0	High.
ML	A–4	100	95–100	75–100	0. 8–2. 5	. 21	6. 6–7. 5	Moderate or low.
CH	A–7	100	95–100	75–100	0. 05–0. 2	. 17	7. 0–7. 8	High.
CH	A–7	100	95–100	75–100	0. 00–0. 2	. 15	8. 0	High.
SM	A–2	100	95–100	15–25	2. 5–5. 0	. 10	4. 5–6. 0	Low.
[6]	[6]	100	95–100	[6]	2. 5–5. 0	. 05	4. 5–6. 5	Low.
ML or SM	A–4	100	100	45–70	0. 8–2. 5	. 18	5. 5–7. 0	Low.
CL	A–6	100	95–100	70–90	0. 2–2. 5	. 18	6. 5–7. 5	Low to moderate.
[7]	A–4	100	95–100	60–100	0. 2–2. 5	. 17	7. 5–8. 0	Low to moderate.
SM or SP	A–2, A–3, or A–4	100	90–100	0–50	5. 0–10. 0	. 06	6. 0–7. 5	Low.
SP–SM	A–3	100	90–100	5–10	5. 0–10. 0+	. 03	6. 5–7. 5	Low.
ML or CL	A–4 or A–6	95–100	90–100	65–90	0. 2–2. 5	. 17	7. 5–8. 0	Moderate.
SM or ML	A–4	100	100	40–60	0. 8–2. 5	. 18	6. 5–7. 5	Low.
CL	A–6	100	95–100	70–90	0. 2–2. 5	. 18	7. 0–7. 8	Moderate to low.
[7]	A–4	100	95–100	[8]	0. 2–2. 5	. 17	7. 5–8. 0	Low to moderate.
ML or SM	A–4 or A–2	100	95–100	30–70	0. 8–2. 5	. 20	5. 0–7. 0	Low.
Pt					5. 0–10. 0	. 50	5. 0–7. 0	Moderate.
Pt					5. 0–10. 0	. 50	5. 0–7. 0	Moderate.
SP–SM or SM	A–2 or A–3	85–100	80–100	5–15	5. 0–10. 0	. 07	4. 8–6. 0	Low.
SP	A–3	95–100	90–100	0–5	5. 0–10. 0	. 03	4. 8–6. 5	Low.
[9]	[9]	95–100	90–100	[9]	5. 0–10. 0	. 04	5. 5–7. 0	Low.
SM	A–2 or A–4	95–100	90–100	25–45	0. 8–2. 5	. 16	4. 5–6. 5	Low.
SC	A–6	95–100	90–100	35–50	0. 8–2. 5	. 16	5. 0–7. 0	Low to moderate.
SM	A–2 or A–4	95–100	90–100	20–40	0. 8–2. 5	. 10	7. 0–8. 0	Low.
SP or SM	A–2 or A–3	100	95–100	2–15	10. 0+	. 06	4. 5–6. 0	Low.
SP or SP–SM	A–3	100	95–100	2–10	10. 0+	. 04	4. 5–6. 0	Low.
SP	A–3	100	95–100	0–5	10. 0+	. 03	5. 5–6. 5	Low.

TABLE 5.—*Estimated*

Soil series and map symbol	Depth to water table [1]	Depth from surface [2]	Classification
			USDA texture
	Feet	*Inches*	
Dawson (Da)	0–2	0–22	Peat
		22–60	Sand or loamy sand
Dighton (DgB, DgC, DgD2)	4–30	0–11	Sandy loam
		11–32	Clay loam or sandy clay loam
		32–60	Sand or loamy sand
East Lake (EaB, EaC, EaD, EIA)	4–30	0–7	Gravelly loamy sand, loamy sand, or sandy loam
		7–36	Gravelly sand or sand
		36–60	Gravelly sand
Edmore (Em)	0–3	0–32	Sandy loam or loamy sand
For Tonkey part, see the Tonkey series.		32–60	Loamy sand
Edwards (Er)	0–3	0–30	Muck or peat
		30–42	Marl
		42–60	(11)
Ensley (Es, Et)	0–3	0–12	Sandy loam or loam
For Tonkey parts, see the Tonkey series.		12–34	Sandy loam or sandy clay loam
		34–60	Sandy loam
Evart (Eu, Ev)	0–3	0–10	Loamy sand, sandy loam, loam or clay loam
		10–60	Stratified loamy sand and sand
Gladwin (GaA, GaB, GdA, GdB)	2–10	0–10	Loamy sand
		10–30	Loamy sand or gravelly sandy loam
		30–60	Fine gravel and sand
Grayling (GrB, GrC, GrE)	5–30	0–60	Sand
Greenwood (Gt)	0–2	0–46	Peat
Gullied land:			
(Gu)	10–40	0–60	Sand or loamy sand
(Gx)	5–30	0–60	Clay loam or sandy clay loam
Houghton (Hm)	0–2	0–48	Muck
Iosco (IcA, IcB, IdA, IdB)	2–8	0–8	Loamy fine sand, loamy sand, sand, or sandy loam
		8–34	Sand or loamy sand
		34–60	Silty clay loam or sandy clay loam
Isabella (IeB, IeC, IeC2, IeD, IeD2, ImB, ImC, ImC2, ImD, ImD2, InD3, InE3, IsB, IsB2, IsC, IsC2, IsD, IsD2, IsE).	5–30	0–23	Loam or clay loam Loamy sand or sandy loam
		23–42	Sandy clay loam or sandy clay
		42–60	Sandy clay loam
Kalkaska (KaB, KkB, KkC, KkC3, KkD, KkD3, KkE, KkE3, KkF, KlB, KlC, KlE).	5–40	0–8	Gravelly sand, sand, or loamy sand
		8–24	Sand
		24–60	Sand
Kawkawlin (KnA, KnB, KoA, KoB, KrA, KrB, KsB)	2–8	0–10	Loam or sandy loam
		10–20	Heavy clay loam or silty clay
		20–60	Clay loam or silty clay loam
Kent (KtB, KtC, KtC2, KtD, KtD2)	4–30	0–8	Loam, sandy loam, or silt loam
		8–20	Silty clay or clay
		20–60	Silty clay or clay
Kerston (Kv, Kw)	0–3	0–60	Alternate layers: Muck Mineral material, mostly sandy
Kinross (Kx)	0–3	0–16	Sand or loamy sand
		16–60	Sand

See footnotes at end of table.

properties of the soils—Continued

Classification—Continued		Percentage passing sieve—			Permeability [3]	Available water capacity [4]	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH value*	
Pt					5. 0–10. 0	. 50	3. 6–5. 0	
SP or SP–SM	A–3	95–100	90–100	0–10	5. 0–10. 0+	. 03	4. 5–6. 5	Low.
SM	A–4	95–100	95–100	35–50	0. 8–2. 5	. 14	5. 0–6. 5	Low.
CL or SC	A–6	95–100	90–100	40–80	0. 2–1. 5	. 17	5. 5–7. 0	Moderate.
SP or SM	A–2	100	95–100	2–20	5. 0–10. 0	. 06	5. 5–7. 5	Low.
SM	A–2	80–95	75–95	15–30	5. 0–10. 0	. 05	5. 5–7. 0	Low.
GW or SP	A–1	40–70	30–70	0–5	10. 0+	. 03	6. 0–7. 5	Low.
GW or SP	A–1	20–80	10–60	0–5	10. 0+	. 02	7. 5–8. 0	Low.
SM	A–2	95–100	90–100	10–35	2. 5–5. 0	. 10	6. 0–7. 0	Low.
SM	A–2	95–100	90–100	15–25	5. 0–10. 0	. 07	6. 5–8. 0	Low.
Pt					2. 5–5. 0	. 05	7. 4–8. 0	Moderate.
					[10]	[11]	7. 8–8. 4	Low.
[11]					0. 8–5. 0			
SM	A–4 or A–2	95–100	90–100	25–50	0. 8–2. 5	. 15	6. 0–7. 0	Low.
SM	A–4 or A–2	95–100	90–100	20–40	2. 5–5. 0	. 13	6. 5–7. 5	Low.
SM	A–2	95–100	90–100	20–35	0. 8–2. 5	. 11	7. 0–8. 0	Low.
SM, ML, or CL	A–2, A–4, or A–6	100	95–100	30–80	0. 8–5. 0	. 17	6. 5–7. 5	Low to moderate.
SM or SP–SM	A–2	100	90–100	5–15	5. 0–10. 0	. 06	6. 5–7. 5	Low.
SM	A–2	90–100	85–100	10–25	5. 0–10. 0	. 08	6. 0–7. 0	Low.
SM	A–2	50–95	40–95	10–25	5. 0–10. 0	. 06	6. 5–7. 5	Low.
GW or SW	A–1	20–70	15–70	0–5	10. 0+	. 02	7. 5–8. 0	Low.
SP	A–3	100	95–100	0–5	10. 0+	. 04	4. 5–6. 5	Low.
Pt					5. 0–10. 0	. 50	3. 5–5. 0	Low.
SP–SM or SM	A–2 or A–3	95–100	90–100	5–25	5. 0–10. 0+	. 04	5. 0–7. 5	Low.
CL or SC	A–6	95–100	90–100	40–80	0. 05–0. 8	. 17	6. 0–8. 0	Moderate.
Pt					2. 5–5. 0	. 50	5. 0–7. 0	Moderate.
SM or SP	A–2	100	95–100	2–30	5. 0–10. 0+	. 07	5. 0–6. 5	Low.
SP or SP–SM	A–3	100	95–100	0–10	10. 0+	. 06	5. 0–7. 0	Low.
CL, SC, or ML	A–6 or A–4	95–100	90–100	40–90	0. 2–2. 5	. 17	7. 0–8. 0	Moderate.
ML or CL	A–4 or A–6	95–100	90–100	60–80	0. 8–2. 5	. 15	4. 5–6. 0	Moderate.
SM	A–2	95–100	90–100	20–35	2. 5–5. 0	. 08	4. 5–6. 0	Low.
SC	A–6 or A–2	95–100	90–100	30–50	0. 8–2. 5	. 17	5. 0–7. 0	Moderate.
SC	A–6 or A–2	95–100	90–100	30–40	0. 2–2. 5	. 16	7. 0–8. 0	Moderate.
SM or SP–SM	A–2	85–100	80–100	5–15	5. 0–10. 0	. 06	4. 5–6. 0	Low.
SP	A–3	95–100	90–100	0–5	5. 0–10. 0	. 05	5. 0–6. 5	Low.
SP	A–3	100	95–100	0–5	10. 0+	. 04	5. 5–6. 5	Low.
SM, ML, or CL	A–4	95–100	90–100	35–70	0. 8–2. 5	. 18	6. 0–7. 0	Low.
CL or CH	A–6 or A–7	95–100	90–100	70–90	0. 05–0. 8	. 18	6. 5–7. 5	Moderate to high.
CL	A–6	95–100	90–100	70–90	0. 05–0. 8	. 17	7. 5–8. 0	Moderate.
ML, CL, or SM	A–4 or A–2	100	95–100	30–75	0. 8–2. 5	. 19	6. 0–7. 0	Low.
CH	A–7	100	95–100	60–95	0. 05–0. 2	. 17	6. 5–7. 5	High.
CH	A–7	100	95–100	70–95	0–0. 2	. 16	7. 5–8. 0	High.
Pt					[11]	. 50	6. 0–7. 5	Moderate.
[12]	[12]	100	95–100	0–50	[11]	[11]	6. 0–7. 5	Variable.
SP–SM or SP	A–3 or A–2	100	95–100	0–10	10. 0+	. 06	4. 0–5. 5	Low.
SP	A–3	100	95–100	0–5	10. 0+	. 04	4. 0–6. 0	Low.

TABLE 5.—*Estimated*

Soil series and map symbol	Depth to water table [1]	Depth from surface [2]	Classification
			USDA texture
	Feet	*Inches*	
Linwood (Lm)	0–2	0–23	Muck or peat; loam overwash in some areas
		23–60	Fine sandy loam, silt loam, clay loam, or silty clay loam
Loxley (Lo)	0–2	0–44	Muck or peaty muck
Lupton (Lu)	0–2	0–42	Muck
Mancelona (MaA, MaB, MaC, MaD, MaE, McA)	4–30	0–40	Loamy sand or sandy loam
		40–60	Sand and gravel
Manistee (MdB, MdC, MdD)	4–30	0–8	Loamy sand
		8–30	Sand or loamy sand
		30–60	Silty clay or clay
Markey (Me)	0–3	0–28	Muck
		28–60	Sand
McBride (MgC, MlB, MlC, MlC2, MlD, MlD2, MlE, MmA, MmB, MmB2, MmC, MmC2, MmD, MmD2, MmD3, MmE, MmE2, MmE3, MnB, MnC, MoF).	4–30	0–28	Sandy loam, loamy sand, or gravelly sandy loam
		28–52	Sandy clay loam
		52–60	Sandy loam
Menominee (MpA, MpB, MpC, MpC2, MpD, MpD2, MpE).	4–30	0–9	Loamy sand or sand
		9–35	Sand
		35–60	Loam, sandy clay loam, clay loam, or silty clay loam
Montcalm (MrB, MrC, MrD, MrE, MsB, MsC, MsC2, MsC3, MsD, MsD2, MsD3, MsE, MtB, MtC, MtD, MuB, MuC, MuD, MuE, MvF).	4–30	0–36	Loamy sand, gravelly loamy sand, or sandy loam
		36–60	Alternate layers: Sand, 2 to 8 inches thick Loamy sand to sandy loam, ½ inch to 3 inches thick
Munuscong (Mw)	0–3	0–8	Fine sandy loam
		8–30	Fine sandy loam or sandy loam
		30–60	Silty clay or clay
Nester (NaC3, NaD3, NaE3, NcC, NeA, NeB, NeB2, NeC, NeC2, NeD, NeD2, NlB, NlC, NlD, NmA, NmB, NmB2, NmC, NmC2, NmD, NmD2, NnC, NoB, NrE, NrE2, NrF).	4–30	0–8	Loam, sandy loam, gravelly loam, loamy sand or clay loam (eroded areas).
		8–26	Heavy clay loam, silty clay, or clay
		26–60	Clay loam or silty clay loam
Newaygo (NsB, NsD)	4–20	0–21	Sandy loam
		21–33	Sandy clay loam or gravelly clay loam
		33–60	Gravel and sand
Ogemaw (OgA)	0–6	0–11	Loamy sand or sand
		11–19	Sand, cemented
		19–30	Sand
		30–60	Loam, clay loam, silty clay loam, or clay
Otisco (OsA, OsB, OtA, OtB)	2–8	0–8	Loamy sand
		8–17	Loamy sand
		17–44	Alternate layers: Loamy sand or sand, 2 to 6 inches thick Sticky sandy loam to sandy clay loam about 3 inches thick.
		44–60	Loamy sand
Pickford (Pc, Pk)	0–3	0–8	Silty clay loam and fine sandy loam
		8–19	Silty clay or clay
		19–60	Silty clay or clay
Pinconning (Pn)		0–7	Loamy sand
		7–25	Sand or loamy sand
		25–60	Silty clay or clay
Richter (RcB)	2–8	0–13	Sandy loam or loamy sand
		13–28	Heavy sandy loam to sandy clay loam
		28–60	Stratified; mostly sandy loam

See footnotes at end of table.

properties of the soils—Continued

Classification—Continued		Percentage passing sieve—			Permeability [3]	Available water capacity [4]	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH value*	
[13]	[13]				5. 0–10. 0	. 50	5. 0–7. 0	Moderate.
SM, ML, or CL	A–4 or A–6	95–100	90–100	45–90	0. 2–2. 5	. 17	6. 0–8. 0	Moderate to low.
Pt					5. 0–10. 0	. 50	4. 0–5. 5	Low.
Pt					2. 5–5. 0	. 50	7. 0–8. 0	Moderate.
SM	A–2	60–95	55–95	15–35	2. 5–10. 0	. 10	5–5–7. 0	Low.
GP or SP	A–1	20–60	10–60	0–5	10. 0+	. 02	7. 0–8. 0	Low.
SM	A–2	100	95–100	15–25	5. 0–10. 0	. 07	5. 0–6. 5	Low.
SM or SP–SM	A–3 or A–2	100	95–100	5–25	5. 0–10. 0+	. 06	5. 5–7. 0	Low.
CH	A–7	100	95–100	75–95	0–0. 2	. 16	7. 0–8. 0	High.
Pt					5. 0–10. 0	. 50	7. 0–8. 0	Moderate.
SP	A–3	100	95–100	0–5	10. 0+	. 03	7. 0–8. 0	Low.
SM	A–2 or A–4	90–100	80–100	25–45	0. 2–2. 5	. 13	4. 5–6. 0	Low.
SC	A–6 or A–2	95–100	95–100	20–45	0. 8–2. 5	. 15	5. 5–7. 0	Low to moderate.
SM	A–2 to A–4	[14]	[14]	[14]	0. 8–2. 5	. 10	7. 0–8. 0	Low.
SM or SP–SM	A–2	100	95–100	5–20	5. 0–10. 0	. 08	4. 5–6. 0	Low.
SP–SM or SP	A–3 or A–2	100	95–100	0–10	5. 0–10. 0+	. 02	5. 0–6. 5	Low.
CL	A–6	95–100	90–100	70–90	0. 2–2. 5	. 17	7. 0–8. 0	Moderate.
SM	A–2	85–100	75–100	15–35	2. 5–5. 0	. 08	4. 5–6. 0	Low.
SP–SM or SP	A–3 or A–2	95–100	95–100	0–10	5. 0–10. 0	. 04	5. 0–7. 0	Low.
SM	A–2	95–100	95–100	15–30	2. 5–5. 0	. 07	5. 5–7. 0	Low.
SM	A–4	95–100	90–100	35–50	0. 8–2. 5	. 19	6. 0–7. 0	Low.
SM	A–4	95–100	90–100	35–50	0. 8–2. 5	. 16	6. 5–7. 5	Low.
CH	A–7	100	95–100	75–90	0–0. 2	. 17	7. 5–8. 0	High.
SM or CL	A–4, A–2, or A–6	95–100	80–100	20–70	0. 8–2. 5	. 17	6. 0–7. 0	Low.
CL or CH	A–6 or A–7	100	95–100	60–85	0. 2–0. 8	. 17	6. 6–7. 5	High to moderate.
CL	A–6	100	95–100	55–85	0. 05–0. 8	. 17	7. 5–8. 0	Moderate.
SM	A–2 or A–4	90–100	85–95	25–45	0. 8–2. 5	. 13	5. 5–6. 5	Low.
SC	A–6 or A–2	80–90	70–85	25–45	2. 5–5. 0	. 16	6. 0–7. 5	Low to moderate.
GW, GP or SP	A–1	10–60	10–60	0–5	10. 0+	. 02	7. 5–8. 0	Low.
SM or SP–SM	A–2	100	95–100	10–25	5. 0–10. 0	. 06	4. 5–6. 0	Low.
SP–SM	A–3 or A–2	100	95–100	2–10	0. 2–2. 5	. 04	4. 5–6. 0	Low.
SP	A–3	100	95–100	0–5	5. 0–10. 0+	. 02	5. 0–6. 5	Low.
ML–CL or CL	A–6	95–100	90–100	60–90	0. 2–2. 5	. 17	7. 0–8. 0	Moderate.
SM	A–2	95–100	90–100	15–25	2. 5–5. 0	. 07	4. 5–6. 0	Low.
SM	A–2	95–100	90–100	15–25	2. 5–5. 0	. 06	4. 5–6. 0	Low.
SM or SP–SM	A–2	95–100	90–100	5–20	5. 0–10. 0	. 05	5. 0–6. 5	Low.
SM or SC	A–6 or A–2	95–100	90–100	15–45	0. 8–5. 0	. 11	5. 5–7. 0	Low to moderate.
SM	A–2	95–100	90–100	15–25	2. 5–5. 0	. 08	7. 0–8. 0	Low.
CL or SM	A–6 or A–4	100	95–100	40–90	0. 2–1. 5	. 18	6. 0–7. 0	Moderate.
CH	A–7	100	100	75–95	0. 05–0. 2	. 17	6. 5–7. 5	High.
CH	A–7	100	100	75–95	0–0. 2	. 16	7. 5–8. 0	High.
SM	A–2	100	95–100	15–25	5. 0–10. 0	. 10	6. 0–7. 0	Low.
SP or SM	A–3 or A–2	100	95–100	2–20	5. 0–10. 0+	. 04	6. 0–7. 5	Low.
CH	A–7	100	95–100	70–95	0–0. 2	. 16	7. 5–8. 0	High.
SM	A–4 or A–2	100	95–100	20–45	2. 5–5. 0	. 14	5. 5–7. 0	Low.
SM or SC	A–6 or A–2	100	95–100	15–40	2. 5–5. 0	. 16	6. 0–7. 5	Low to moderate.
SM	[15]	100	95–100	[15]	2. 5–5. 0	10	7. 0–8. 0	Low.

TABLE 5.—*Estimated*

Soil series and map symbol	Depth to water table [1]	Depth from surface [2]	Classification
			USDA texture
	Feet	*Inches*	
Rifle (Re, Rf, Rl)	0–2	0–14	Muck or peat
		14–50	Peat
Roscommon (Rm)	0–3	0–4	Mucky sand, sand, or loamy sand
		4–60	Sand
Rousseau (RnB, RnC, RnD)	4–30	0–11	Loamy fine sand or fine sand
		11–24	Loamy fine sand or fine sand
		24–60	Loamy fine sand or fine sand
Rubicon:			
Normal (RoB, RoC, RoD, RoE, RoF)	4–30	0–2	Sand
		2–60	Sand
Loamy substratum (RuB, RuC, RuD, RuE)	4–30	0–8	Loamy sand or sand
		8–54	Sand
		54–60	Loam, clay loam, silty clay loam, silty clay, or clay
Saranac (Sa)	0–3	0–9	Clay loam or loam
			Loamy sand or sand
		9–60	Clay loam or silty clay loam
Saugatuck (ScB)	0–6	0–15	Sand
		15–31	Sand, cemented
		31–60	Sand
Selkirk (SeA, SeB)	2–8	0–11	Loam or silt loam
		11–22	Silty clay or clay
		22–60	Silty clay or clay
Shoals (Sh, Sl)	2–8	0–8	Loam, sandy loam, or silt loam
		8–60	Stratified loam, silt loam, and sandy loam
Sims (Sm, Sn, So, Ss)	0–3	0–7	Loam, clay loam, or sandy loam
		7–32	Heavy clay loam or silty clay loam
		32–60	Clay loam or silty clay loam
Sloan (St)	0–3	0–27	Loam
		27–60	Stratified loam, sandy loam, and loamy sand
Tawas (Ta, Tc, Tp)	0–3	0–14	Muck, peat, or loam
		14–22	Muck or peat
		22–60	Sand or loamy sand
Tonkey (mapped only in undifferentiated units with Edmore and Ensley soils.)	0–3	0–7	Loam and sandy loam
		7–60	Stratified sandy loam, loamy sand, and sandy clay loam
Traverse (Tr)	3–10	0–29	Sandy loam or loam
		29–44	Loamy sand
		44–60	Loamy sand
Twining (TwA, TwB)	2–8	0–16	Sandy loam to loam
		16–37	Heavy sandy clay loam or sandy clay
		37–60	Sandy clay loam
Ubly:			
Normal (UbB, UbC, UbD)	4–30	0–30	Sandy loam or fine sandy loam
		30–60	Loam, clay loam, silty clay loam, or sandy clay loam
Clay subsoil variant (UlB, UlC)	4–30	0–20	Fine sandy loam
		20–37	Fine sandy loam to sandy clay loam
		37–60	Silty clay to clay
Wallace (WaB, WaD)	4–15	0–7	Sand
		7–30	Sand, cemented
		30–60	Sand

See footnotes at end of table.

properties of the soils—Continued

Classification—Continued		Percentage passing sieve—			Permeability [3]	Available water capacity [4]	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH value*	
Pt					5. 0–10. 0	. 05	4. 5–6. 5	Low.
Pt					5. 0–10. 0	. 05	4. 5–6. 5	Low.
SP–SM or SM	A–2 or A–3	100	95–100	2–20	10. 0+	. 10	5. 5–7. 0	Low.
SP	A–3	100	95–100	0–5	10. 0+	. 04	5. 5–7. 0	Low.
SM	A–2	100	95–100	15–35	5. 0–10. 0	. 07	4. 5–6. 0	Low.
SM	A–2	100	95–100	15–35	5. 0–10. 0	. 05	5. 0–6. 0	Low.
SM	A–2	100	95–100	15–35	5. 0–10. 0	. 05	6. 0–7. 5	Low.
SP or SP–SM	A–3	100	95–100	2–10	10. 0+	. 06	4. 5–6. 0	Low.
SP	A–3	100	95–100	0–5	10. 0+	. 04	5. 5–7. 0	Low.
SM or SP–SM	A–2 or A–3	100	95–100	5–20	5. 0–10. 0	. 06	4. 5–6. 0	Low.
SP	A–3	100	95–100	0–5	10. 0+	. 04	5. 0–6. 5	Low.
CL or CH	A–6 or A–7	95–100	90–100	70–95	0–1. 5	. 17	7. 0–8. 0	Moderate to high.
CL or ML	A–6 or A–4	100	95–100	60–80	0. 8 to 2. 5	. 21	6. 5–7. 5	Moderate.
SM or SP–SM	A–2	100	95–100	5–20	2. 5–5. 0	. 06	6. 5–7. 5	Low.
CL	A–6	100	95–100	70–95	0. 05–0. 8	. 17	6. 5–7. 5	Moderate.
SP–SM or SP	A–3	100	95–100	2–10	10. 0+	. 06	4. 5–6. 5	Low.
SP	A–3	100	95–100	2–5	0. 2–2. 5	. 03	4. 5–6. 5	Low.
SP	A–3	100	95–100	0–5	10. 0+	. 02	5. 5–7. 0	Low.
CL or ML	A–4 or A–6	100	95–100	60–90	0. 8–1. 5	. 20	6. 0–7. 0	Moderate to low.
CH	A–7	100	95–100	70–95	0. 05–0. 2	. 17	6. 5–7. 5	High.
CH	A–7	100	95–100	70–95	0–0. 2	. 16	7. 5–8. 0	High.
SM or ML	A–2 or A–4	100	100	35–60	0. 8–2. 5	. 16	6. 0–7. 8	Low.
SM or ML	A–2 or A–4	100	100	35–60	0. 8–2. 5	. 16	6. 6–8. 0	Low.
CL or SM	A–6 or A–4	100	95–100	35–80	0. 8–1. 5	. 20	6. 5–7. 5	Moderate to low.
CL	A–6	100	90–100	70–90	0. 2–0. 8	. 18	7. 0–7. 8	Moderate.
CL	A–6	100	90–100	70–90	0. 05–0. 2	. 17	7. 5–8. 0	Moderate.
SM or ML	A–2 or A–4	100	100	35–60	0. 8–2. 5	. 16	6. 5–7. 5	Low.
SM or ML	A–2 or A–4	100	95–100	20–60	2. 5–5. 0	. 10	7. 5–8. 0	Low.
[16]	[16]				5. 0–10. 0	. 50	5. 0–7. 0	Moderate.
Pt					5. 0–10. 0	. 50	5. 0–7. 0	Moderate.
SP or SM	A–3 or A–2	100	95–100	0–15	5. 0–10. 0+	. 03	6. 0–7. 5	Low.
ML or SM	A–2 or A–4	100	95–100	25–60	2. 5–5. 0	. 15	6. 0–7. 5	Low.
SM	[17]	100	95–100	[17]	2. 5–5. 0	. 10	7. 0–8. 0	Low.
SM or ML	A–4	95–100	90–100	35–65	2. 5–5. 0	. 16	5. 5–7. 0	Low.
SM	A–2	95–100	90–100	15–30	5. 0–10. 0	. 08	5. 5–7. 0	Low.
SM	A–2	100	95–100	15–25	5. 0–10. 0	. 06	5. 0–7. 5	Low.
ML or SM	A–4	95–100	90–100	40–75	0. 8–2. 5	. 16	5. 0–6. 0	Low.
SC or CL	A–6	95–100	90–100	35–60	0. 2–0. 8	. 18	5. 0–6. 5	Moderate.
SC	A–6	95–100	90–100	35–50	0. 2–1. 5	. 16	7. 0–8. 0	Moderate to low.
SM	A–4 or A–2	90–100	85–95	25–45	2. 5–5. 0	. 12	5. 0–6. 5	Low.
ML or CL	A–4 or A–6	95–100	90–100	70–90	0. 05–1. 5	. 17	7. 0–8. 0	Moderate.
SM	A–4 or A–2	95–100	90–100	25–45	0. 8–2. 5	. 13	5. 0–6. 5	Low.
SM or SC	A–4 or A–2	95–100	90–100	25–45	0. 8–2. 5	. 14	5. 5–7. 0	Low.
CH	A–7	100	95–100	70–95	0–0. 2	. 16	7. 0–8. 0	High.
SP or SP–SM	A–3	100	95–100	2–10	5. 0–10. 0	. 03	4. 5–6. 0	Low.
SP	A–3	100	95–100	2–5	0. 2–2. 5	. 03	4. 5–6. 0	Low.
SP	A–3	100	95–100	0–5	10. 0+	. 02	5. 5–7. 0	Low.

TABLE 5.—*Estimated*

Soil series and map symbol	Depth to water table [1]	Depth from surface [2]	Classification: USDA texture
	Feet	*Inches*	
Warners (We)	0–3	0–7	Muck, marl, or loam
		7–42	Marl
		42–60	Variable mineral material; sandy in most places
Wheatley (Wh, Wk)	0–3	0–7	Loamy sand, sandy loam, or mucky loamy sand
		7–20	Loamy sand or sand
		20–60	Sand and fine gravel
Willette (Wl)	0–2	0–8	Muck or loam
		8–25	Muck or peat
		25–60	Silty clay to clay
Wind eroded land (WnC, WnF)	3–30	0–60	Loamy sand to sand

[1] Estimated depth to water table assumes that no artificial drainage practices are in operation. Prolonged extremely wet or dry periods might result in depths outside the ranges given.

[2] The depths given here represent typical profiles of the soils in Osceola County. Variations, mostly of a magnitude of 1 foot or less in the depths to and thickness of the various layers occur in most areas. All of the organic soils are classified on the basis of the upper 42 inches of soil material. Many of them are variable below that depth. The Roscommon soil also is variable below 42 inches. For all the soils, however, data are provided that characterize the materials most commonly occurring at a depth of 42 to 60 inches.

[3] Estimates of permeability are based on soil texture and structure, as they are known to influence the downward movement of water.

[4] Estimates of available water capacity are based on the general relationships, influenced primarily by soil texture and organic-matter content, and are coordinated with field observations of comparative plant growth.

[5] Depends on the season.

[6] The sand in this layer has a Unified classification of SP and an AASHO classification of A–3; the material in the bands has a Unified classification of SM and an AASHO classification of A–2 to A–4. In the same layer, only 0 to 10 percent of the sand, but 20 to 50 percent of the material in the bands, passes a No. 200 sieve.

[7] The silt has a Unified classification of ML, and the coarser textured material has a Unified classification of SM.

[8] In this layer 70 to 90 percent of the silt, but only 40 to 50 percent of the coarser textured material, passes a No. 200 sieve.

[9] In this layer the sand has a Unified classification of SP and an AASHO classification of A–3; the loamy sand in the bands has a Unified classification of SP–SM or SM and an AASHO classification of A–2. In the same layer, only 0 to 5 percent of the sand, but 5 to 15 percent of the loamy sand, passes a No. 200 sieve.

[10] Variable, but between 0.8 and 5.0.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Abscota (Ab, Ac)	Poor	Fair to poor; several layers of loamy sand.	Unsuitable	Good	Soil on flood plains; occasional flooding.	No unfavorable features.
Adrian (Ad)	Fair to poor; organic soil.	Good below the organic layers (12 to 42 inches).	Unsuitable	Unsuitable; organic material to a depth of 12 to 42 inches; wet sand below.	Organic soils; high water table.	Organic soil; high water table; low stability.

See footnotes at end of table.

properties of the soils—Continued

Classification—Continued		Percentage passing sieve—			Permeability [3]	Available water capacity [4]	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH value*	
Pt or ML	[18]				2. 5–5. 0	. 50	7. 8–8. 4	Low.
					2. 5–5. 0	[11]	7. 8–8. 4	Low.
[19]	[19]	[11]	[11]	[11]	[11]	[11]	7. 8–8. 4	Variable.
SM	A–2	85–95	80–95	15–35	2. 5–5. 0	. 13	6. 5–7. 8	Low.
SM	A–2	85–95	80–90	15–25	5. 0–10. 0	. 07	7. 0–8. 0	Low.
GW or SW	A–1	20–80	10–80	0–5	10. 0+	. 03	7. 5–8 0	Low.
Pt or ML	[18]				5. 0–10. 0	. 50	5. 0–7. 0	Low.
Pt					5. 0–10. 0	. 50	5. 0–7. 0	Moderate.
CH	A–7	100	95–100	70–95	0–0. 2	. 16	5. 5–8. 0	High.
SM or SP–SM	A–2	100	95–100	5–25	2. 5–10. 0	. 05	5. 0–7. 5	Low.

[11] Variable.
[12] Variable, but the Unified classification is generally SP or SM and the AASHO classification is generally A–2 or A–3.
[13] The muck or peat has a Unified classification of Pt; the overwash generally has a Unified classification of SM and an AASHO classification of A–4.
[14] Between depths of 48 and 60 inches in the MmE2, MmE3, MnB, MnC, and MoF mapping units, 80 to 95 percent of the soil material passes a No. 4 sieve; 75 to 90 percent passes a No. 10 sieve; and 20 to 45 percent passes a No. 200 sieve. In the other McBride mapping units, 95 to 100 percent passes No. 4 and No. 10 sieves, and only 20 to 40 percent passes a No. 200 sieve.
[15] The sandy loam has an AASHO classification of A–4, but the material in the thin layers has an AASHO classification of A–2. In this same layer, 15 to 40 percent of the sandy loam, but as little as 5 percent of the coarser textured material in the thin layers, passes a No. 200 sieve.
[16] The muck and peat have a Unified classification of Pt. The overwash has a Unified classification of ML and an AASHO classification of A–4. Because this is an organic soil, estimates are not given of the amount passing sieves of various sizes.
[17] The material in this horizon is stratified. The AASHO classification is A–4 or A–2, depending on the texture of the material in the thin layers. Generally, 20 to 40 percent of the sandy loam and loamy sand, but as little as 5 percent of the material in the thin layers, passes a No. 200 sieve.
[18] A–4 or organic.
[19] Variable, but the Unified classification is mostly SM and the AASHO classification is mostly A–2.

of the soils

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
High seepage rate; occasional flooding.	High seepage rate; sandy.	Occasional flooding.	Occasional flooding; very rapid permeability; drainage not needed.	Low water-holding capacity; rapid intake rate.	Occurs on flood plains; not needed.	Soil on flood plains; low available water capacity; generally not needed.
Water table usually near the surface; high seepage rate.	Upper 12 to 42 inches is organic materials unsuited; sand below has high seepage rate; low stability.	High water table.	Drainage needed for crops; organic material and sand make tiling difficult; ditching is generally the best practice; control of water table needed to prevent overdrainage.	Rapid intake rate; very high water-holding capacity.	Wet organic soil; not needed.	Wet organic soil in depressions; generally not needed.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Algansee (Ae, Ag)	Fair	Fair to poor; stratified sand and loamy sand.	Unsuitable	Fair; wet in many places below 2 to 4 feet; good if not too wet.	Occasional flooding; seasonal high water table; occurs on flood plains.	Seasonal high water table; hazard of piping.
Allendale (AlB, AmB)	Fair in upper 6 to 8 inches.	Poor to fair; sandy to a depth of 18 to 42 inches.	Unsuitable	Good in upper 18 to 42 inches; poor below 42 inches (fine texture).	Seasonal high water table.	High shrink-swell potential and low bearing capacity below depth of 18 to 42 inches.
Au Gres:						
Normal (ArB)	Poor; very sandy.	Good; mostly medium sand, but some fine sand; poorly graded.	Unsuitable	Good; wet sand below 3 to 4 feet.	Seasonal high water table.	Hazard of piping; seasonal high water table.
Loamy substratum (AuB)	Poor; very sandy.	Fair; sand to a depth of 42 to 66 inches.	Unsuitable	Upper 42 to 66 inches, good; deeper layers fair to poor.	Seasonal high water table.	Hazard of piping above 42 to 66 inches; seasonal high water table.
Belding:						
Normal (BdA, BdB)	Upper 8 to 10 inches good.	Unsuitable	Unsuitable	Fair; wet and slightly plastic below 3 to to 4 feet in most places.	Seasonal high water table.	Some heaving by frost; seasonal high water table.
Clay subsoil variant (BeB).	Upper 6 to 10 inches good.	Unsuitable	Unsuitable	Fair; wet and highly plastic below 3 to 4 feet in most places.	Seasonal high water table.	Seasonal high water table; moderate heaving by frost; high shrink-swell below 18 to 42 inches.

See footnotes at end of table.

of the soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
High seepage rate; occasional flooding.	High seepage rate; sandy.	Seasonal high water table.	Somewhat poorly drained; drainage needed for most crops; sandy soil, rapid permeability; occasional flooding.	Low water-holding capacity; rapid intake rate.	Occurs on flood plains; not needed.	Occurs on flood plains; generally not needed.
High seepage rate in sand above depth of 18 to 42 inches; slowly permeable below.	High seepage rate in sand above depth of 18 to 42 inches; underlying clay, unstable when wet, high shrink-swell potential.	Seasonal high water table; slow permeability below depth of 18 to 42 inches.	Silty clay or clay below depth of 18 to 42 inches has slow permeability; tiling generally is satisfactory; seasonal high water table.	Low water-holding capacity; rapid intake rate.	Most areas nearly level; a few gentle short and irregular slopes; not needed.	Low available water capacity causes difficulty in establishing vegetation.
High seepage rate.	High seepage rate; very sandy.	Seasonal high water table.	Seasonal high water table; sand causes difficulty in tiling; good lateral movement of water.	Very low water-holding capacity; rapid intake rate; frequent irrigation required.	Very sandy; little runoff; not needed.	Low available water capacity, low fertility, and erodibility cause difficulty in establishing vegetation.
High seepage rate in sand to depth of 42 to 66 inches; slow seepage rate in deeper layers.	Sand has high seepage rate; material below 42 to 66 inches is suitable.	Seasonal high water table; moderate to slow permeability below 42 to 66 inches.	Seasonal high water table; sand to a depth of 42 to 66 inches makes tiling difficult; good lateral movement of water.	Low water-holding capacity; rapid intake rate.	Very sandy; little runoff; most areas nearly level; not needed.	Low available water capacity and low fertility cause difficulty in establishing vegetation.
Moderate seepage rate in upper 18 to 42 inches; slow in deeper layers.	Good compaction properties; mixture of upper 18 to 42 inches with finer material below gives fill that has low seepage rate.	Seasonal high water table; moderate to slow permeability below 18 to 42 inches.	Seasonal high water-table; tile is satisfactory; relief is undulating, and random lines are adequate in many fields.	Moderate water-holding capacity; moderate intake rate.	Most areas are nearly level; some are gently sloping and slopes are short and irregular; not needed.	No unfavorable features.
Moderate seepage rate to a depth of 18 to 42 inches; slow in deeper layers.	Good compaction properties to a depth of 18 to 42 inches; deeper clay has low stability and high shrink-swell potential.	Seasonal high water table; slow or very slow permeability below a depth of 18 to 42 inches.	Somewhat poorly drained; slow or very slow permeability below a depth of 18 to 42 inches.	Moderate water-holding capacity; moderate intake rate; slow permeability below a depth of 18 to 42 inches.	Most areas are nearly level; most slopes are short and irregular; not needed in most areas.	Runoff is likely to be high, as a result of slow permeability in the substratum.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Bergland (Bg)	Upper 10 to 12 inches good but sticky and difficult to handle.	Unsuitable	Unsuitable	Unsuitable; highly plastic; high water table.	High water table; highly plastic; sometimes ponded.	Low bearing capacity; high shrink-swell potential; severe heaving by frost; poor shear strength.
Blue Lake (BlA, BlB, BlC, BlD, BlE).	Poor	Fair to poor; sand and 10 to 20 percent fines to a depth of 4 to 5 feet; better below 5 feet in most places.	Unsuitable	Good, but easily eroded.	No unfavorable features.	No unfavorable features.
Bohemian (BoB, BoC, BoD).	Fair in upper 6 to 8 inches.	Unsuitable	Unsuitable	Poor; poor compaction properties; unstable; should be placed at least 3 feet below earth grade.	Unstable silt and very fine sand; subject to heaving by frost.	Low bearing capacity; severe heaving by frost.
Brevort (Br, Bt, Bv)	Fair in upper 4 to 6 inches.	Fair to poor; sandy to a depth of 18 to 42 inches.	Unsuitable	Fair; wet in most places below 1 to 2 feet; good if not wet.	High water table; occasional ponding.	High water table.
Brimley (ByB)	Good in upper 6 to 8 inches.	Unsuitable	Unsuitable	Poor; poor compaction properties; unstable; should be placed at least 3 feet below earth grade.	Unstable silt and very fine sand; subject to heaving by frost; seasonal high water table.	Low bearing capacity; high hazard of heaving by frost; hazard of piping.
Carbondale (CaA, CbA, CbC, CdA).	Fair to poor; slightly to moderately decomposed organic soil.	Unsuitable	Unsuitable	Unsuitable	Organic soil; high water table.	Unstable; organic soil; high water table.

See footnotes at end of table.

of the soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Little seepage; slow or very slow permeability.	High shrink-swell potential; slow seepage rate.	Slow or very slow permeability.	Slow or very slow permeability; naturally poorly drained.	High water-holding capacity; moderate intake rate unless wet or crusted; slow or very slow permeability.	Level or in depressions; not needed.	Wet; plants suited to wet soil are needed.
High seepage rate.	Compacted fill has moderate permeability.	No unfavorable features.	Well drained to moderately well drained; not needed.	Low water-holding capacity; rapid intake rate.	Moderately rapid to rapid permeability.	Erodibility and low water-holding capacity cause difficulty in establishing vegetation.
Moderate seepage rate; sandy layers in some places.	Low strength and stability; moderate seepage rate.	Moderate permeability.	Well drained; not needed.	Moderate to slow intake rate; high water-holding capacity.	Most slopes are short, some are irregular; no other unfavorable features.	Highly erodible.
Sandy, and high seepage rate to a depth of 18 to 42 inches; moderate to slow seepage rate in deeper layers.	High seepage rate to a depth of 18 to 42 inches; deeper material compacts well.	High water table; moderate to moderately slow permeability below a depth of 18 to 42 inches.	Naturally poorly drained; moderate to moderately slow permeability; sandy soil to a depth of 18 to 42 inches makes tiling difficult; good outlets not available in many areas.	Low water-holding capacity; high intake rate.	Level or in depressions; not needed.	Wet; plants suited to wet soil are needed.
Moderate seepage rate; sandy layers in some places.	Low strength and stability; moderate seepage rate.	Seasonal high water table; moderate permeability.	Somewhat poorly drained; moderately permeable; ditchbanks are unstable.	Medium to slow intake rate; high water-holding capacity.	Most areas are level; some are gently sloping, and slopes are short; not needed.	Highly erodible.
Water table near the surface most of the time; high seepage rate.	Organic material; not suitable.	High water table.	Very poorly drained; organic material is unstable; ditches generally are adequate for drainage; structures to control water table are desirable to prevent over-drainage.	High intake rate; very high water-holding capacity.	Level or in depressions; not needed.	Level or in depressions; generally not needed.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Chelsea (ChB, ChC, ChD, ChE, ChF, ClB, ClC, ClD).	Unsuitable or poor.	Good; mostly poorly graded medium to fine sand; few lenses of finer sand.	Unsuitable	Good, but easily eroded.	Subject to wind erosion if bare; no other unfavorable features.	No unfavorable features.
Coral (CoA, CoB)	Good in upper 6 to 8 inches.	Unsuitable	Unsuitable	Fair; wet below a depth of 3 to to 4 feet in most places; good if not wet.	Seasonal high water table; slight heaving by frost.	Seasonal high water table; slight heaving by frost.
Croswell (CrB, CrC)	Unsuitable; very sandy.	Good; mostly poorly graded medium and fine sand.	Unsuitable	Good, but easily eroded by water and wind.	Water table within 2½ feet for a short time in most years; no other unfavorable features.	Water table less than 2½ feet below the surface for a short time in most years.
Dawson (Da)	Unsuitable	Fair; sand covered by 12 to 42 inches of organic material.	Unsuitable	Unsuitable	Organic soil; high water table.	Unstable; organic soil; high water table.
Dighton (DgB, DgC, DgD2).	Fair in upper 6 to 8 inches.	Fair to poor; 18 to 42 inches of fine material over sand that contains some fine material.	Unsuitable	Fair in upper 18 to 42 inches; good in deeper layers.	No unfavorable features.	No unfavorable features.
East Lake (EaB, EaC, EaD, ElA).	Poor	Good; mixture of fine to coarse sand and fine gravel.	Fair; contains much sand; most gravel is fine.	Good	Subject to wind erosion if left bare; no other unfavorable features.	No unfavorable features.
Edmore (Em). (For Tonkey part, refer to Tonkey series).	Good in upper 10 to 12 inches.	Poor; typically loamy sand, 10 to 25 percent silt and clay.	Unsuitable	Poor; wet most of the time; fair to good if not wet.	High water table; ponded occasionally.	High water table; moderate heaving by frost; moderate bearing capacity.

See footnotes at end of table.

of the soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
High seepage rate.	High seepage rate; very sandy.	No unfavorable features.	Excessively drained; not needed.	Very low water-holding capacity; rapid intake rate; poor soil for crops.	Very sandy; little runoff; most slopes short and irregular; generally not needed.	Low available water capacity causes difficulty in establishing vegetation; usually little runoff.
Moderate seepage rate.	Slow seepage rate in a well-compacted fill.	Seasonal high water table.	Somewhat poorly drained; moderate permeability; random tile lines are generally adequate.	Moderate water-holding capacity; moderate intake rate.	Most areas nearly level; most slopes short and irregular; generally not needed.	No unfavorable features.
High seepage rate.	High seepage rate; very sandy.	Water table less than 2½ feet below the surface for a short time in most years.	Well drained; not needed.	Very low water-holding capacity; rapid intake rate; poor soil for crops.	Very sandy; little runoff; not needed.	Low available water capacity; low fertility; little runoff.
Water table near the surface most of the time; high seepage rate.	Organic material to a depth of 12 to 42 inches is unsuitable; underlying sand has high seepage rate.	High water table.	Very poorly drained; unstable organic material to a depth of 12 to 42 inches; deeper material is sand; control of water table needed; ditches generally are adequate.	High water-holding capacity; high intake rate; very acid peat, generally not used for crops.	In depressions; not needed.	In depressions; generally not needed.
Slow seepage rate, except where sandy underlying material is exposed.	Soil to a depth of 18 to 42 inches has good compaction properties and slow seepage rate; deeper layers too sandy.	Moderate permeability to a depth of 18 to 42 inches; rapid permeability in deeper layers.	Well drained to moderately well drained; not needed.	High water-holding capacity; moderate intake rate.	Slopes in some areas are short and irregular; no other unfavorable features.	No unfavorable features.
High seepage rate.	High seepage rate; sandy and gravelly.	No unfavorable features.	Well drained; not needed.	Very low water-holding capacity; rapid intake rate; poor soil for crops.	Very sandy; little runoff; not needed.	Low available water capacity causes difficulty in establishing vegetation; usually little runoff.
High seepage rate; high, fluctuating water table.	High seepage rate.	High water table.	Poorly drained; moderately rapid permeability. Tile functions well if good outlets are available.	Low water-holding capacity; rapid intake rate.	Level or in depressions; not needed.	Erodible; wet; plants suited to wet soil are needed.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Edwards (Er)	Fair; organic soil; possible source of marl below 12 to 42 inches:	Unsuitable	Unsuitable	Unsuitable; organic material over marl.	Organic soil; high water table.	Unstable; organic soil; high water table.
Ensley (Es, Et). (For Tonkey part, refer to Tonkey series).	Good	Unsuitable	Unsuitable	Poor; wet most of the time; fair if not wet.	High water table; moderate heaving by frost; ponded occasionally.	High water table; moderate heaving by frost; moderate bearing capacity; moderate hazard of piping.
Evart (Eu, Ev)	Fair to good	Fair to poor; stratified sand and loamy sand.	Unsuitable	Poor; wet most of the time; fair if not wet.	On flood plains; occasional flooding; high water table.	High water table; moderate hazard of piping.
Gladwin (GaA, GaB, GdA, GdB).	Fair	Fair; loamy sand to a depth of 18 to 36 inches; deeper layers are loose sand and gravel.	Fair to good; contains some sand.	Good; wet below a depth of 3 to 4 feet some of the time.	Seasonal high water table.	Seasonal high water table; slight hazard of piping.
Grayling (GrB, GrC, GrE).	Unsuitable	Good; mostly poorly graded medium sand.	Unsuitable	Good, but droughty and easily eroded by wind.	Likely to be eroded by wind, if left bare; no other unfavorable features.	No unfavorable features.
Greenwood (Gt)	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Organic soil; high water table.	Unstable; organic soil; high water table.
Gullied land: Coarse textured (Gu)	Unsuitable	Fair; layers of loamy sand in most areas.	Poor; few pockets of gravel.	Good	Broken relief; no other unfavorable features.	Leveling needed in many areas; no other unfavorable features.
Moderately fine textured (Gx).	Unsuitable	Unsuitable	Unsuitable	Fair to poor	Broken relief; no other unfavorable features.	Moderate shrink-swell potential; moderate bearing capacity; leveling needed in many areas.

See footnotes at end of table.

of the soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Moderate to high seepage rate to a depth of 24 to 42 inches; variable rate in deeper layers.	Organic material and marl are unsuitable.	High water table.	Very poorly drained; sand and gravel lie under the marl in many places and make tiling difficult.	Very high water-holding capacity; rapid intake rate.	Level or in depressions; not needed.	Level or in depressions; not needed in most areas.
Moderate seepage rate; high fluctuating water table.	Good compaction properties; well-compacted fill has little seepage.	High water table.	Poorly drained; moderately rapid permeability; tile works well if outlets are adequate.	Moderate water-holding capacity; moderate intake rate.	Level or in depressions; not needed.	Erodible; plants should be those suited to a wet soil.
High seepage rate; high water table; occasional flooding.	High seepage rate; sandy.	High water table; occasional flooding.	Poorly drained; rapid permeability; sand causes difficulty in tiling; occasional flooding.	Low water-holding capacity; moderate to rapid intake rate.	On flood plains; not needed.	On flood plains; not needed in most areas.
High seepage rate.	High seepage rate; very sandy and gravelly.	Seasonal high water table.	Somewhat poorly drained; sand and gravel cause difficulty in tiling; rapid permeability.	Low water-holding capacity; rapid intake rate.	Little runoff; most areas nearly level; few gently sloping areas have short slopes; not needed.	Little runoff; generally not needed.
High seepage rate.	High seepage rate; very sandy.	No unfavorable features.	Well drained; not needed.	Very low water-holding capacity; rapid intake rate; poor soil for crops.	Very sandy; little runoff; not needed.	Rapid intake rate; not needed in most areas.
Water table near surface most of the time; high seepage rate.	Organic material; unsuitable.	High water table.	Very poorly drained organic soil; unstable; likely to subside if overdrained.	Very high water-holding capacity; rapid intake rate; very acid peat; not much use for crops.	In depressions; not needed.	In depressions; not needed.
High seepage rate.	High seepage rate; sandy.	No unfavorable features.	Well drained; not needed.	Low to very low water-holding capacity; rapid to medium intake rate.	Slopes short and irregular; generally unsuited to farming.	Low available moisture capacity causes difficulty in establishing vegetation.
Slow seepage rate; generally no unfavorable features.	Slow seepage rate; slopes unstable when wet.	Slow to moderately slow permeability.	Well drained; not needed.	High water-holding capacity; slow intake rate.	Many slopes short and irregular; leveling needed before terracing; generally unsuited to farming.	Low organic-matter content; slow to moderately slow permeability; high runoff.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Houghton (Hm)	Good	Unsuitable	Unsuitable	Unsuitable	Organic soil; high water table.	Unstable; organic soil; high water table.
Iosco (IcA, IcB, IdA, IdB).	Poor; very sandy.	Fair; poorly graded medium and fine sand to a depth of 18 to 42 inches.	Unsuitable	Good to a depth of 18 to 42 inches; deeper layers poor, clay loam or loam, wet most of the time.	Seasonal high water table.	Seasonal high water table.
Isabella (IeB, IeC, IeC2, IeD, IeD2, ImB, ImC, ImC2, ImD, ImD2 InD3, InE3, IsB, IsB2, IsC, IsC2, IsD, IsD2, IsE).	Fair	Unsuitable	Unsuitable	Good to a depth of 20 inches, but fair in zone from 20 to 40 inches because material is plastic.	Some areas are steep; no other unfavorable features.	Slight heaving by frost; no other unfavorable features.
Kalkaska (KaB, KkB, KkC, KkC3, KkD, KkD3, KkE, KkE3, KkF, KlB, KlC, KlE).	Unsuitable	Good; in most places poorly graded medium and fine sand.	Unsuitable	Good, but easily eroded by wind and water.	Some areas are steep; no other unfavorable features.	No unfavorable features.
Kawkawlin (KnA, KnB, KoA, KoB, KrA, KrB, KsB).	Good	Unsuitable	Unsuitable	Fair to a depth of 3 to 4 feet; deeper layers poor because of wetness.	Seasonal high water table; hazard of heaving by frost.	Moderate heaving by frost; moderate shrink-swell potential; seasonal high water table.
Kent (KtB, KtC, KtC2, KtD, KtD2).	Fair	Unsuitable	Unsuitable	Poor; poor compaction properties; unstable when wet.	Plastic; subject to heaving by frost; few seep spots.	High shrink-swell potential; low shear strength; slight to moderate heaving by frost.
Kerston (Kv, Kw)	Good to a depth of 36 to 48 inches or more.	Unsuitable	Unsuitable	Unsuitable; organic soil.	Organic soil; high water table.	Unstable; organic soil; high water table
Kinross (Kx)	Poor; very sandy; strongly acid.	Good; mostly poorly graded medium sand.	Unsuitable	Fair to poor because wet; good if not wet.	High water table.	High water table; hazard of piping.

See footnotes at end of table.

of the soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Water table near surface most of the time; high seepage rate.	Organic material; unsuitable.	High water table.	Very poorly drained; organic soil; unstable; likely to subside if overdrained.	Very high water-holding capacity; rapid intake rate; organic soil.	In depressions; not needed.	In depressions; generally not needed.
High seepage rate to a depth of 18 to 42 inches; slow in deeper layers.	Sandy material to a depth of 18 to 42 inches; has high seepage rate; material in deeper layers compacts well, has slow seepage rate.	Seasonal high water table; moderate to moderately slow permeability below a depth of 18 to 42 inches.	Somewhat poorly drained; very sandy to a depth of 18 to 42 inches; deeper material has moderate to moderately slow permeability.	Low water-holding capacity; rapid intake rate; moderate to moderately slow permeability below a depth of 18 to 42 inches.	Most areas nearly level; most slopes are gentle and short; not needed in most areas.	Low available water capacity causes difficulty in establishing vegetation.
Slow seepage rate; no unfavorable features.	Good compaction characteristics; slow seepage rate.	Moderately slow permeability.	Well drained; not needed.	High-water-holding capacity; moderate intake rate.	Slopes of some areas are short and irregular; no other unfavorable features.	Erodible.
High seepage rate.	High seepage rate; very sandy.	No unfavorable features. [3]	Well drained; not needed.	Very low water-holding capacity; rapid intake rate; poor soil for crops.	Very sandy; little runoff; not needed.	Little runoff; low available water capacity; generally not needed.
Slow seepage rate; no unfavorable features.	Slow seepage rate; slopes unstable when wet.	Seasonal high water table; moderately slow permeability.	Somewhat poorly drained; moderately slow permeability; tile drainage satisfactory; random lines generally are adequate.	High water-holding capacity; slow intake rate.	Most slopes short and irregular; generally not needed.	No unfavorable features.
Slow seepage rate; no unfavorable features.	Slow seepage rate; slopes unstable when wet.	Slow permeability.	Few seep spots in some areas; otherwise well drained or moderately well drained; generally not needed.	High water-holding capacity; slow intake rate.	Many slopes short and irregular; dense, sticky subsoil; cuts should be of minimum depth to avoid exposing subsoil.	High runoff; erodible.
Water table near surface most of the time; high seepage rate.	Organic material; unsuitable.	High water table.	Very poorly drained; organic soil; unstable; likely to subside if overdrained.	Very high water-holding capacity; rapid intake rate.	On flood plains and in depressions; not needed.	On flood plains and in depressions; generally not needed.
High seepage rate; water table high most of the time but fluctuates greatly.	High seepage rate; very sandy.	High water table.	Poorly drained; very sandy.	Very low water-holding capacity; rapid intake rate; poor soil for crops.	Level or in depressions; not needed.	Level; high infiltration rate; not needed in most areas.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Linwood (Lm)	Fair; organic material to a depth of 12 to 42 inches.	Unsuitable	Unsuitable	Unsuitable; 12 to 42 inches of organic material over wet loam.	Organic soil; high water table.	Unstable; organic soil; high water table.
Loxley (Lo)	Poor; extremely acid organic soil.	Unsuitable	Unsuitable	Unsuitable; organic soil.	Organic soil; high water table.	Unstable; organic soil; high water table.
Lupton (Lu)	Fair; deep organic soil.	Unsuitable	Unsuitable	Unsuitable; organic soil.	Organic soil; high water table.	Unstable; organic soil; high water table.
Mancelona (MaA, MaB, MaC, MaD, MaE, McA).	Poor	Fair to good; contains considerable gravel.	Good; gravel is mixed with sand.	Good	No unfavorable features.	No unfavorable features.
Manistee (MdB, MdC, MdD).	Poor; very sandy.	Fair; sandy to a depth of 18 to 42 inches.	Unsuitable	Good to a depth of 18 to 42 inches.	Plastic below a depth of 18 to 42 inches.	High shrink-swell potential and low shear strength below a depth of 18 to 42 inches.
Markey (Me)	Fair; 18 to 42 inches of organic material.	Fair; 18 to 42 inches of organic material; deeper layers sand.	Unsuitable	Unsuitable; organic material over sand that is wet most of the time; sand good if not wet.	Organic soil; high water table.	Unstable; organic soil; high water table.
McBride (MgC, MlB, MlC, MlC2, MlD, MlD2, MlE, MmA, MmB, MmB2, MmC, MmC2, MmD, MmD2, MmD3, MmE, MmE2, MmE3, MnB, MnC, MoF).	Fair	Unsuitable	Unsuitable	Good	No unfavorable features.	Slight heaving by frost.
Menominee (MpA, MpB, MpC, MpC2, MpD, MpD2, MpE).	Poor	Fair; medium to fine sand to a depth of 18 to 42 inches.	Unsuitable	Good to a depth of 18 to 42 inches; fair in deeper layers.	No unfavorable features.	Moderate shrink-swell potential below a depth of 18 to 42 inches.

See footnotes at end of table.

of the soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Water table near surface most of the time; high seepage rate in organic material; moderate to slow in deeper layers.	Organic material unsuitable; deeper layers also unsuitable.	High water table.	Very poorly drained; organic soil; unstable; likely to subside if overdrained.	Very high water-holding capacity; rapid intake rate; moderate to slow permeability below a depth of 12 to 42 inches.	Level or in depressions; not needed.	Level or in depressions; not needed in most areas.
Water table near surface most of the time; high seepage rate.	Organic soil; unsuitable.	High water table.	Very poorly drained; organic soil; unstable; likely to subside if overdrained.	Very high water-holding capacity; rapid intake rate; poor soil for crops.	Level or in depressions; not needed.	Level or in depressions; not needed in most areas.
Water table near surface most of the time; high seepage rate.	Organic soil; unsuitable.	High water table.	Very poorly drained: organic soil; unstable; likely to subside if overdrained.	Very high water-holding capacity; rapid intake rate.	Level or in depressions; not needed.	Level or in depressions; not needed in most areas.
High seepage rate.	High seepage rate; sandy and gravelly.	No unfavorable features.	Well drained; not needed.	Low water-holding capacity; rapid intake rate.	No unfavorable features; usually little runoff.	High infiltration rate; little runoff; low available water capacity.
High seepage rate in sand to a depth of 18 to 42 inches; slow in deeper layers.	Sand has rapid permeability; underlying clay has slow seepage rate and high shrink-swell potential.	Slow permeability below a depth of 18 to 42 inches.	Well drained; not needed.	Low water-holding capacity; rapid intake rate; slow permeability below a depth of 18 to 42 inches.	Many areas have short, irregular slopes; no other unfavorable features.	Low available water capacity; difficulty in establishing vegetation.
Water table near surface most of the time; high seepage rate.	Organic material unsuitable; underlying sand has high seepage rate.	High water table.	Very poorly drained; organic soil; unstable; likely to subside if overdrained.	Very high water-holding capacity; rapid intake rate.	Level or in depressions; not needed.	Level or in depressions; not needed in most areas.
Moderate seepage rate.	Compacted fill is stable and has low seepage rate.	No unfavorable features.	Excessively drained; not needed.	Moderate water-holding capacity; moderate intake rate.	Some areas have short, irregular slopes; no other unfavorable features.	No unfavorable features.
High seepage rate to a depth of 18 to 42 inches; moderate to moderately slow in deeper layers.	High seepage rate to a depth of 18 to 42 inches; deeper layers suitable.	Moderate to moderately slow permeability below a depth of 18 to 42 inches.	Well drained; not needed.	Low water-holding capacity; rapid intake rate; moderate to moderately slow permeability below a depth of 18 to 42 inches.	Some areas have short, irregular slopes; no other unfavorable features.	Low available water capacity to a depth of 18 to 42 inches; erodible; establishment of vegetation is difficult.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Montcalm (MrB, MrC, MrD, MrE, MsB, MsC, MsC2, MsC3, MsD, MsD2, MsD3, MsE, MtB, MtC, MtD, MuB, MuC, MuD, MuE, MvF).	Poor	Poor; loamy sand in most places, but some sand below a depth of 48 inches.	Unsuitable	Good; easily eroded.	No unfavorable features.	No unfavorable features.
Munuscong (Mw)	Good	Unsuitable	Unsuitable	Poor; wet; plastic below a depth of 18 to 42 inches.	High water table; highly subject to heaving by frost; plastic below a depth of 18 to 42 inches.	Highly subject to heaving by frost; high shrink-swell potential and low shear strength below a depth of 18 to 42 inches.
Nester (NaC3, NaD3, NaE3, NcC, NeA, NeB, NeB2, NeC, NeC2, NeD, NeD2, NlB, NlC, NlD, NmA, NmB, NmB2, NmC, NmC2, NmD, NmD2, NnC, NoB, NrE, NrE2, NrF).	Fair	Unsuitable	Unsuitable	Fair; slightly plastic.	Firm; slightly plastic; irregular relief.	Moderate shrink-swell potential; slight heaving by frost.
Newaygo (NsB, NsD)	Fair to poor	Fair to poor; contains fine material to a depth of 24 to 40 inches; deeper layers are sandy and gravelly.	Good below a depth of 24 to 40 inches.	Good	No unfavorable features.	No unfavorable features.
Ogemaw (OgA)	Poor	Poor; sandy to a depth of 18 to 42 inches but has a cemented layer.	Unsuitable	Poor; wet in many places; good to a depth of 18 to 42 inches if not too wet.	High water table; cemented sandy hardpan.	High water table; hazard of piping.
Otisco (OsA, OsB, OtA, OtB).	Fair	Poor; mostly loamy sand, 10 to 25 percent silt and clay.	Unsuitable	Fair; many areas wet below a depth of 3 to 4 feet; good if not too wet.	Seasonal high water table.	Moderate bearing capacity; moderate hazard of piping; seasonal high water table.

See footnotes at end of table.

of the soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
High seepage rate.	Too sandy; compacted fill has moderate seepage rate.	No unfavorable features.	Well drained; not needed.	Low water-holding capacity; rapid intake rate.	Some areas have short, irregular slopes; no other unfavorable features.	Erodible; low runoff.
Moderate seepage rate to a depth of 18 to 42 inches; slow in deeper layers.	Material below a depth of 18 to 42 inches; has high shrink-swell potential and low stability when wet.	High water table; slow to very slow permeability below a depth of 18 to 42 inches.	Poorly drained; slow to very slow permeability below a depth of 18 to 42 inches.	High water-holding capacity; moderate intake rate; slow to very slow permeability below a depth of 18 to 42 inches.	Level or in depressions; not needed.	Wet; plants suited to wet soil are needed.
Slow seepage rate; favorable.	Slow seepage rate; good compaction characteristics.	Moderately slow permeability.	Well drained; not needed.	High water-holding capacity; medium to slow intake rate.	Some areas have short, irregular slopes; no other unfavorable features.	High runoff; vegetation can be established easily.
Moderate seepage rate to a depth of 24 to 40 inches; rapid in deeper layers.	Compacted fill material to a depth of 24 to 40 inches; has slow seepage rate; deeper layers too gravelly.	No unfavorable features.	Well drained; not needed.	Moderate water-holding capacity; moderate intake rate; rapid permeability below a depth of 24 to 40 inches.	Some areas have short, irregular slopes; no other unfavorable features.	No unfavorable features.
High seepage rate to a depth of 18 to 42 inches; slow in deeper layers.	Rapid seepage rate and sandy to a depth of 18 to 42 inches; deeper layers favorable.	High water table.	Wet; very sandy; cemented hardpan at a depth of 10 to 24 inches.	Low water-holding capacity; rapid to moderate intake rate; moderate to slow permeability below a depth of 18 to 42 inches.	Most areas are level; gently sloping areas have short slopes; little runoff; not needed.	Most areas are broad and level; not needed in most areas.
High seepage rate.	Moderate seepage rate in compacted fill.	Seasonal high water table.	Somewhat poorly drained; moderately rapid permeability.	Low water-holding capacity; rapid intake rate.	Most areas are nearly level; most of the gentle slopes are short and irregular; generally not needed.	Erodible; low runoff.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Pickford (Pc, Pk)	Good, but sticky and difficult to handle.	Unsuitable	Unsuitable	Unsuitable; wet; highly plastic clay.	High water table; plastic; subject to heaving by frost.	High shrink-swell potential; low shear strength; moderate heaving by frost; high water table.
Pinconning (Pn)	Good to a depth of a few inches.	Fair to poor; sandy to a depth of 18 to 42 inches.	Unsuitable	Fair to a depth of 18 to 42 inches, but likely to be wet; deeper layers clayey, unsuitable.	High water table; plastic below a depth of 18 to 42 inches.	High shrink-swell potential and low shear strength below a depth of 18 to 42 inches; high water table; subject to heaving by frost.
Richter (RcB)	Good	Poor; few strata of sand; most layers have 20 to 40 percent silt and clay.	Unsuitable	Poor; wet below 3 feet much of the time; stability less than optimum.	Seasonal high water table; subject to heaving by frost.	Low stability; high hazard of heaving by frost; hazard of piping; seasonal high water table.
Rifle (Re, Rf, Rl)	Unsuitable; undecomposed organic soil.	Unsuitable	Unsuitable	Unsuitable; organic soil.	Organic soil; high water table.	Organic soil; high water table; unsuitable.
Roscommon (Rm)	Fair to a depth of a few inches.	Good; mostly poorly graded, medium and fine sand.	Poor; gravelly in some places below a depth of 42 inches.	Fair; wet most of the time; good if not too wet.	High water table; occasional flooding.	High water table; hazard of piping.
Rousseau (RnB, RnC, RnD)	Poor	Fair; mostly fine sand and strata of loamy fine sand.	Unsuitable	Fair; fine sand slightly unstable.	Slopes are easily eroded; no other unfavorable features.	Moderate hazard of heaving by frost; moderate stability.
Rubicon						
Normal (RoB, RoC, RoD, RoE, RoF)	Good; mostly poorly graded medium sand.	Unsuitable	Unsuitable	Good; easily eroded by wind and water.	Likely to be eroded by wind if left bare; no other unfavorable features.	No unfavorable features.
Loamy substratum (RuB, RuC, RuD, RuE).	Unsuitable; very sandy.	Good; poorly graded medium to fine sand to a depth of 42 to 66 inches; deeper layers loamy.	Unsuitable	Good to a depth of 42 to 66 inches; deeper layers fair to poor.	Subject to wind erosion if left bare; no other unfavorable features.	Moderate to high shrink-swell potential below a depth of 42 to 66 inches.

See footnotes at end of table.

of the soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Slow seepage rate; favorable.	Slow seepage rate; slopes unstable when wet; high shrink-swell potential.	Slow to very slow permeability; high water table.	Poorly drained; slow to very slow permeability; close spacing of tile needed.	High water-holding capacity; slow intake rate; slow permeability.	Level or in depressions; not needed.	Wet; plants suited to wet soil are needed; waterways generally not needed.
High seepage rate to a depth of 18 to 42 inches; slow in deeper layers.	Too sandy to a depth of 18 to 42 inches; in deeper layers, slow seepage rate; high shrink-swell potential.	High water table; slow to very slow permeability below a depth of 18 to 42 inches.	Poorly drained; sandy to a depth of 18 to 42 inches; slow to very slow permeability in deeper layers.	Low water-holding capacity; rapid intake rate; slow permeability below a depth of 18 to 42 inches.	Level or in depressions; not needed.	Wet; plants suited to wet soil are needed; waterways generally not needed.
Sandy layers; high seepage rate.	Moderate to slow seepage rate in compacted fill; low stability.	Seasonal high water table.	Somewhat poorly drained; moderately rapid permeability; drainage needed for most crops.	Moderate water-holding capacity; moderate intake rate.	Most areas are nearly level; slopes generally are short; generally not needed.	No unfavorable features.
Water table near the surface most of the time; high seepage rate.	Organic soil; unsuitable.	High water table.	Very poorly drained; organic soil; unstable; likely to subside if overdrained.	Very high water-holding capacity; rapid intake rate.	In depressions; not needed.	In depressions; not needed.
High seepage rate; water table high most of the time but fluctuates widely.	High seepage rate; very sandy.	High water table.	Poorly drained; very sandy; rapid permeability.	Very low water-holding capacity; rapid intake rate; frequent applications necessary.	Level or in depressions; not needed.	Rapid infiltration; areas are level and broad; generally not needed
High seepage rate.	High seepage rate; sandy.	No unfavorable features.	Well drained to moderately well drained; moderately rapid to rapid permeability; not needed.	Low water-holding capacity; rapid intake rate.	Most slopes short; no other unfavorable features.	Highly erodible; rapid infiltration; low runoff.
High seepage rate.	High seepage rate; very sandy.	No unfavorable features.[3]	Well drained; very rapid permeability; not needed.	Very low water-holding capacity; rapid intake rate; poor soil for crops.	Very sandy; little runoff; not needed.	Rapid infiltration; not needed.
High seepage rate in sand to a depth of 42 to 66 inches, moderate to slow in deeper layers.	High seepage rate in sand to a depth of 42 to 66 inches; material in deeper layers is suitable.	Moderate to slow permeability below a depth of 42 to 66 inches.	Well drained; not needed.	Very low water-holding capacity; rapid intake rate; moderate to slow permeability below a depth of 42 to 66 inches.	Sandy; little runoff.	Low available water capacity; erodible; difficulty in establishing vegetation.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Saranac (Sa)	Good	Unsuitable	Unsuitable	Poor; wet below a depth of 1 to 2 feet most of the time; fair if not wet.	On flood plains; occasional flooding; high water table; subject to heaving by frost.	High hazard of heaving by frost; moderate bearing capacity; moderate shrink-swell potential; high water table.
Saugatuck (ScB)	Poor	Good below the cemented layer.	Unsuitable	Poor; wet most of the time; cemented layer at a depth of 10 to 24 inches; good if not too wet.	High water table	High water table; hazard of piping.
Selkirk (SeA, SeB)	Good	Unsuitable	Unsuitable	Poor; plastic clay; wet below a depth of 3 feet much of the time.	Seasonal high water table; plastic; subject to heaving by frost.	High shrink-swell potential; low shear strength; moderate heaving by frost; seasonal high water table.
Shoals (Sh, Sl)	Good	Unsuitable	Unsuitable	Poor; generally wet below a depth of 3 or 4 feet; fair to poor capacity to support loads.	Seasonal high water table; moderate risk of frost heave; flooding hazard.	Seasonal high water table; fair to poor capacity to support loads; moderate shrink-swell potential; subject to flooding.
Sims (Sm, Sn, So, Ss)	Good	Unsuitable	Unsuitable	Poor; somewhat plastic; wet most of the time; fair if not too wet.	High water table; firm; somewhat plastic; highly subject to heaving by frost.	Moderate shrink-swell potential; high hazard of heaving by frost; high water table.
Sloan (St)	Good	Unsuitable	Unsuitable	Poor; generally wet; fair to poor bearing capacity.	High water table; moderate risk of frost heave; flooding hazard.	High water table; fair to poor bearing capacity; moderate risk of frost heave; flooding hazard.
Tawas (Ta, Tc, Tp)	Fair; organic material to a depth of 12 to 42 inches.	Fair; sand is covered by 12 to 42 inches of organic material.	Unsuitable	Unsuitable; 12 to 42 inches of organic material over wet sand.	Organic soil; high water table.	Organic soil; unstable; high water table.

See footnotes at end of table.

of the soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Slow seepage rate; occasional flooding.	Fair to low stability; slow seepage rate.	High water table; moderately slow permeability.	Poorly drained; occasional flooding; moderately slow permeability.	High water-holding capacity; moderate to slow intake rate.	On flood plains; not needed.	On flood plains; generally not needed.
High seepage rate.	High seepage rate; very sandy.	High water table.	Somewhat poorly drained; very sandy; cemented, sandy hardpan at a depth of 10 to 24 inches.	Very low water-holding capacity; rapid intake rate; poor soil for crops.	Very sandy; little runoff; most areas level; cemented sandy layer at a depth of 10 to 24 inches; not needed in most areas.	Rapid infiltration; generally not needed.
Slow seepage rate.	Slow seepage rate; high shrink-swell potential; low stability when wet.	Slow permeability; seasonal high water table.	Somewhat poorly drained; slow permeability; close spacing of tile needed.	High water-holding capacity; slow intake rate; slow permeability.	Many areas level; most gentle slopes are short and irregular.	No unfavorable features; high runoff; likely to be needed.
Slow seepage rate; subject to flooding.	Slow seepage rate	Seasonal high water table; moderate permeability; subject to flooding.	Somewhat poorly drained; subject to flooding; moderate permeability.	High water-holding capacity; medium intake rate; subject to flooding.	Generally not needed; flood plain.	On flood plains; generally not needed.
Slow seepage rate.	Slow seepage rate; good compaction characteristics.	High water table; moderately slow permeability.	Poorly drained; moderately slow permeability; good outlets not available in all areas.	High water-holding capacity; moderate to slow intake rate.	Level or in depressions; not needed.	Wet; plants suited to wet soil are needed.
High water table; slow seepage rate; subject to stream overflow.	High water table; fair to good stability and compaction properties; slow seepage rate.	High water table; subject to stream overflow.	Poorly drained; moderately slow permeability; subject to stream overflow.	Medium to slow rate of water intake; high water-holding capacity; subject to stream overflow.	Not needed; level or depressional; flood plain.	On flood plain; not needed.
Water table near surface most of the time; high seepage rate.	Organic material to a depth of 12 to 42 inches is unsuitable; sand in deeper layers has high seepage rate.	High water table.	Very poorly drained; organic soil to a depth of 12 to 42 inches over sand; ditches likely to be more satisfactory than tile.	Very high water-holding capacity; rapid intake rate; rapid permeability below a depth of 12 to 42 inches.	Level or in depressions; not needed.	Wet; plants suited to wet soil are needed.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Tonkey (Mapped only in undifferentiated units with Edmore and Ensley soils.)	Good	Poor; few layers of sand, but mostly sandy loam and loamy sand.	Unsuitable	Poor; wet most of the time; stability less than optimum.	High water table; highly subject to heaving by frost; low bearing capacity.	Low bearing capacity; highly subject to heaving by frost; high water table.
Traverse (Tr)	Fair to poor	Poor to fair; several strata of loamy sand and sandy loam.	Unsuitable	Good	Few seepy spots; slight heaving by frost.	No unfavorable features.
Twining (TwA, TwB)	Good	Unsuitable	Unsuitable	Fair; wet most of the time below a depth of 3 to 4 feet.	Seasonal high water table; slight heaving by frost.	Moderate heaving by frost; seasonal high water table.
Ubly: Normal (UbB, UbC, UbD).	Fair	Unsuitable	Unsuitable	Good to a depth of 18 to 42 inches; deeper layers, fair.	No unfavorable features.	Moderate shrink-swell potential below a depth of 18 to 42 inches; slight heaving by frost.
Clay subsoil variant (UlB, UlC).	Fair in upper 6 to 8 inches.	Unsuitable	Unsuitable	Good to a depth of 18 to 42 inches; deeper layers highly plastic, fair.	No unfavorable features.	High shrink-swell potential and moderate bearing capacity below a depth of 18 to 42 inches.
Wallace (WaB, WaD)	Unsuitable	Good, except for cemented layer at a depth of 10 to 24 inches.	Unsuitable	Good, except in layer from 10 to 24 inches; easily eroded.	Cemented, sandy hardpan between depth of 10 and 24 inches; subject to wind erosion if left bare.	No unfavorable features.

See footnotes at end of table.

of the soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
High seepage rate in layers of sand.	Moderate to slow seepage rate in compacted fill; low stability.	High water table.	Poorly drained; moderately rapid permeability; good outlets not available in all areas.	Moderate water-holding capacity; moderate intake rate.	Level or in depressions; not needed.	Wet; plants suited to wet soil are needed.
Moderate seepage rate; layers of sand in many places.	Compacted fill has slow seepage rate.	No unfavorable features.	Well drained or moderately well drained except for a few seepy spots; drainage not needed elsewhere.	Moderate water-holding capacity; moderate intake rate.	Nearly level; not needed.	No unfavorable features.
Slow seepage rate; favorable.	Compacted fill has slow seepage rate.	Moderately slow permeability; seasonal high water table.	Somewhat poorly drained; moderately slow permeability; needed for most crops.	High water-holding capacity; moderate intake rate.	Many areas nearly level; most slopes are short and irregular; generally not needed.	No unfavorable features.
Moderate seepage rate to a depth of 18 to 42 inches; slow in deeper layers.	Slow seepage rate; good compaction characteristics.	Moderate to moderately slow permeability.	Well drained to moderately well drained; moderate permeability; not needed.	Moderate water-holding capacity; moderate intake rate; moderate to moderately slow permeability below a depth of 18 to 42 inches.	Many areas have short, irregular slopes; no other unfavorable features.	Erodible.
Moderate seepage rate to a depth of 18 to 42 inches; slow in deeper layers.	Good compaction characteristics to a depth of 18 to 42 inches; clay in deeper layers has low stability; high shrink-swell potential.	Slow to very slow permeability below a depth of 18 to 42 inches.	Well drained to moderately well drained; not needed.	Moderate water-holding capacity; moderate intake rate; slow permeability below a depth of 18 to 42 inches.	Some areas have short, irregular slopes; no other unfavorable features.	Slow permeability in substratum; high runoff in many areas.
High seepage rate.	High seepage rate; very sandy.	No unfavorable features.[3]	Well drained to moderately well drained; rapid permeability; not needed.	Very low water-holding capacity; rapid intake rate; poor soil for crops.	Very sandy; little runoff; not needed.	Rapid infiltration; generally not needed; establishment of vegetation is difficult.

TABLE 6.—*Engineering properties*

Soil series and map symbols	Suitability as a source of—				Soil features affecting engineering practices—	
	Topsoil [1]	Sand	Gravel	Road fill	Highway location	Foundations for low buildings [2]
Warners (We)	Fair to poor; calcareous in most places; organic or mineral soil over marl.	Unsuitable in most places; sand in some places under marl.	Unsuitable	Unsuitable; marl.	High water table; marl.	Marl and underlying material are unstable; high water table.
Wheatley (Wh, Wk)	Good	Fair; loamy sand to a depth of 18 to 36 inches; deeper layers loose sand and gravel.	Fair to good; considerable content of sand.	Fair; wet most of the time below a depth of 2 feet; good if not wet.	High water table.	High water table; slight hazard of piping.
Willette (Wl)	Fair; organic material to a depth of 12 to 42 inches.	Unsuitable	Unsuitable	Unsuitable; organic material over wet clay.	Organic soil; high water table.	Organic soil; unstable; high water table.
Wind eroded land (WnC, WnF)	Unsuitable	Fair; content of silt and clay is 5 to 25 percent.	Poor; some gravelly spots; gravel in some places below a depth of 5 feet.	Good	Subject to wind erosion if left bare; no other unfavorable features.	No unfavorable features.

[1] Refers to the surface layer as described in "Descriptions of the Soils," unless otherwise stated.
[2] Engineers and others should not assign any specific values to the estimated ratings given for bearing capacity of the soils.

table, topography, and the depth to soil material unfavorable for root growth.

The ratings of suitability of the soils for terraces and diversions are based on features of the soils that affect terrace layout and construction, such as topography, texture, and the depth to soil material unfavorable to crop production.

Considered in rating the suitability of the soils for grassed waterways were soil features that affect the establishment, growth, and maintenance of vegetation in a waterway, and that also affect the layout and construction of a waterway.

Special engineering considerations

Summarized in the following paragraphs are facts about some of the major soils in the county when they are used for highways, for dams and other structures used for soil and water conservation on farms, and as sites for residences.

HIGHWAYS.—Seepy areas and small wet spots are common in most areas of the Isabella, Kent, Nester, and Ubly soils, even though these soils are predominantly well drained or moderately well drained. In many places random tile lines are needed to drain these wet and seepy spots.

Good materials for road subbase are plentiful in the sandy and gravelly soils of the county. They are well distributed throughout the county.

Of special concern to engineers are the silty soils of the county, particularly the Bohemian and Brimley soils. The stratified silt and very fine sand of these soils are soft and very unstable. These soils have low bearing capacity and high frost susceptibility.

AGRICULTURAL ENGINEERING.—Artificial drainage is widely needed in areas of Osceola County that have been

of the soils—Continued

Soil features affecting engineering practices—Continued						
Farm ponds		Disposal fields for septic tanks	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Reservoir area	Embankment					
Water table at or near the surface most of the time; moderate to slow seepage rate.	Marl is not suitable; material under marl is variable.	High water table.	Very poorly drained; contains marl; marl and deeper layers in many places are too unstable to permit a good system of tile drains.	Variable water-holding capacity; wet most of the time moderate to rapid intake rate; not used for crops.	In depressions; not needed.	In depressions; not needed.
High seepage rate; high water table that fluctuates considerably.	High seepage rate; very sandy and gravelly.	High water table.	Poorly drained; rapid permeability; sand causes difficulty in tiling.	Low water-holding capacity; rapid intake rate.	Level or in depressions; not needed.	Level or in depressions; generally not needed.
Water table near the surface most of the time; high seepage rate in organic material to a depth of 12 to 42 inches; slow seepage rate in deeper layers.	Organic material; unsuitable, to a depth of 12 to 42 inches; clay in deeper layers has high shrink-swell potential and low stability when wet.	High water table.	Very poorly drained; organic material to a depth of 12 to 42 inches is unstable; slow to very slow permeability below a depth of 12 to 42 inches.	Very high water-holding capacity; rapid intake rate; slow to very slow permeability below a depth of 12 to 42 inches.	In depressions; not needed.	In depressions; not needed.
High seepage rate.	High seepage rate; sandy.	No unfavorable features.	Very irregular slopes; not needed.	Low water-holding capacity; rapid intake rate.	Very irregular, short slopes.	Erodible; low available water capacity; establishment of vegetation is difficult.

[3] If a septic tank is installed, the effluent can reach ground water and pollute nearby shallow wells.

cleared for farming. Because of excess wetness, a large acreage is used for pasture that could be used for other crops if the soils were adequately drained and managed. Less than one-third of the total acreage of some of the wet soils, for example the Kawkawlin, Sims, Twining, Coral, Ensley, Richter, Brimley, and Tonkey, is used for crops. These soils can be drained satisfactorily by tile, but drainage by tile is not feasible in many areas, because of a lack of adequate outlets. Drainage ditches to provide outlets for tile are needed in many areas. Because of the slow to very slow permeability of the Bergland, Pickford, and Selkirk soils, closer spacing of tile is required in them for adequate tile drainage than in the more permeable soils.

Little of the acreage of the organic soils of the county is drained and used for farming. The drainage of organic soils is usually best accomplished in two phases. First, outlet ditches are dug to lower the water table to a depth of about 3 feet. Then, after a year or two, tile drains are installed. The period between construction of the ditches and installation of the tile allows initial subsidence to occur without interfering with the grade in the tile lines.

The soils formed in sandy clay loam, clay loam, and silty clay to clay are favorable for the construction of farm ponds because of their slow seepage rates. The soils developed in sandy loam materials, such as the McBride and Coral soils, have a moderate seepage rate that results in wide fluctuations in the water level of ponds constructed on them. By careful selection of materials from the subsoils for use in blanketing the reservoir area and by good compaction, it is possible to construct successful ponds on these soils. The sands and loamy sands have an excessive seepage rate.

Many of the low areas in the county have springs that provide a good flow of water. Such springs make it possible to have good ponds on soils having a rapid seepage rate. Such areas should be carefully studied before ponds are constructed in them.

Establishing dense, erosion-resistant sod in well-constructed waterways is relatively easy on most soils in Osceola County, partly because rains of high intensity are less common here than in States to the south and west.

Waterways are sometimes constructed in the limy glacial till of the Nester, Isabella, and Kent soils. The till has poor soil structure and is low in content of organic matter. Liberal applications of manure are advisable when establishing seedings on this material.

All of the sloping upland soils in Osceola County generally are suited to the construction of terraces and diversions, except where slopes are too complex. In the constuction of terraces or diversions on the Kent and Nester soils, cuts into the lower subsoil expose material that is low in productivity and difficult to till.

Very little irrigation of crops was practiced in Osceola County when this survey was made. Irrigation could make a large acreage of sandy soils quite productive of a wide variety of crops, including many specialty crops not presently grown but climatically suited to the area. Water for irrigation is readily available from shallow wells or lakes in many areas.

RESIDENTIAL USES.—Soil characteristics have an important bearing on the suitability of a site for residential development, whether for a subdivision or an individual home. Soil drainage, permeability, and stability and frequency of flooding are important considerations.

The low bearing capacity of the Bohemian and Brimley soils often results in cracks in basement walls and settling of foundations, particularly in buildings of more than one story. The risk of frost heaving is relatively high on the somewhat poorly drained and poorly drained, finer textured soils, such as Kawkawlin, Sims, Bergland, Pickford, and Selkirk. Paved sidewalks, driveways, and garage or carport floors are likely to be damaged by frost heaving on those soils unless a foot or more of coarse-textured material is placed below the paving. Soils that have a high shrink-swell potential have a severe limitation for the construction of foundations and other structures.

Figure 9.—**Flooding of lowland near village of Marion during spring rains.**

The alluvial soils of the county, on the flood plains of streams, have severe limitations for residential development because of a flooding hazard (fig. 9).

Formation and Classification of the Soils

This section first discusses briefly the five major factors of soil formation and four important processes that are involved in the differentiation of soil horizons. Then the current system of classifying soils is explained briefly.

Factors of Soil Formation

Soil is formed by the interaction of five major factors. These soil-forming factors are parent material, climate, living organisms (especially vegetation) on topography or relief, and time. The kind of soil at any place depends on the influence of these factors.

Parent materials of most of the soils of Osceola County were mineral materials that were deposited by glaciers or by meltwater when the glaciers receded from this part of North America. Some of the soils, however, have been formed in recent alluvium along the streams, and the organic soils consist of remains of plants that accumulated and were preserved under water in swamps or shallow lakes. The mineral materials consist of gravel, sand, loam, and clay. They were deposited on outwash plains, in valley drainageways, and on till plains, moraines, and flood plains. The nature of the parent material has much to do with the texture, mineral composition, and chemical properties of the soil that has been formed at any place.

The *climate* of Osceola County is cool and humid. Climate is nearly uniform throughout the county, and differences among the different soils are largely the result of differences in the other soil-forming factors. More details about the climate are given in the section "General Nature of the County."

Living organisms that affect soils are green plants, fungi, bacteria, large and medium-sized animals, and insects and other small animals. Living organisms cause gains in the content of organic matter and nitrogen, gains and losses in the content of plant nutrients, and changes in the structure and porosity of the soil.

Vegetation has had greater effects than other living organisms on formation of soils in the county. Hardwood and coniferous trees have been dominant in the vegetation during much of the time while the soils were being formed.

Topography, or relief, affects formation of soils through its influence on drainage, erosion, plants, and temperature of the soils. The county has extremely variable relief, and the surface features range from enclosed depressions to steep hills. In some places the local differences in elevation are as much as 150 to 200 feet. In others there are large, nearly level plains that have slopes of less than 2 percent. There are also many small, nearly level areas interspersed in the undulating and hilly areas. The level areas receive runoff from the slopes. In depressions and in some level areas, the water table is at or near the surface and the soils are poorly drained or somewhat poorly drained. Examples of somewhat poorly drained or poorly drained soils are those of the Sims, Kawkawlin, and Roscommon series.

Time, generally hundreds or thousands of years, is required for formation of soils that have distinct horizons. The differences in time that parent materials have been in place or that have been subjected to soil-forming processes are commonly reflected in the degree of development of the soil profile.

Some soils in the county are young, and some are old. The young soils show very little profile development, but the old soils show well-expressed soil horizons. Soils of the Abscota series are young soils that do not have a developed profile. The surface layer has been darkened by accumulation of organic matter, but otherwise the Abscota soils retain most of the characteristics of their parent material. Kalkaska soils are older soils that have developed soil horizons.

Differentiation of Soil Horizons

Four main processes that are involved in the formation of soil horizons are (1) accumulation of organic matter, (2) leaching of calcium carbonate and of other basic compounds, (3) reduction and transfer of iron, and (4) formation and translocation of silicate clay minerals. In most soils more than one of these processes have been active in formation of the soil horizons.

In many soils organic matter accumulates in the upper part of the profile to form a dark-colored horizon of mineral soil that is called the A1 horizon. The soils of Osceola County range from high to very low in their content of organic matter.

Leaching of carbonates and of other bases has occurred in nearly all the soils of the county. Soil scientists generally agree that leaching of bases in soils precedes the translocation of silicate clay minerals. Most soils in the county have been moderately to strongly leached, and the leaching has contributed to the formation of soil horizons.

Reduction and transfer of iron compounds, a process called gleying, has taken place in the poorly drained and very poorly drained soils of the county. Gray color in the subsoil horizons indicates that iron compounds have been reduced and probably have been moved by leaching. Some horizons have in them reddish-brown mottles and concretions, which indicate that iron compounds have been segregated and oxidized.

In some soils of the county, translocation of clay minerals has contributed to the formation of soil horizons. The eluviated A2 horizon above the B horizon in many soils has platy structure, has lower clay content, and has lighter color than the B horizon. The B horizon in many soils has in it accumulated clay in the form of clay films in pores and on the surfaces of peds. Soils that have one or more horizons in which clay has accumulated probably were leached of most of their carbonates and soluble salts before the translocation of silicates took place. Nester soils have in them translocated silicate clay minerals that have accumulated in the B horizon in the form of clay films.

In some soils of the county, iron compounds and humus have been moved from the surface layers and have accumulated in the B horizon. Such a B horizon ranges from dark reddish brown to yellowish brown in color. The Kalkaska, Rubicon, and Grayling soils each have a B horizon in which translocated iron compounds and humus have accumulated.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First, through classification, and then through use of soil maps, we can apply our knowledge to specific fields and other tracts of land.

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and revised later (*6*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study (*5*, *8*). Therefore, readers interested in developments of the new system should search the latest literature available.

Under the current system of classification, six categories are recognized. Beginning with the broadest and most inclusive, these are the order, the suborder, the great group, the subgroup, the family, and the series. Table 7 gives the family, subgroup, and order for each soil series in the county according to the current classification.

TABLE 7.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Abscota	Sandy, mixed, frigid	Typic Udipsamments	Entisols.
Adrian			Histosols.[1]
Algansee [2]	Sandy, mixed, mesic	Aquic Udipsamments	Entisols.
Allendale	Sandy over clayey, mixed, frigid	Aqualfic Haplorthods	Spodosols.
Au Gres [3]	Sandy, mixed, frigid	Entic Haplaquods	Spodosols.
Belding	Coarse-loamy, mixed, frigid	Alfic Haplaquods	Spodosols.
Belding, clay subsoil variant	Coarse-loamy over clayey, mixed, frigid	Alfic Haplaquods	Spodosols.
Bergland	Clayey, illitic, nonacid, frigid	Histic Humaquepts	Inceptisols.
Blue Lake	Sandy, mixed, frigid	Alfic Haplorthods	Spodosols.
Bohemian	Fine-loamy, mixed, frigid	Alfic Haplorthods	Spodosols.
Brevort [4]	Sandy over loamy, mixed, nonacid, frigid	Mollic Haplaquepts	Inceptisols.
Brimley	Fine-loamy, mixed, frigid	Alfic Haplaquods	Spodosols.

See footnotes at end of table.

TABLE 7.—*Soil series classified according to the current system of classification*—Continued

Series	Family	Subgroup	Order
Carbondale			Histosols.
Chelsea [5]	Sandy, mixed, mesic	Alfic Udipsamments	Entisols.
Coral	Coarse-loamy, mixed, frigid	Alfic Haplaquods	Spodosols.
Croswell	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
Dawson			Histosols.
Dighton	Fine-loamy over sandy or sandy skeletal, mixed, frigid.	Typic Eutroboralfs	Alfisols.
East Lake	Sandy, mixed, frigid	Typic Haplorthods	Spodosols.
Edmore	Sandy, mixed, frigid	Mollic Haplaquepts	Inceptisols.
Edwards			Histosols.
Ensley	Coarse-loamy, mixed, nonacid, frigid	Mollic Haplaquepts	Inceptisols.
Evart [6]	Sandy, mixed, noncalcareous, frigid	Fluventic Haplaquolls	Mollisols.
Gladwin	Sandy, mixed, frigid	Alfic Haplaquods	Spodosols.
Grayling	Sandy, mixed, frigid	Alfic Udipsamments	Entisols.
Greenwood			Histosols.
Houghton			Histosols.
Iosco	Sandy over loamy, mixed, frigid	Aqualfic Haplorthods	Spodosols.
Isabella	Fine-loamy, mixed, frigid	Alfic Fragiorthods	Spodosols.
Kalkaska	Sandy, mixed, frigid	Typic Haplorthods	Spodosols.
Kawkawlin [7]	Fine, mixed, frigid	Aeric Glossaqualfs	Alfisols.
Kent	Fine, illitic, frigid	Typic Eutroboralfs	Alfisols.
Kerston			Histosols.
Kinross [3]	Sandy, mixed, frigid	Typic Haplaquods	Spodosols.
Linwood			Histosols.
Loxley			Histosols.
Lupton			Histosols.
Mancelona	Sandy, mixed, frigid	Alfic Haplorthods	Spodosols.
Manistee	Sandy over clayey, mixed, frigid	Alfic Haplorthods	Spodosols.
Markey			Histosols.
McBride	Coarse-loamy, mixed, frigid	Alfic Fragiorthods	Spodosols.
Menominee	Sandy over loamy, mixed, frigid	Alfic Haplorthods	Spodosols.
Montcalm	Sandy, mixed, frigid	Alfic Haplorthods	Spodosols.
Munuscong	Coarse-loamy over clayey, mixed, nonacid, frigid	Mollic Haplaquepts	Inceptisols.
Nester	Fine, mixed, frigid	Typic Eutroboralfs	Alfisols.
Newaygo	Fine-loamy over sandy or sandy skeletal, mixed frigid.	Alfic Haplorthods	Spodosols.
Ogemaw	Sandy over loamy, mixed, frigid, ortstein	Aquic Haplorthods	Spodosols.
Otisco	Sandy, mixed, frigid	Entic Haplaquods	Spodosols.
Pickford	Very fine, illitic, nonacid, frigid	Aeric Haplaquepts	Inceptisols.
Pinconning	Sandy over clayey, mixed, nonacid, frigid	Mollic Haplaquepts	Inceptisols.
Richter	Coarse-loamy, mixed, frigid	Alfic Haplaquods	Spodosols.
Rifle			Histosols.
Roscommon	Sandy, mixed, frigid	Mollic Psammaquents	Entisols.
Rousseau	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
Rubicon	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
Saranac [5]	Fine, mixed, noncalcareous, mesic	Fluventic Haplaquolls	Mollisols.
Saugatuck [5]	Sandy, mixed, mesic, ortstein	Aeric Haplaquods	Spodosols.
Selkirk [7]	Fine, illitic, frigid	Aquic Eutroboralfs	Alfisols.
Shoals [4 5]	Fine-loamy, nonacid, mixed, mesic	Aeric Fluventic Haplaquepts	Inceptisols.
Sims	Fine, mixed, nonacid, frigid	Mollic Haplaquepts	Inceptisols.
Sloan [5]	Fine-loamy, mixed, noncalcareous, mesic	Fluventic Haplaquolls	Mollisols.
Tawas			Histosols.
Tonkey	Coarse-loamy, mixed, nonacid, frigid	Mollic Haplaquepts	Inceptisols.
Traverse [6]	Coarse-loamy, mixed, frigid	Cumulic Hapludolls	Mollisols.
Twining	Fine-loamy, mixed, frigid	Alfic Haplorthods	Spodosols.
Ubly	Coarse-loamy, mixed, frigid	Alfic Haplorthods	Spodosols.
Ubly, clay subsoil variant	Coarse-loamy over clayey, mixed, frigid	Alfic Haplorthods	Spodosols.
Wallace	Sandy, mixed, frigid, ortstein	Typic Haplorthods	Spodosols.
Warners [5]	Loamy, carbonatic, calcareous, mesic	Histic Humaquepts	Inceptisols.
Wheatley	Sandy, mixed, frigid	Mollic Psammaquents	Entisols.
Willette			Histosols.

[1] Classification of Histosols below the soil order has not been developed.

[2] Lacks mottles that have a chroma of 2 and that are within 40 inches of the surface, but responds as an Aquic Udipsamment.

[3] Lacks mottling in the albic or spodic horizon that is typical of Aquods but responds as an Aquod.

[4] Lacks colors typical of the Aquepts at depths of less than 20 inches but responds as an Aquept.

[5] These soils normally occur in a mesic family, but in Osceola County they occur near the boundary between the mesic and frigid temperature zones.

[6] Lacks colors typical of the Aquolls immediately below the mollic epipedon but responds as an Aquoll.

[7] Profile described is not typical of the series over its entire range of occurrence, as it lacks evidence of the albic horizon tonguing into the argillic horizon.

General Nature of the County

In this section the climate, relief, geology, and basic features of the agriculture of Osceola County are discussed. The statistics given are from reports published by the U.S. Bureau of the Census, from the records of local weather stations, and from records of the U.S. Geological Survey.

Climate[8]

As in other parts of Michigan's Lower Peninsula, the continental climate is modified by the Great Lakes. The prevailing westerly winds, which have crossed Lake Michigan, are warmed and pick up moisture in winter, and are cooled by the waters of the lake in summer. In Osceola County the winters are slightly warmer and the summers are cooler than at comparable latitudes in Wisconsin and Minnesota.

Osceola County experiences a wide range in temperatures during the year, as illustrated in table 8. This table shows the average monthly temperatures and precipitation, as well as the probability of very high and very low temperatures and amounts of precipitation. For example, an average of 2 years in 10 will have at least 4 days in August with temperatures of 92° or higher at the Evart weather station. On an average of 6 days each summer, the temperature climbs to 90° or higher. At the other extreme, Evart in February has temperatures of 10° below zero or colder on at least 4 days on an average of 2 years in 10. The 4 days are not necessarily consecutive. Temperatures of zero or lower occur on an average of 18 days during winter.

At Reed City, the highest temperature ever recorded was 102 degrees, and the lowest was 42 degrees below zero. A spread of 120 degrees between the hottest and coldest temperatures recorded in 1 year is not uncommon in the county.

The average date of the last killing frost in spring is May 21 at the Reed City weather station. The first killing frost in fall occurs on September 23, on the average. Therefore, the average frost-free growing season is 125 days. This figure varies, depending upon the air drainage. In low depressions without air drainage, the heavier cold air tends to settle. In such areas frosts often occur later in spring and earlier in fall than on sloping areas with good air drainage.

The figures in table 9 show that at Evart on an average of 1 year in 10 temperatures are as low as 32° F. as late or later than June 8 in spring, and as early or earlier than August 30 in fall. The likelihood of these cool days late in spring and early in fall both occurring in the same year is low.

The precipitation during the growing season is suitable for a wide variety of crops. Usually, it is well distributed and averages about 18 inches during the 6-month period from April through September. Long drought periods are rare, but there are usually short periods each summer when crops suffer slightly from lack of moisture, even on the medium-textured soils. The data in table 8 show that at Evart on an average of 1 year in 10 less than 1.1 inches of rain will be received in June, 1.8 inches in July, and 1.4 inches in August.

The evaporation and transpiration rates are relatively low due to the cool temperatures, high humidity, and relatively high percentage of cloudy or partly cloudy days. This fact, coupled with the well-distributed rainfall, results in less severe and less frequent drought periods than in States to the south and west where the evaporation-transpiration rate is higher.

The length of growing season and relatively cool summer temperatures approach the minimum requirements for the production of corn for grain. However, some corn

[8] A. EICHMEIER, former State climatologist of the Michigan Weather Bureau, U.S. Department of Commerce, assisted in the preparation of this section.

TABLE 8.—*Temperature and precipitation at Evart, Osceola County, Mich.*

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average total	One year in 10 will have—		Days with snow cover	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	29.2	12.9	40	−9	1.81	0.2	2.9	29	6.1
February	31.1	12.6	44	−10	1.56	.5	2.7	25	8.3
March	40.2	20.1	53	6	1.76	.6	2.8	15	8.0
April	55.5	31.4	77	24	2.06	1.5	3.7	1	1.4
May	68.4	42.2	82	31	3.05	1.3	5.2	0	.0
June	77.6	51.9	90	44	3.58	1.1	6.1	0	.0
July	77.0	54.9	91	48	2.39	1.8	3.8	0	.0
August	80.8	54.0	92	47	3.43	1.4	5.8	0	.0
September	71.7	46.2	88	36	3.37	1.4	5.4	0	.0
October	59.9	36.4	76	29	2.29	.4	4.4	0	.0
November	43.9	26.9	61	19	2.59	1.2	4.2	4	2.4
December	32.6	18.6	47	8	1.71	.7	2.6	17	3.8
Year	55.7	34.0			29.60			91	

TABLE 9.—*Probabilities of last freezing temperatures in spring and first in fall, Evart, Osceola County, Mich.*[1]

Probability	Dates for given probability and temperature:				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	April 25	May 4	May 22	June 2	June 8.
2 years in 10 later than	April 20	April 29	May 17	May 28	June 3.
5 years in 10 later than	April 10	April 19	May 7	May 18	May 24.
Fall:					
1 year in 10 earlier than	October 29	October 17	September 22	September 9	August 30.
2 years in 10 earlier than	November 3	October 22	September 27	September 14	September 4.
5 years in 10 earlier than	November 14	November 2	October 8	September 25	September 15.

[1] Based on records for 1957–62.

is grown for grain in Osceola County. Varieties that require about 110 days to mature should mature during most seasons if the corn is planted around the frost-free date of May 23. In fields with depressions having poor air drainage, 90-day varieties offer some insurance against the greater frost hazard in the depressions.

Most soils are near the saturation point in spring after the snow melts. Subsequent rainfall often results in a high rate of runoff and erosion on sloping cultivated land. Level areas of poorly or somewhat poorly drained soils with inadequate artificial drainage often remain wet until late in spring, and planting of crops is delayed as a result.

The most intense rains usually fall during the summer months and cause runoff and erosion on sloping cultivated land. In Osceola County, however, the rains usually are less intense and cause less runoff and less erosion than rains in the southern Lower Peninsula and in States to the south and west. A rainfall with an intensity of 1.0 inch per hour occurs on an average of once every year. One with an intensity of 1.7 inches per hour occurs on an average of once every 10 years, and one of 1.9 inches per hour occurs on an average of every 25 years. Rainfalls of 3.5 inches in a period of 24 hours occur on an average of once every 10 years.

Yields of oats generally are good due to cool daytime temperatures and relatively high soil moisture levels that prevail in most years during the bloom stage of the crop. The yields of hay and pasture are favored by the cool, moist growing seasons, and usually are very good on well-fertilized soils that are not too sandy. Soil moisture conditions during most fall seasons are very favorable for seedbed preparation and germination of fall-seeded grain. Snow cover protects winter grain crop from excessively cold weather during most of the winter. The ground is covered with snow on an average of 91 days. The average annual snowfall is 44.2 inches, and there usually are measurable amounts of snowfall during 6 months of each year.

Wind velocities of sufficient magnitude to cause erosion of unprotected muck soils and sandy soils occur on several days during the year.

Relief and Geology

Most of Osceola County is a hilly moraine that formed between the Lake Michigan and Lake Huron lobes of the ice sheet that covered the county as recently as 12,000 years ago. The glaciated material that makes up this moraine is estimated to be 1,200 feet thick in the north-central part of the county. There also are two glacial till plains in the county. One is in the southwestern part of the county, and the other is in the eastern and northeastern portion of the county. Two major outwash plains also are a part of the relief of the county. One is along the Muskegon River in the eastern and southeastern part of the county. The other is in the northwestern corner of Burdell Township and extends into Wexford County.

Elevations are highest in the north-central part of the county. The highest point is 1,626 feet at the Cadillac Fire Tower. Lowest elevation in the county is 1,000 feet in the valley of the Muskegon River.

Osceola County is drained by the Pine River and its tributaries in the northwestern part, and by the Muskegon River and its tributaries in most of the rest of the county. A small part of the southeastern corner is drained by the Chippewa River. There are many small lakes in the central and southern parts of the county, the largest being Rose Lake.

Agriculture

Agriculture was slow to develop in Osceola County. The early settlers found the county clothed with a dense forest. The sandy soils were covered with Norway spruce, jack pine, and scattered clumps of hardwoods. The clayey soils supported hardwoods that included oak, hard maple, sugar maple, beech, elm, yellow birch, ash, cherry, basswood, and some hemlock. In the swamps and bogs and on stream bottoms, the major trees were spruce, tamarack, white-cedar, and balsam fir.

The pines were logged first and then the hardwoods. In the present forests aspen and birch generally are dominant.

The first crops grown were in family gardens of the early settlers. As the land was cleared of trees, the soils were found to be productive for potatoes, hay, and grain. By 1880 wheat was an important crop, with average yields of 14.5 bushels per acre. At the turn of the century, agriculture had become one of the most important industries in the county, and it continues to be so to this day.

During the past 20 years, the total acreage of land in farms and number of farms in Osceola County has declined. Records of the U.S. Census Bureau show that 814 farms were in the county and that 174,949 acres was in

farms in 1964. Though there has been a gradual decrease in the number of farms during the past few years, there has been a trend toward larger farming units. About 50 percent of the county is in State forests, privately owned woods, abandoned farms, and some industrial and urban sites.

In 1964 there were 356 dairy farms in the county, 89 farms where livestock other than dairy cattle provided the principal income, 39 general farms, 8 cash-grain farms, 8 farms with other types of field crops predominating, 5 poultry farms, and 1 fruit-and-nut farm. A total of 308 other farms were listed as miscellaneous and unclassified by the Census Bureau.

The 1964 Census of Agriculture lists alfalfa hay, corn, mixtures of clovers and grasses cut for hay, oats, and wheat as the principal crops grown in Osceola County, in order of decreasing acreage. Rye, buckwheat, barley, truck crops, and potatoes are grown on small acreages. Except for the truck crops, potatoes, and some grain sold for cash, the crops grown generally are used to feed livestock.

In 1964 the acreages of the principal crops included hay and grass silage harvested on 34,352 acres, corn on 9,371 acres, oats on 4,862 acres, wheat on 3,639 acres, and a total of 459 acres of barley, rye, and buckwheat harvested. Yields of crops grown in the county have increased in the last 30 years. This increase has come partly through the use of improved varieties of seed and partly because of better soil management methods and improved farming practices.

Livestock on farms in 1964 included 25,040 cattle and calves of which 8,028 were milk cows. There were 3,525 sheep and lambs, 1,380 hogs and pigs, and 24,305 chickens in that year. Few horses and mules remain on Osceola County farms.

In 1964 nearly 84 percent of the total farm income derived from the sale of farm products was from livestock and livestock products, and about 16 percent was from the sale of crops. Of the livestock and livestock products sold, dairy cattle and dairy products accounted for almost 64 percent of the total farm income.

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Glossary

Acidity. See Reaction, soil.

Aggregate (soil structure). Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alkalinity. See Reaction, soil.

Alluvium. Fine material, such as sand, silt, or clay, that has been deposited on land by streams.

Available moisture capacity. The difference between the amount of water in a soil at field capacity and the amount in the same soil at the permanent wilting point. Commonly expressed as inches of water per inch depth of soil.

Base (chemistry). Any of the positive, generally metallic elements or combinations of elements that make up the nonacid plant nutrients. The most important of these in plant nutrition are calcium (Ca), potassium (K), magnesium (Mg), and ammonium (NH_4).

Blowout. An excavation produced by wind action in loose soil, usually sand.

Broad-base terrace. A ridge-type terrace 10 to 20 inches high and 15 to 30 feet wide, with gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. This kind of terrace is constructed to control erosion by diverting runoff along the contour at a nonscouring velocity. It may be level or have a grade toward one or both ends.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: Clay coat, clay skin.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Clean tillage. Cultivation to prevent the growth of all vegetation except the particular crop desired.

Coarse-textured soil. Sand and loamy sand.

Cobblestone. A rounded or partly rounded fragment of rock, 3 to 10 inches in diameter.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose. Noncoherent; will not hold together in a mass.

Friable. When moist, crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm. When moist crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic. When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a wire when rolled between thumb and forefinger.

Sticky. When wet, adheres to other material; tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard. When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Compact. A combination of firm consistence and close packing or arrangement of soil particles.

Soft. When dry, breaks into powder or individual grains under very slight pressure.

Cemented. Hard and brittle; little affected by moistening.

Contour. An imaginary line connecting points of equal elevation on the surface of the soil.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to the terrace grade.

Contour stripcropping. Growing crops in strips that follow the contour or are parallel to terraces or diversions. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Cover crop. A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production.

Cradle knoll. A mound or ridge of earth on a forest floor, often no more than 1 or 2 feet high; usually caused by the overthrow of large trees and consequent accumulation of the soil in the root mat through rainfall, frost action, and decay of the wood.

Crusty soil. Soil tending to form a thin, massive or platy surface layer under the beating action of raindrops.

Depressed area. A low-lying area that lacks surface outlets for removal of water or has only poorly developed ones. Sometimes called depressional area.

Diversion. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Dominant trees. The tallest trees in a stand.

Drainage, natural. Refers to the conditions that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. The following seven different classes of natural drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time; the water table is within 12 to 24 inches of the surface during part of the year; and in Podzolic soils mottlings are below 6 to 16 inches in the lower A horizon and in the B and C horizons. Synonymous with imperfectly drained, the term that has been used in Michigan.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Drift (geology). Material of any sort deposited by geologic processes in one place after having been removed from another; includes drift materials deposited by glaciers and by streams and lakes associated with them.

Fine-textured soils. *Moderately fine textured:* Clay loam, sandy clay loam, silty clay loam; *Fine-textured:* sandy clay, silty clay, and clay. Roughly, soil that contains 35 percent or more of clay.

Fragipan. A dense, brittle subsurface horizon very low in organic matter and clay but rich in silt or very fine sand. The layer seems to be cemented when it is dry, is hard or very hard, and has a high bulk density in comparison with the horizon or horizons above it. When moist, the fragipan tends to rupture suddenly if pressure is applied, rather than to deform slowly. The layer is generally mottled, is slowly or very slowly permeable to water, and has few or many bleached fracture planes that form polygons. Fragipans are a few inches to several feet thick. They generally occur below the B horizon, 15 to 40 inches below the surface.

Friability. Term for the ease with which soil crumbles. A friable soil is one that crumbles easily.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt water as it flowed from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Granule. A single mass, or cluster, of many individual soil particles.

Gravelly soil material. From 15 to 50 percent of material, by volume, consists of rounded or angular rock fragments that are not prominently flattened and are up to 3 inches in diameter.

Green manure. A crop grown for the purpose of being turned under in an early stage of maturity or soon after maturity for soil improvement.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the 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.

Intermittent stream. A stream or part of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long-continued supply from melting snow or other sources.

Internal soil drainage. The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by the height of the water table, either permanent or perched. Relative terms for expressing internal drainage are *none, very slow, slow, medium, rapid,* and *very rapid.*

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Mechanical analysis (soils). The percentage of the various sizes of individual mineral particles, or separates, in the soil. Also, a laboratory method of determining soil texture.

Medium-textured soil. Soil of very fine sandy loam, loam, silt loam, or silt texture.

Micronutrients. See Trace elements.

Mineral soil. Soil composed mainly of inorganic (mineral) material and low in content of organic matter. Its bulk density is greater than that of an organic soil.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Types are these: *Terminal, lateral, medial, ground.*

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *Fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Muck. An organic soil consisting of fairly well decomposed organic material that is relatively high in mineral content, finely divided, and dark in color.

Munsell notation. A system for designating color by degrees of the the three simple variables—*hue, value,* and *chroma.* For example, a notation of 10YR 6/4 is a color that has a hue of 10YR, a value of 6, and a chroma of 4.

Neutral soil. In practice, a soil having a pH value between 6.6 and 7.3. Strictly speaking, a soil that has a pH value of 7.0. See also Reaction, soil.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Organic soil. A general term applied to a soil or to a soil horizon that consists primarily of organic matter, such as peat soils, muck soils, and peaty soil layers.

Ortstein. The B horizon of Podzol soils that are cemented by the accumulated sesquioxides, by organic matter, or by both.

Outlet channel. A waterway constructed or altered primarily to carry water from manmade structures, such as terraces, tile lines, and diversion ditches.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Peat. Unconsolidated soil material, largely undecomposed organic matter, that has accumulated where there has been excess moisture.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permanent pasture. Pasture that is on the soil for a long time, in contrast to rotation pasture, which is on the soil only a year or two because it is grown in rotation with other crops.

Permeability, soil. 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. A numerical means for designating relative acidity and alkalinity in soils. See also Reaction, soil.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. See also Horizon, soil.

Reaction, soil. The degree of acidity or alkalinity of a soil expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction, because it is neither acid nor alkaline. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rolling. Having moderately steep, complex slopes; intermediate between undulating and hilly.

Row crop. A crop planted in rows so as to allow cultivation between rows during the growing season.

Runoff. The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff. That which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water. In this publication runoff is used in the sense of surface runoff.

Sand. Individual rock or mineral fragments in soils having diameters 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 sand and not more than 10 percent clay.

Seepage. Slow escape of water from a soil along an extensive line of surface.

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.

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 millimeters to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in a mature soil consists of the A and B horizons. Generally, the characteristics of the soil 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.

Sphagnum. A group of mosses that grow in moist places. By annual increments of growth, deep layers of fibrous and highly absorbent peat may be built up. Sphagnum grows best in cool, humid regions.

Stratified. Composed of, or arranged in, strata, or layers, such as stratified alluvium. The term is confined to geological material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) massive (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum, or true soil; the C or R horizon.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak in to the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in a permanent sod. See also Broad-base terrace.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. See also Clay, Sand, and Silt. The basic textural classes, in order of increasing proportions of fine particles are as follows: Sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tile drain. Concrete or pottery pipe placed at suitable spacing and depths in the soil or subsoil to provide water outlets from the soil.

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.

Trace elements. The chemical elements found in soils in extremely small amounts, yet that are essential to plant growth. Some of the trace elements are zinc, cobalt, manganese, and copper.

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify establishing a new soil series, but of such limited known extent 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.

Weathering. All physical and chemical changes produced in rocks at or near the earth's surface by atmospheric agents. These changes result in more or less complete disintegration and decomposition of the rock.

GUIDE TO MAPPING UNITS

[To obtain a complete description of a mapping unit, it is necessary to read the description of the mapping unit and the description of the soil series to which it belongs.

[See table 1, page 5, for approximate acreage and proportionate extent of the soils and table 2, page 87, for the predicted average acre yields of crops. For woodland suitability groups, see page 91; for information about engineering uses, see section beginning on page 96. Dashes indicate that a mapping unit was not placed in a group, because it was not suited to the use. Michigan Agricultural Experiment Station will continue to name Au Gres, loamy substratum, as Arenac; Chelsea as Graycalm; Rubicon, loamy substratum, as Melita; Shoals as Pennock, and Sloan as Pinora. The symbol in parentheses in the capability unit is the management group in which the mapping unit belongs on a statewide basis]

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
Ab	Abscota sand	8	Vw-3 (L-4a)	85	O	95
Ac	Abscota loam	8	Vw-3 (L-4a)	85	O	95
Ad	Adrian muck	8	Vwc-1 (M/4c)	85	J	94
Ae	Algansee sand	9	Vw-3 (L-4c)	85	O	95
Ag	Algansee loam	9	Vw-3 (L-4c)	85	O	95
AlB	Allendale loamy sand, 2 to 6 percent slopes	9	IIIw-9 (4/1b)	82	G	94
AmB	Allendale sandy loam, 2 to 6 percent slopes	10	IIIw-9 (4/1b)	82	G	94
ArB	Au Gres sand, 0 to 6 percent slopes	10	IVw-2 (5b)	84	F	93
AuB	Au Gres sand, loamy substratum, 0 to 6 percent slopes	10	IVw-2 (5/2b)	84	F	93
BdA	Belding sandy loam, 0 to 2 percent slopes	11	IIw-8 (3/2b)	79	G	94
BdB	Belding sandy loam, 2 to 6 percent slopes	11	IIw-8 (3/2b)	79	G	94
BeB	Belding sandy loam, clay subsoil variant, 2 to 6 percent slopes	12	IIw-8 (3/2b)	79	G	94
Bg	Bergland mucky silt loam	12	IIIw-2 (1c)	81	P	95
BlA	Blue Lake loamy sand, 0 to 2 percent slopes	13	IIIs-3 (4a)	83	C	92
BlB	Blue Lake loamy sand, 2 to 6 percent slopes	13	IIIs-4 (4a)	83	C	92
BlC	Blue Lake loamy sand, 6 to 12 percent slopes	13	IIIe-9 (4a)	81	C	92
BlD	Blue Lake loamy sand, 12 to 18 percent slopes	13	IVe-9 (4a)	84	C	92
BlE	Blue Lake loamy sand, 18 to 25 percent slopes	14	VIe-2 (4a)	85	C	92
BoB	Bohemian fine sandy loam, 2 to 6 percent slopes	14	IIe-2 (2.5a)	77	A	92
BoC	Bohemian fine sandy loam, 6 to 12 percent slopes	14	IIIe-5 (2.5a)	80	A	92
BoD	Bohemian fine sandy loam, 12 to 18 percent slopes	15	IVe-4 (2.5a)	83	A	92
Br	Brevort fine sandy loam	15	IIIw-10 (4/2c)	82	W	95
Bt	Brevort loamy sand	15	IIIw-10 (4/2c)	82	W	95
Bv	Brevort loamy sand, overwash	15	IIIw-10 (4/2c)	82	W	95
ByB	Brimley fine sandy loam, 2 to 6 percent slopes	16	IIw-7 (2.5b)	79	G	94
CaA	Carbondale loam, 0 to 2 percent slopes, overwash	17	Vwc-1 (Mc)	85	J	94
CbA	Carbondale muck, 0 to 2 percent slopes	17	Vwc-1 (Mc)	85	J	94
CbC	Carbondale muck, 6 to 12 percent slopes	17	Vwc-1 (Mc)	85	J	94
CdA	Carbondale peat, 0 to 2 percent slopes	17	Vwc-1 (Mc)	85	J	94
ChB	Chelsea sand, 0 to 6 percent slopes	17	IVs-4 (5a)	84	E	93
ChC	Chelsea sand, 6 to 12 percent slopes	18	VIs-1 (5a)	85	E	93
ChD	Chelsea sand, 12 to 18 percent slopes	18	VIIs-1 (5a)	86	E	93
ChE	Chelsea sand, 18 to 25 percent slopes	18	VIIs-1 (5a)	86	E	93
ChF	Chelsea sand, 25 to 55 percent slopes	18	VIIs-1 (5a)	86	E	93
ClB	Chelsea stony sand, 0 to 6 percent slopes	18	VIIs-1 (5a)	86	E	93
ClC	Chelsea stony sand, 6 to 12 percent slopes	18	VIIs-1 (5a)	86	E	93
ClD	Chelsea stony sand, 12 to 18 percent slopes	18	VIIs-1 (5a)	86	E	93
CoA	Coral fine sandy loam, 0 to 2 percent slopes	19	IIw-7 (2.5b)	79	G	94
CoB	Coral fine sandy loam, 2 to 6 percent slopes	19	IIw-7 (2.5b)	79	G	94
CrB	Croswell sand, 0 to 6 percent slopes	20	IVs-4 (5a)	84	E	93
CrC	Croswell sand, 6 to 12 percent slopes	20	VIs-1 (5a)	85	E	93
Da	Dawson peaty muck	21	VIIIw-1 (Mc-a)	86	L	94
DgB	Dighton sandy loam, 2 to 6 percent slopes	21	IIe-2 (2.5a)	77	B	92
DgC	Dighton sandy loam, 6 to 12 percent slopes	21	IIIe-5 (2.5a)	80	B	92
DgD2	Dighton sandy loam, 12 to 18 percent slopes, moderately eroded	22	IVe-4 (2.5a)	83	B	92
EaB	East Lake loamy sand, 0 to 6 percent slopes	22	IVs-4 (5a)	84	E	93
EaC	East Lake loamy sand, 6 to 12 percent slopes	22	VIs-1 (5a)	85	E	93

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
EaD	East Lake loamy sand, 12 to 18 percent slopes	23	VIIs-1 (5a)	86	E	93
ElA	East Lake sandy loam, 0 to 2 percent slopes	23	IVs-4 (5a)	84	E	93
Em	Edmore and Tonkey sandy loams	23	IIIw-6 (4c)	82	W	95
Er	Edwards muck	24	Vwc-1 (M/mc)	85	J	94
Es	Ensley and Tonkey loams	25	IIw-8 (3c)	79	W	95
Et	Ensley and Tonkey loams, overwash	25	IIw-8 (3c)	79	W	95
Eu	Evart loam	25	Vw-3 (L-4c)	85	O	95
Ev	Evart sand	25	Vw-3 (L-4c)	85	O	95
GaA	Gladwin loamy sand, 0 to 2 percent slopes	26	IIIw-5 (4b)	81	G	94
GaB	Gladwin loamy sand, 2 to 6 percent slopes	26	IIIw-5 (4b)	81	G	94
GdA	Gladwin sandy loam, 0 to 2 percent slopes	26	IIIw-5 (4b)	81	G	94
GdB	Gladwin sandy loam, 2 to 6 percent slopes	26	IIIw-5 (4b)	81	G	94
Gp	Gravel and sand pits	26	----------	--	---	--
GrB	Grayling sand, 0 to 6 percent slopes	27	VIIs-1 (5.7a)	86	N	94
GrC	Grayling sand, 6 to 12 percent slopes	27	VIIs-1 (5.7a)	86	N	94
GrE	Grayling sand, 18 to 25 percent slopes	27	VIIs-1 (5.7a)	86	N	94
Gt	Greenwood peat	28	VIIIw-1 (Mc-a)	86	L	94
Gu	Gullied land, coarse textured	28	VIIs-1 (5a)	86	C	92
Gx	Gullied land, moderately fine textured	28	VIIe-2 (1.5a)	85	B	92
Hm	Houghton muck	28	Vwc-1 (Mc)	85	J	94
IcA	Iosco loamy sand, 0 to 2 percent slopes	29	IIIw-9 (4/2b)	82	G	94
IcB	Iosco loamy sand, 2 to 6 percent slopes	29	IIIw-9 (4/2b)	82	G	94
IdA	Iosco sandy loam, 0 to 2 percent slopes	29	IIIw-9 (4/2b)	82	G	94
IdB	Iosco sandy loam, 2 to 6 percent slopes	29	IIIw-9 (4/2b)	82	G	94
IeB	Isabella loam, 2 to 6 percent slopes	30	IIe-2 (2.5a)	77	D	93
IeC	Isabella loam, 6 to 12 percent slopes	30	IIIe-5 (2.5a)	80	D	93
IeC2	Isabella loam, 6 to 12 percent slopes, moderately eroded	30	IIIe-5 (2.5a)	80	D	93
IeD	Isabella loam, 12 to 18 percent slopes	31	IVe-4 (2.5a)	83	D	93
IeD2	Isabella loam, 12 to 18 percent slopes, moderately eroded	31	IVe-4 (2.5a)	83	D	93
ImB	Isabella loamy sand, 2 to 6 percent slopes	31	IIe-2 (2.5a)	77	D	93
ImC	Isabella loamy sand, 6 to 12 percent slopes	31	IIIe-5 (2.5a)	80	D	93
ImC2	Isabella loamy sand, 6 to 12 percent slopes, moderately eroded	31	IIIe-5 (2.5a)	80	D	93
ImD	Isabella loamy sand, 12 to 18 percent slopes	31	IVe-4 (2.5a)	83	D	93
ImD2	Isabella loamy sand, 12 to 18 percent slopes, moderately eroded	31	IVe-4 (2.5a)	83	D	93
InD3	Isabella sandy clay loam, 12 to 18 percent slopes, severely eroded	32	VIe-2 (2.5a)	85	D	93
InE3	Isabella sandy clay loam, 18 to 25 percent slopes, severely eroded	32	VIIe-2 (2.5a)	85	D	93
IsB	Isabella sandy loam, 2 to 6 percent slopes	32	IIe-2 (2.5a)	77	D	93
IsB2	Isabella sandy loam, 2 to 6 percent slopes, moderately eroded	32	IIe-2 (2.5a)	77	D	93
IsC	Isabella sandy loam, 6 to 12 percent slopes	32	IIIe-5 (2.5a)	80	D	93
IsC2	Isabella sandy loam, 6 to 12 percent slopes, moderately eroded	32	IIIe-5 (2.5a)	80	D	93
IsD	Isabella sandy loam, 12 to 18 percent slopes	32	IVe-4 (2.5a)	83	D	93
IsD2	Isabella sandy loam, 12 to 18 percent slopes, moderately eroded	32	IVe-4 (2.5a)	83	D	93
IsE	Isabella sandy loam, 18 to 25 percent slopes	33	VIe-1 (2.5a)	85	D	93
KaB	Kalkaska gravelly sand, 2 to 6 percent slopes	33	IVs-4 (5a)	84	E	93
KkB	Kalkaska sand, 0 to 6 percent slopes	33	IVs-4 (5a)	84	E	93
KkC	Kalkaska sand, 6 to 12 percent slopes	34	VIs-1 (5a)	85	E	93
KkC3	Kalkaska sand, 6 to 12 percent slopes, severely eroded	34	VIs-1 (5a)	85	E	93
KkD	Kalkaska sand, 12 to 18 percent slopes	34	VIIs-1 (5a)	86	E	93
KkD3	Kalkaska sand, 12 to 18 percent slopes, severely eroded	34	VIIs-1 (5a)	86	E	93
KkE	Kalkaska sand, 18 to 25 percent slopes	34	VIIs-1 (5a)	86	E	93
KkE3	Kalkaska sand, 18 to 25 percent slopes, severely eroded	34	VIIs-1 (5a)	86	E	93
KkF	Kalkaska sand, 25 to 55 percent slopes	34	VIIs-1 (5a)	86	E	93
KlB	Kalkaska stony sand, 0 to 6 percent slopes	34	VIIs-1 (5a)	86	E	93

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
K1C	Kalkaska stony sand, 6 to 12 percent slopes	35	VIIs-1 (5a)	86	E	93
K1E	Kalkaska stony sand, 12 to 25 percent slopes	35	VIIs-1 (5a)	86	E	93
KnA	Kawkawlin loam, 0 to 2 percent slopes	35	IIw-2 (1.5b)	78	Z	96
KnB	Kawkawlin loam, 2 to 6 percent slopes	36	IIw-3 (1.5b)	78	Z	96
KoA	Kawkawlin loam, overwash, 0 to 2 percent slopes	36	IIw-2 (1.5b)	78	Z	96
KoB	Kawkawlin loam, overwash, 2 to 6 percent slopes	36	IIw-3 (1.5b)	78	Z	96
KrA	Kawkawlin sandy loam, 0 to 2 percent slopes	36	IIw-2 (1.5b)	78	Z	96
KrB	Kawkawlin sandy loam, 2 to 6 percent slopes	36	IIw-3 (1.5b)	78	Z	96
KsB	Kawkawlin stony loam, 2 to 6 percent slopes	36	IIw-3 (1.5b)	78	Z	96
KtB	Kent loam, 2 to 6 percent slopes	37	IIIe-3 (1a)	80	B	92
KtC	Kent loam, 6 to 12 percent slopes	37	IIIe-2 (1a)	79	B	92
KtC2	Kent loam, 6 to 12 percent slopes, moderately eroded	37	IIIe-2 (1a)	79	B	92
KtD	Kent loam, 12 to 18 percent slopes	37	IVe-1 (1a)	83	B	92
KtD2	Kent loam, 12 to 18 percent slopes, moderately eroded	37	IVe-1 (1a)	83	B	92
Kv	Kerston loam	38	Vw-3 (L-4c)	85	J	94
Kw	Kerston muck	38	Vw-3 (L-4c)	85	J	94
Kx	Kinross sand	38	IIIw-11 (5c)	83	Q	95
Lm	Linwood muck	39	Vwc-1 (M/3c)	85	J	94
Lo	Loxley muck	40	VIIIw-1 (Mc-a)	86	L	94
Lu	Lupton muck	40	Vwc-1 (Mc)	85	J	94
MaA	Mancelona loamy sand, 0 to 2 percent slopes	41	IIIs-3 (4a)	83	C	92
MaB	Mancelona loamy sand, 2 to 6 percent slopes	41	IIIs-4 (4a)	83	C	92
MaC	Mancelona loamy sand, 6 to 12 percent slopes	41	IIIe-9 (4a)	81	C	92
MaD	Mancelona loamy sand, 12 to 18 percent slopes	41	IVe-9 (4a)	84	C	92
MaE	Mancelona loamy sand, 18 to 25 percent slopes	41	VIe-2 (4a)	85	C	92
McA	Mancelona sandy loam, 0 to 2 percent slopes	41	IIIs-3 (4a)	83	C	92
MdB	Manistee loamy sand, 2 to 6 percent slopes	42	IIIs-4 (4/2a)	83	C	92
MdC	Manistee loamy sand, 6 to 12 percent slopes	42	IIIe-9 (4/2a)	81	C	92
MdD	Manistee loamy sand, 12 to 18 percent slopes	42	IVe-9 (4/2a)	84	C	92
Me	Markey muck	43	Vwc-1 (M/4c)	85	J	94
MgC	McBride gravelly sandy loam, 6 to 12 percent slopes	43	IIIe-6 (3a)	80	A	92
M1B	McBride loamy sand, 2 to 6 percent slopes	44	IIe-3 (3a)	78	A	92
M1C	McBride loamy sand, 6 to 12 percent slopes	44	IIIe-6 (3a)	80	A	92
M1C2	McBride loamy sand, 6 to 12 percent slopes, moderately eroded	44	IIIe-6 (3a)	80	A	92
M1D	McBride loamy sand, 12 to 18 percent slopes	44	IVe-4 (3a)	83	A	92
M1D2	McBride loamy sand, 12 to 18 percent slopes, moderately eroded	44	IVe-4 (3a)	83	A	92
M1E	McBride loamy sand, 18 to 25 percent slopes	44	VIe-2 (3a)	85	A	92
MmA	McBride sandy loam, 0 to 2 percent slopes	45	IIe-3 (3a)	78	A	92
MmB	McBride sandy loam, 2 to 6 percent slopes	45	IIe-3 (3a)	78	A	92
MmB2	McBride sandy loam, 2 to 6 percent slopes, moderately eroded	45	IIe-3 (3a)	78	A	92
MmC	McBride sandy loam, 6 to 12 percent slopes	45	IIIe-6 (3a)	80	A	92
MmC2	McBride sandy loam, 6 to 12 percent slopes, moderately eroded	45	IIIe-6 (3a)	80	A	92
MmD	McBride sandy loam, 12 to 18 percent slopes	45	IVe-4 (3a)	83	A	92
MmD2	McBride sandy loam, 12 to 18 percent slopes, moderately eroded	45	IVe-4 (3a)	83	A	92
MmD3	McBride sandy loam, 12 to 18 percent slopes, severely eroded	46	IVe-4 (3a)	83	A	92
MmE	McBride sandy loam, 18 to 25 percent slopes	46	VIe-2 (3a)	85	A	92
MmE2	McBride sandy loam, 18 to 25 percent slopes, moderately eroded	46	VIe-2 (3a)	85	A	92
MmE3	McBride sandy loam, 18 to 25 percent slopes, severely eroded	46	VIIe-2 (3a)	85	A	92
MnB	McBride stony sandy loam, 2 to 6 percent slopes	46	VIIs-1 (3a)	86	A	92
MnC	McBride stony sandy loam, 6 to 12 percent slopes	46	VIIs-1 (3a)	86	A	92
MoF	McBride soils, 25 to 45 percent slopes	47	VIIe-2 (3a)	85	A	92
MpA	Menominee loamy sand, 0 to 2 percent slopes	47	IIIs-3 (4/2a)	83	C	92

GUIDE TO MAPPING UNITS

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
MpB	Menominee loamy sand, 2 to 6 percent slopes	47	IIIs-4 (4/2a)	83	C	92
MpC	Menominee loamy sand, 6 to 12 percent slopes	48	IIIe-9 (4/2a)	81	C	92
MpC2	Menominee loamy sand, 6 to 12 percent slopes, moderately eroded	48	IIIe-9 (4/2a)	81	C	92
MpD	Menominee loamy sand, 12 to 18 percent slopes	48	IVe-9 (4/2a)	84	C	92
MpD2	Menominee loamy sand, 12 to 18 percent slopes, moderately eroded	48	IVe-9 (4/2a)	84	C	92
MpE	Menominee loamy sand, 18 to 25 percent slopes	48	VIe-2 (4/2a)	85	C	92
MrB	Montcalm gravelly loamy sand, 0 to 6 percent slopes	49	IIIs-4 (4a)	83	C	92
MrC	Montcalm gravelly loamy sand, 6 to 12 percent slopes	50	IIIe-9 (4a)	81	C	92
MrD	Montcalm gravelly loamy sand, 12 to 18 percent slopes	50	IVe-9 (4a)	84	C	92
MrE	Montcalm gravelly loamy sand, 18 to 25 percent slopes	50	VIe-2 (4a)	85	C	92
MsB	Montcalm loamy sand, 0 to 6 percent slopes	50	IIIs-4 (4a)	83	C	92
MsC	Montcalm loamy sand, 6 to 12 percent slopes	50	IIIe-9 (4a)	81	C	92
MsC2	Montcalm loamy sand, 6 to 12 percent slopes, moderately eroded	50	IIIe-9 (4a)	81	C	92
MsC3	Montcalm loamy sand, 6 to 12 percent slopes, severely eroded	51	IIIe-9 (4a)	81	C	92
MsD	Montcalm loamy sand, 12 to 18 percent slopes	51	IVe-9 (4a)	84	C	92
MsD2	Montcalm loamy sand, 12 to 18 percent slopes, moderately eroded	51	IVe-9 (4a)	84	C	92
MsD3	Montcalm loamy sand, 12 to 18 percent slopes, severely eroded	51	VIe-2 (4a)	85	C	92
MsE	Montcalm loamy sand, 18 to 25 percent slopes	51	VIe-2 (4a)	85	C	92
MtB	Montcalm sandy loam, 0 to 6 percent slopes	51	IIIs-4 (4a)	83	C	92
MtC	Montcalm sandy loam, 6 to 12 percent slopes	52	IIIe-9 (4a)	81	C	92
MtD	Montcalm sandy loam, 12 to 18 percent slopes	52	IVe-9 (4a)	84	C	92
MuB	Montcalm stony loamy sand, 2 to 6 percent slopes	52	VIIs-1 (4a)	86	C	92
MuC	Montcalm stony loamy sand, 6 to 12 percent slopes	52	VIIs-1 (4a)	86	C	92
MuD	Montcalm stony loamy sand, 12 to 18 percent slopes	52	VIIs-1 (4a)	86	C	92
MuE	Montcalm stony loamy sand, 18 to 25 percent slopes	52	VIIs-1 (4a)	86	C	92
MvF	Montcalm soils, 25 to 45 percent slopes	52	VIIe-2 (4a)	85	C	92
Mw	Munuscong fine sandy loam	53	IIw-8 (3/1c)	79	P	95
NaC3	Nester clay loam, 6 to 12 percent slopes, severely eroded	54	IIIe-4 (1.5a)	80	B	92
NaD3	Nester clay loam, 12 to 18 percent slopes, severely eroded	54	VIe-1 (1.5a)	85	B	92
NaE3	Nester clay loam, 18 to 25 percent slopes, severely eroded	54	VIIe-2 (1.5a)	85	B	92
NcC	Nester gravelly loam, 6 to 12 percent slopes	54	IIIe-4 (1.5a)	80	B	92
NeA	Nester loam, 0 to 2 percent slopes	54	IIs-1 (1.5a)	79	B	92
NeB	Nester loam, 2 to 6 percent slopes	55	IIe-1 (1.5a)	77	B	92
NeB2	Nester loam, 2 to 6 percent slopes, moderately eroded	55	IIIe-3 (1.5a)	80	B	92
NeC	Nester loam, 6 to 12 percent slopes	55	IIIe-4 (1.5a)	80	B	92
NeC2	Nester loam, 6 to 12 percent slopes, moderately eroded	55	IIIe-4 (1.5a)	80	B	92
NeD	Nester loam, 12 to 18 percent slopes	55	IVe-1 (1.5a)	83	B	92
NeD2	Nester loam, 12 to 18 percent slopes, moderately eroded	55	IVe-1 (1.5a)	83	B	92
N1B	Nester loamy sand, 2 to 6 percent slopes	55	IIe-1 (1.5a)	77	B	92
N1C	Nester loamy sand, 6 to 12 percent slopes	56	IIIe-4 (1.5a)	80	B	92
N1D	Nester loamy sand, 12 to 18 percent slopes	56	IVe-1 (1.5a)	83	B	92
NmA	Nester sandy loam, 0 to 2 percent slopes	56	IIs-1 (1.5a)	79	B	92
NmB	Nester sandy loam, 2 to 6 percent slopes	56	IIe-1 (1.5a)	77	B	92
NmB2	Nester sandy loam, 2 to 6 percent slopes, moderately eroded	56	IIIe-3 (1.5a)	80	B	92
NmC	Nester sandy loam, 6 to 12 percent slopes	56	IIIe-4 (1.5a)	80	B	92
NmC2	Nester sandy loam, 6 to 12 percent slopes, moderately eroded	56	IIIe-4 (1.5a)	80	B	92
NmD	Nester sandy loam, 12 to 18 percent slopes	57	IVe-1 (1.5a)	83	B	92
NmD2	Nester sandy loam, 12 to 18 percent slopes, moderately eroded	57	IVe-1 (1.5a)	83	B	92
NnC	Nester stony loam, 6 to 12 percent slopes	57	IIIe-4 (1.5a)	80	B	92
NoB	Nester stony sandy loam, 2 to 6 percent slopes	57	IIe-1 (1.5a)	77	B	92

GUIDE TO MAPPING UNITS--CONTINUED

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
NrE	Nester soils, 18 to 25 percent slopes	57	VIe-1 (1.5a)	85	B	92
NrE2	Nester soils, 18 to 25 percent slopes, moderately eroded	57	VIe-1 (1.5a)	85	B	92
NrF	Nester soils, 25 to 45 percent slopes	58	VIIe-2 (1.5a)	85	B	92
NsB	Newaygo sandy loam, 2 to 6 percent slopes	58	IIe-3 (3a)	78	A	92
NsD	Newaygo sandy loam, 6 to 18 percent slopes	58	IIIe-6 (3a)	80	A	92
OgA	Ogemaw loamy sand, 0 to 2 percent slopes	59	IVw-2 (5b-h)	84	F	93
OsA	Otisco loamy sand, 0 to 2 percent slopes	60	IIIw-5 (4b)	81	G	94
OsB	Otisco loamy sand, 2 to 6 percent slopes	60	IIIw-5 (4b)	81	G	94
OtA	Otisco sandy loam, 0 to 2 percent slopes	60	IIIw-5 (4b)	81	G	94
OtB	Otisco sandy loam, 2 to 6 percent slopes	60	IIIw-5 (4b)	81	G	94
Pc	Pickford fine sandy loam	60	IIIw-2 (1c)	81	P	95
Pk	Pickford silty clay loam	61	IIIw-2 (1c)	81	P	95
Pn	Pinconning loamy sand	61	IIIw-10 (4/1c)	82	W	95
RcB	Richter sandy loam, 2 to 6 percent slopes	62	IIw-7 (2.5b)	79	G	94
Re	Rifle loam, overwash	62	Vwc-1 (Mc)	85	J	94
Rf	Rifle muck	62	Vwc-1 (Mc)	85	J	94
Rl	Rifle peat	62	Vwc-1 (Mc)	85	J	94
Rm	Roscommon mucky sand and sand	63	IIIw-11 (5c)	83	Q	95
RnB	Rousseau fine sand, 2 to 6 percent slopes	64	IIIs-4 (4a)	83	C	92
RnC	Rousseau fine sand, 6 to 12 percent slopes	64	IIIe-9 (4a)	81	C	92
RnD	Rousseau fine sand, 12 to 18 percent slopes	64	IVe-9 (4a)	84	C	92
RoB	Rubicon sand, 0 to 6 percent slopes	64	VIIs-1 (5.3a)	86	H	94
RoC	Rubicon sand, 6 to 12 percent slopes	65	VIIs-1 (5.3a)	86	H	94
RoD	Rubicon sand, 12 to 18 percent slopes	65	VIIs-1 (5.3a)	86	H	94
RoE	Rubicon sand, 18 to 25 percent slopes	65	VIIs-1 (5.3a)	86	H	94
RoF	Rubicon sand, 25 to 55 percent slopes	65	VIIs-1 (5.3a)	86	H	94
RuB	Rubicon sand, loamy substratum, 0 to 6 percent slopes	65	IVs-4 (5/2a)	84	C	92
RuC	Rubicon sand, loamy substratum, 6 to 12 percent slopes	65	VIs-1 (5/2a)	85	C	92
RuD	Rubicon sand, loamy substratum, 12 to 18 percent slopes	65	VIIs-1 (5/2a)	86	C	92
RuE	Rubicon sand, loamy substratum, 18 to 25 percent slopes	65	VIIs-1 (5/2a)	86	C	92
Sa	Saranac loam	66	Vw-3 (L-2c)	85	O	95
ScB	Saugatuck sand, 0 to 6 percent slopes	67	IVw-2 (5b-h)	84	F	93
SeA	Selkirk loam, 0 to 2 percent slopes	67	IIIw-2 (1b)	81	Z	96
SeB	Selkirk loam, 2 to 6 percent slopes	67	IIIw-2 (1b)	81	Z	96
Sh	Shoals loam	68	Vw-3 (L-2c)	85	O	95
Sl	Shoals loamy sand	68	Vw-3 (L-2c)	85	O	95
Sm	Sims clay loam	68	IIw-2 (1.5c)	78	P	95
Sn	Sims loam	68	IIw-2 (1.5c)	78	P	95
So	Sims loam, overwash	69	IIw-2 (1.5c)	78	P	95
Ss	Sims sandy loam	69	IIw-2 (1.5c)	78	P	95
St	Sloan loam	69	Vw-3 (L-2c)	85	O	95
Ta	Tawas loam, overwash	70	Vwc-1 (M/4c)	85	J	94
Tc	Tawas muck	70	Vwc-1 (M/4c)	85	J	94
Tp	Tawas peat	70	Vwc-1 (M/4c)	85	J	94
Tr	Traverse loam	71	IIe-3 (3a)	78	A	92
TwA	Twining sandy loam, 0 to 2 percent slopes	72	IIw-2 (1.5b)	78	Z	96
TwB	Twining sandy loam, 2 to 6 percent slopes	72	IIw-3 (1.5b)	78	Z	96
UbB	Ubly sandy loam, 2 to 6 percent slopes	72	IIe-3 (3/2a)	78	A	92
UbC	Ubly sandy loam, 6 to 12 percent slopes	73	IIIe-6 (3/2a)	80	A	92
UbD	Ubly sandy loam, 12 to 18 percent slopes	73	IVe-4 (3/2a)	83	A	92
UlB	Ubly sandy loam, clay subsoil variant, 2 to 6 percent slopes	73	IIe-3 (3/2a)	78	A	92
UlC	Ubly sandy loam, clay subsoil variant, 6 to 12 percent slopes	73	IIIe-6 (3/2a)	80	A	92
WaB	Wallace sand, 0 to 6 percent slopes	74	VIIs-1 (5a-h)	86	H	94
WaD	Wallace sand, 6 to 18 percent slopes	74	VIIs-1 (5a-h)	86	H	94
We	Warners muck and Marl	75	Vwc-1 (M/mc)	85	J	94
Wh	Wheatley mucky loamy sand	75	IIIw-6 (4c)	82	W	95
Wk	Wheatley mucky sandy loam	75	IIIw-6 (4c)	82	W	95
Wl	Willette muck	76	Vwc-1 (M/1c)	85	J	94
WnC	Wind eroded land, sloping	76	VIIs-1 (5.7a)	86	N	94
WnF	Wind eroded land, steep	76	VIIs-1 (5.7a)	86	N	94

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If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

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Supplemental Nutrition Assistance Program

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