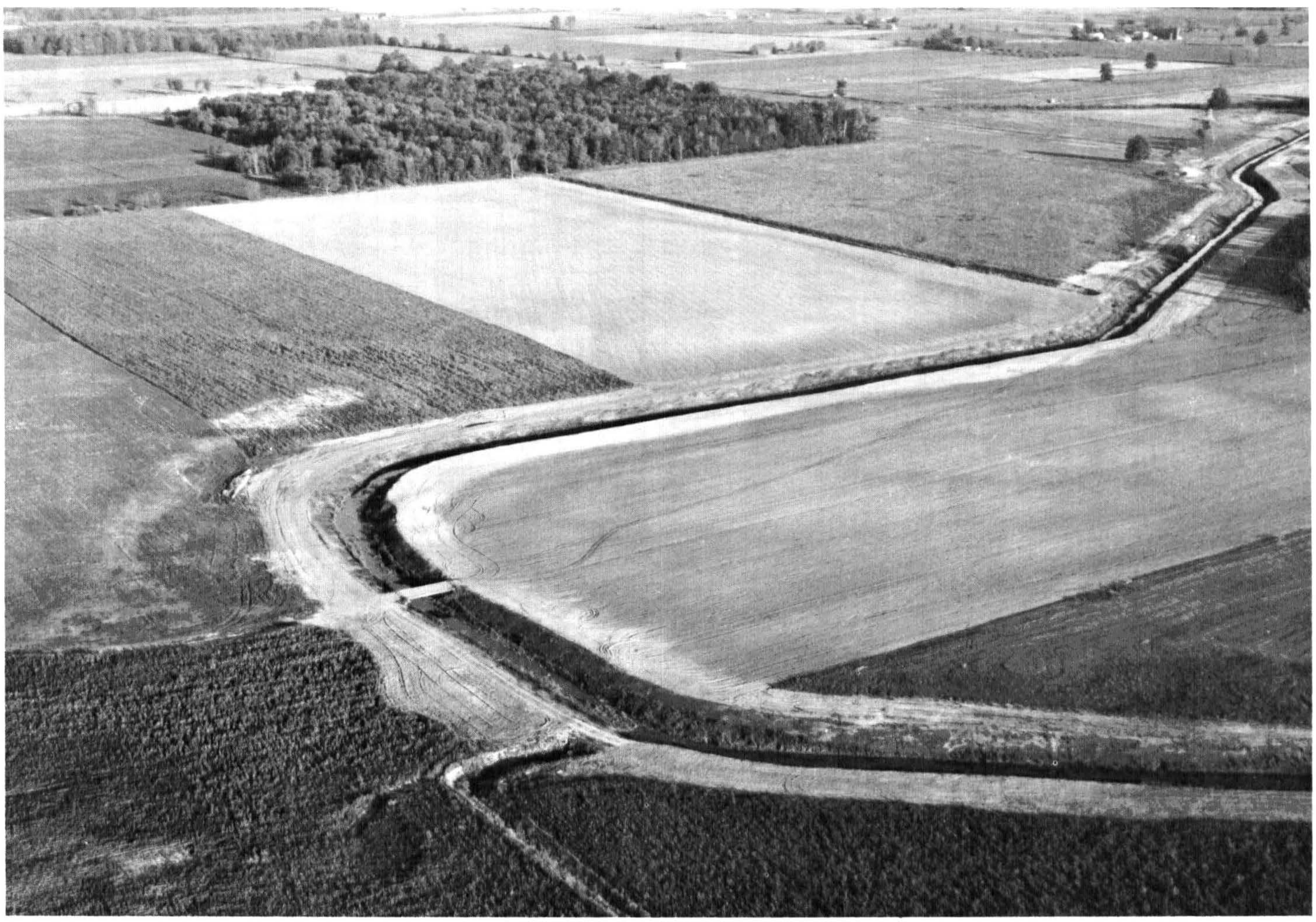
Issued April 1972

SOIL SURVEY

Genesee County, Michigan



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

Major fieldwork for this soil survey was done in the period 1962-66. Soil names and descriptions were approved in 1967. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1967. This survey was made cooperatively by the Soil Conservation Service and the Michigan Agricultural Experiment Station. It is part of the technical assistance furnished to the Genesee County Soil and Water Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D. C. 20250.

HOW TO USE THIS SOIL SURVEY

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

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The 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 the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil and each capability unit is described.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the descriptions of the soils and from the discussions of the capability units.

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

Community planners and others can read about soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas in the section "Use of Soils in Community Development."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain estimates of soil properties and information about soil features that affect engineering practices.

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

Newcomers in Genesee 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.

Cover: Area of Conover-Brookston association in Clayton Township. These are among the most productive soils in Genesee County.

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SOIL SURVEY OF GENESEE COUNTY, MICHIGAN

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UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH MICHIGAN AGRICULTURAL EXPERIMENT STATION

GENESEE COUNTY is in the southeastern part of Michigan (fig. 1). It has a land area of 412,160 acres, or 644 square miles. Flint, the county seat, is the cultural, industrial, and commercial center of the county. The automobile and associated industries dominate the economy.

This area is noted for its productive soils, intensive cropping, and high level of management. Corn, wheat, and soybeans are the principal crops. They are grown mainly for sale. Dairying and raising of livestock are important agricultural enterprises in the undulating to rolling areas of the county.

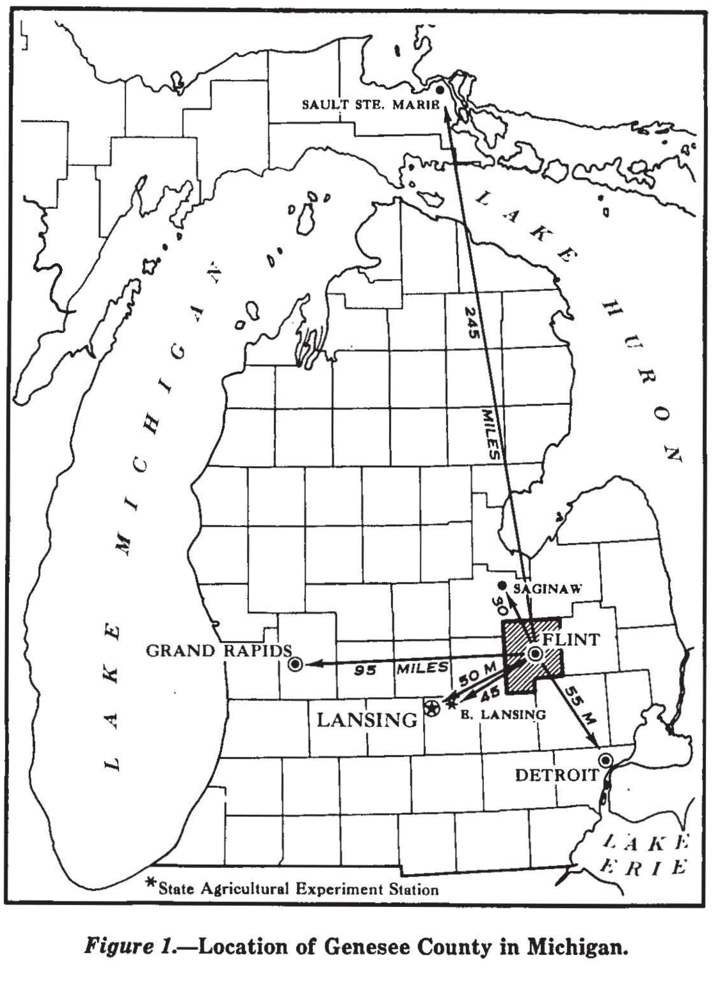

***Figure 1.*—Location of Genesee County in Michigan.**

How This Survey Was Made

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

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey (*11*)[1].

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

[1] Italic numbers in parentheses refer to Literature Cited p. 111.

those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristics that affect use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Boyer loamy sand, 6 to 12 percent slopes, is one of several phases within the Boyer series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication 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 the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Genesee County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Celina-Owosso sandy loams, 2 to 6 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Carlisle and Linwood mucks is an example.

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

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

The soil scientists set up trial groups of soils on the basis of yield and practice tables and other data they have collected. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Genesee 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 a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one asssociation ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The eight soil associations in Genesee County are discussed in the following pages.

1. Conover-Brookston association

Level to gently sloping, somewhat poorly drained and poorly drained loams that have a clay loam subsoil; on till plains

This association occupies 39 percent of the county and is located in its central and western parts. It includes some of the most poorly drained soils in the county.

Conover soils make up about 50 percent of the association; Brookston soils 30 percent; and minor soils 20 percent.

The major soils of this association formed in loam and light clay loam glacial till. The somewhat poorly drained Conover soils occur in broad, smooth areas and have a dominant slope of 1 to 3 percent. The poorly drained Brookston soils are of darker color than the Conover soils and are weathered to a greater depth. They generally occur in broad areas and have a dominant slope of less than 1 percent, but in places they are confined to local depressions and shallow drainage channels next to Conover soils.

Minor soils of this association are the moderately well drained Celina, Owosso, and Tuscola soils, and the somewhat poorly drained Kibbie and Metamora soils.

The native vegetation is hardwoods, including elm, ash, hickory, and maple. Except for small, scattered woodlots, most of this association has been cultivated.

The soils of this association are suited to intensive farming when they are drained and fertilized. They are limited mainly by a seasonal high water table and excess moisture. Where outlets are available, these soils are easy to drain by tile drains and open ditches. Hazard of erosion is slight, but slow runoff causes ponding in low areas early in the growing season and following heavy rainfall.

The major soils of this association are moderately to severely limited for highways and residential development. These limitations include frost heaving; a seasonal high water table, which limits operation of septic tank disposal fields; and the problem of disposing of surface water in some areas. These problems are most serious on the poorly drained soils of this association.

Urban expansion is extending the nearby industrial center to this soil association, and cropland is being used for homesite development.

2. *Celina-Conover-Miami association*

Level to sloping, somewhat poorly drained to well-drained loams that have a clay loam subsoil; on uplands

This association occupies 17 percent of the county and is located chiefly in its eastern and southeastern parts. Many drainageways in these soils terminate in potholes and local closed depressions.

Celina soils make up about 40 percent of the association; Conover soils 30 percent; Miami soils 15 percent; and minor soils 15 percent.

The major soils of this association formed in loam or light clay loam glacial till. They are characterized by complex slopes that are generally short to medium in length. The moderately well drained Celina soils occur chiefly on hilltops and side slopes. The dominant range in slope is 3 to 8 percent. The somewhat poorly drained Conover soils occupy lower, smoother positions. Slopes are generally less than 3 percent but are steeper in places. The well-drained Miami soils commonly occur on the steeper side slopes of drainage channels. They ordinarily have slopes up to 200 feet long. The dominant slope range for Miami soils is 8 to 15 percent, but slopes are steeper next to potholes and swales.

Minor soils of this association are the poorly drained Brookston soils and organic soils. These soils lie in broad, incised drainage channels, swales, and small closed depressions and potholes. Some of the larger stream channels have flood plains that are commonly occupied by Ceresco and Cohoctah soils that formed in sandy alluvium.

The native vegetation in the uplands is hardwoods, including oak, maple, elm, ash, and hickory. On organic soils there are dense stands of elm, ash, cedar, willow, alder, and soft maple, and on flood plains, dominantly mixed stands of elm, ash, hickory, and cottonwood.

The major soils of this association are subject to runoff and erosion because of their slope. In some cultivated areas, erosion of the surface layer has reduced organic-matter content, fertility, and available moisture capacity.

Most crops common to the county can be grown if these soils are properly managed. Most of the upland areas have been cultivated. Some of the steeper areas are farmed with the adjoining soils of gentler slopes, but parts of the steeper areas are in permanent pasture. The flood plains are generally kept in woodland because the danger of flooding severely limits use for crops. Many organic soil areas are idle or in woodland because suitable drainage outlets are not available.

The major soils in this association differ in their limitations for highways and residential development. The somewhat poorly drained Conover soils have severe limitations for streets and buildings because of a seasonal high water table and the hazard of frost heaving. The seasonal high water table also hinders the operation of septic tanks. The better drained Celina and Miami soils provide fair to good foundation material for houses, streets, and highways, but because of the slope, some cutting and filling is generally required for highways and homesites. The Celina and Miami soils vary in their limitation for septic tank disposal fields, and they generally require onsite investigation.

3. *Miami-Metea-Muck association*

Undulating to rolling, well-drained loams and loamy sands that have a clay loam to loamy sand subsoil, on uplands; and very poorly drained muck soils, in potholes and swales

This association occupies 14 percent of the county and is located in its eastern and southern parts. It contains many knolls, detached ridges, small lakes, and random drainageways. Many of the drainageways terminate in closed depressions. Included are moderately steep to steep slopes adjacent to streams, channels, and swales, and around potholes and depressions.

Miami soils make up about 35 percent of the association; Metea soils 20 percent; Muck soils 15 percent; and minor soils 30 percent.

Of the major soils in this association, the Miami soils are the most extensive. These soils occupy broad upland areas. They formed in loamy glacial till. Soils of the Metea series occupy the lower positions on side slopes, next to potholes and swales, and along drainageways. They formed in sandy deposits, 18 to 42 inches thick, that are underlain by loamy glacial till. Muck soils, mainly of the Carlisle and Lupton series, formed in thick organic deposits.

The minor soils of this association are chiefly the well-drained Boyer, Spinks, and Arkport, but small areas of somewhat poorly drained and poorly drained mineral soils occur throughout.

The native vegetation in the uplands is hardwoods, including oak, maple, ash, hickory, and cherry. On organic soils there are dense stands of elm, aspen, cedar, and soft maple.

Most areas of the Miami and Metea soils have been farmed (fig. 2). The steepest soils are in pasture or woodland. If tilled crops are grown, controlling erosion and maintaining the content of organic matter are the main concerns in management. Hazard of erosion is greater than for any other soil association in the county.

Many areas of muck lack drainage outlets or are too small to be farmed efficiently. These areas are wooded. A few larger areas are drained and used for commercial sod production or for pasture. Soil blowing is a hazard in large, exposed areas.

Upland soils of this association differ in their limitations for residential and recreational use according to their slope. Gently sloping areas are slightly limited, but the steeper slopes are severely limited. Layout and construction of houses, streets, and utilities are difficult on the steeply sloping soils. The muck soils are severely limited for most kinds of construction by a high water table and the instability of the organic matter.

4. Del Rey-Lenawee association

Level to gently sloping, somewhat poorly drained and poorly drained silt loams and silty clay loams that have a silty clay loam subsoil; on lake plains

This association occupies 9 percent of the county and is located in its western and northern parts. It consists of the finest textured soils in the county. These are also among the most poorly drained. Surface drainage is good only in areas bordering well-defined drainage channels; it is less well developed on the broad interdrainage areas. Slopes are dominantly less than 3 percent but are slightly steeper along drainage channels.

Del Rey soils make up about 50 percent of the association; Lenawee soils 30 percent; and minor soils 20 percent.

The major soils of this association are the somewhat poorly drained Del Rey soils and the poorly drained Lenawee soils. The Del Rey soils occupy the slightly higher positions, and the darker Lenawee soils occupy intermittent drainageways, swales, and other depressions. In places, the Lenawee soils occur on broad areas and the Del Rey soils occur as scattered low knolls and ground swells. Elsewhere, Del Rey soils are more extensive and Lenawee soils occupy shallow drainageways and small depressions.

Minor soils of this association are the somewhat poorly drained Selfridge soils and the moderately well drained Morley and Tuscola soils.

The native vegetation is hardwoods, including elm, ash, hickory, and oak. Most of the woodland of this association consists of small, scattered woodlots.

Most areas of this association are intensively cultivated. The major soils have moderately slow or very slow runoff. The water table is at or near the surface unless the soils are drained. Soils of this association dry out slowly in spring and following heavy rain.

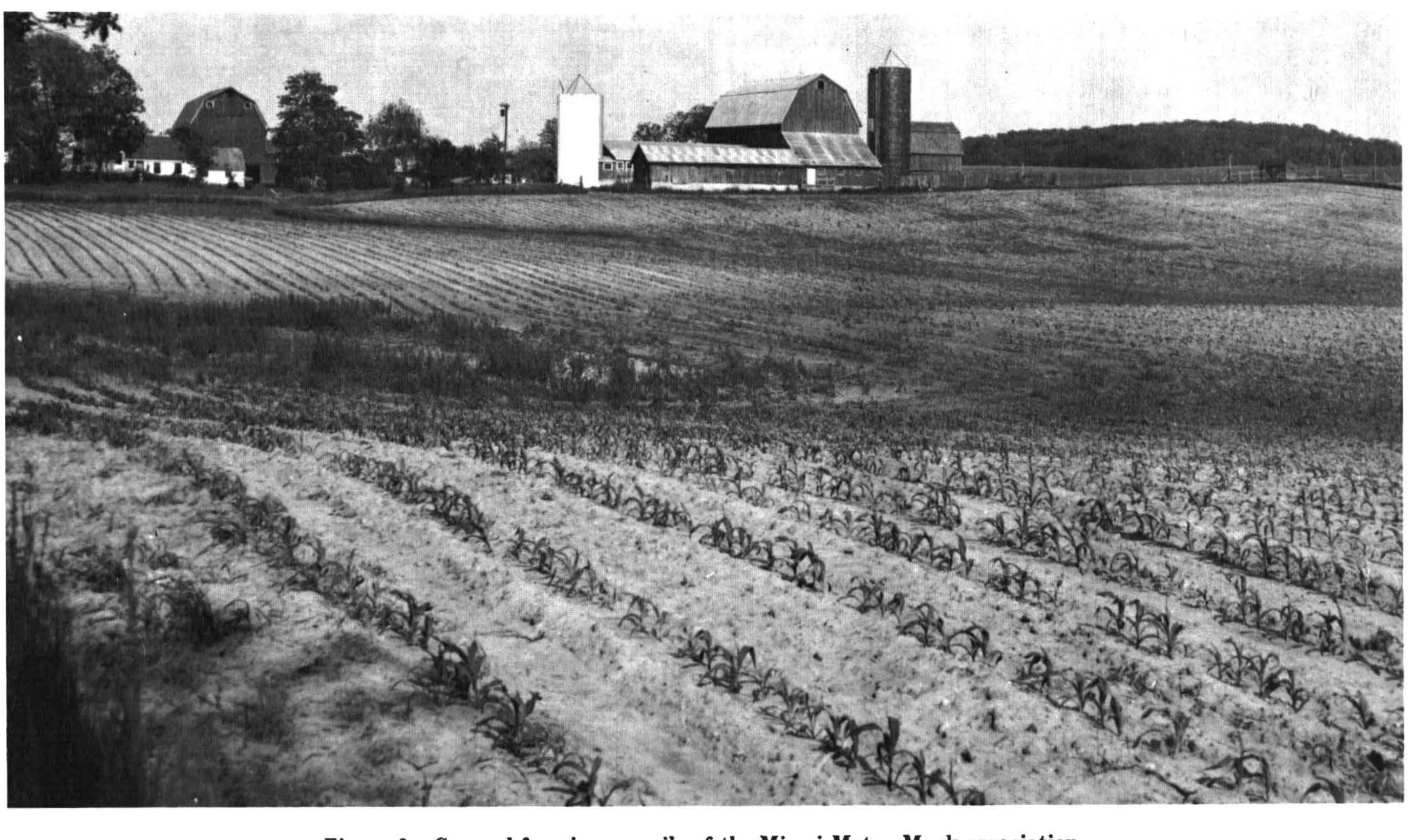

***Figure 2.*—General farming on soils of the Miami-Metea-Muck association.**

Because they have a high content of silt and clay, they are difficult to keep in good tilth. Good tilth is harder to maintain if organic-matter content is low or the soils are tilled when wet.

Soils of this association are severely limited as sites for highways and residences because they have a moderately high clay content. Highways and foundations for buildings are subject to frost heaving. Cracking and other displacements are caused by alternate wetting and drying of the soil material. Moderately slow permeability and a seasonal high water table hinder the operation of septic tank disposal fields in these soils. These problems are more serious on the poorly drained soils of this association.

5. *Pinconning-Allendale-Lenawee association*

Level and nearly level, poorly drained and somewhat poorly drained loamy fine sands underlain by silty clay, and soils that are silty clay loam throughout; on lake plains.

This association occupies 4 percent of the county and is located in its northern part. Pinconning soils make up about 45 percent of the association; Allendale soils 20 percent; Lenawee soils 10 percent; and minor soils 25 percent.

Of the major soils of this association, the somewhat poorly drained Allendale soils occur in broad areas of fine sand or loamy fine sand, 18 to 42 inches thick, that is underlain by clay or silty clay. The darker, poorly drained Pinconning and Lenawee soils occur in narrow, shallow drainageways and closed depressions. Pinconning and Allendale soils formed in similar materials, but the Pinconning soils are more poorly drained and have a darker surface layer. The Lenawee soils formed in slightly stratified silty clay loam containing thin layers and lenses of very fine sand, silt, and silt loam. They are the dominant finer textured soils in the association.

Minor soils of this association are the somewhat poorly drained Del Rey, Kibbie, Au Gres, and Ceresco soils, the poorly drained or very poorly drained Colwood and Cohoctah soils, and the well-drained Oakville, Spinks, and Arkport soils.

The native vegetation in the southern part of this association is elm, ash, basswood, shagbark hickory, swamp white oak, sugar maple, and beech. In the northern part the natural cover is white pine and aspen mixed with southern hardwoods.

The major soils of this association are limited for farming by wetness. Drainage is affected by a slight difference in elevation. Major drainage channels are parallel, located 1 to 2 miles apart, and flow northwestward to empty into the Flint River. Secondary drainage is poorly developed because of low relief. Local drainage is generally by a random network of shallow natural drainageways that eventually empty into one of the better developed major drainage channels. Tile lines and ditches are used in many places for drainage, but lack of outlets hinders drainage in some areas.

Most crops common to the county can be grown on these soils if they are drained and fertilized. Most areas of this association have been drained and are farmed. The flood plains remain wooded, since a high water table and the hazard of flooding severely limit crops. Most of the sandy soils are subject to soil blowing if not protected by vegetation.

The major soils of this association are severely limited as sites for highways and residences. Limitations are most severe on the poorly drained soils. Foundations are subject to displacement caused by alternate wetting and drying of the underlying clayey material. Septic tank disposal fields are limited by a seasonal high water table.

6. *Granby-Gilford association*

Level, poorly drained loamy sands underlain by sands, and sandy loams that have a dominantly coarse sandy loam subsoil underlain by sand and gravel; on lake plains

This association occupies 4 percent of the county and is located in its northern part. It occupies broad, low areas. Granby soils make up about 45 percent of the association; Gilford soils 35 percent; and minor soils 20 percent.

The major soils of this association formed in water-laid sandy deposits. The Granby soils formed in deep sand and loamy sand. The Gilford soils formed in loamy sand, but have a finer textured subsoil than the Granby soils and are underlain by stratified coarse sand and gravel. The Gilford soils commonly occur in areas between the sandier Granby soils and the better drained, more gravelly soils bordering the Flint River.

Minor soils of this association are the well drained or moderately well drained Oakville soils and the somewhat poorly drained Au Gres and Selfridge soils.

The native vegetation on the somewhat poorly drained soils is red pine, white pine, oak, and aspen; on the wetter soils it is dominantly mixed stands of elm, oak, red maple, aspen, alder, willow, and cedar.

These soils are limited for crops by wetness and low fertility. Tile lines and ditches are used in places for drainage. Areas lacking suitable artificial drainage outlets are still woodland. Most cleared areas are farmed. Some cultivated areas have returned to hardwoods and brush. A small amount of acreage is used for specialized crops such as blueberries and to grow sod for landscaping.

The soils of this association are severely limited for residential development by the seasonal high water table, which hinders the operation of septic tank disposal fields. These soils are a potential commercial source of sand and gravel.

7. *Spinks-Metea-Miami association*

Undulating to rolling, well-drained loamy sands that have a dominantly sand and loamy sand subsoil, and loams that have a clay loam subsoil; on uplands

This association occupies 3 percent of the county and is located in its northern part. It occurs mainly in Thetford and Forest Townships and is characterized by complex slopes and local potholes and depressions. In places there are narrow detached ridges and knolls that have moderately steep or steep side slopes.

Spinks soils make up about 40 percent of the association; Metea soils 30 percent; Miami soils 15 percent; and minor soils 15 percent.

The major soils of this association formed in deep sands, sandy material underlain by loamy till, and in loamy till. Spinks soils formed in deep sand and have thin layers of finer texture. They commonly occupy broad areas. Metea soils consist of sandy material, 18 to 42 inches thick, that is underlain by glacial till. They occur at slightly higher elevations on side slopes of ridges. The loamy Miami soils occupy upper slopes and hilltops.

Minor soils of this association are the well-drained Boyer and Oakville soils and the poorly drained Brevort and Granby soils.

The vegetation of this association includes a few large areas that have returned to woodland consisting of beech, maple, aspen, birch, and some white pine. The sandy soils of this association are suitable for growing trees, and some idle land has already been planted to pine.

The more extensive Spinks and Metea soils have a moderate to severe limitation for crops. They are droughty and subject to both soil blowing and water erosion where planted to crops. The less extensive Miami soils are suited to most crops grown in the county if erosion is controlled. If irrigated, the less sloping areas of these soils are suited to vegetables and small fruit. Where larger areas of the more loamy Miami soils are associated with the sandy soils, dairying and raising of beef cattle are feasible.

Limitation for residential and recreational use varies with steepness of the soils. It is difficult to lay out and construct houses and streets and install utilities in the moderately steep or steeply sloping areas. Less sloping areas, particularly of the Spinks soils, provide good foundation material for houses, streets, and highways.

8. *Boyer-Spinks-Ceresco-Cohoctah association*

Nearly level to gently sloping, well-drained loamy sands that have a dominantly sand to sandy loam subsoil, on outwash plains and terraces; and level, somewhat poorly drained, poorly drained, and very poorly drained fine sandy loams underlain by fine sandy loams to sand; on bottom lands

This association occupies 10 percent of the county and is located along the Flint and Shiawassee Rivers and their major tributaries. It includes some of the most droughty and coarse-textured soils in the county. Boyer soils make up about 35 percent of the association; Spinks soils 25 percent; Ceresco soils 10 percent; Cohoctah soils 5 percent; and minor soils 25 percent.

The well-drained Boyer soils formed in loamy sand 18 to 40 inches deep over stratified coarse sand and gravel. These soils occupy the high sandy and gravelly flats. The well-drained Spinks soils formed mainly in sand and loamy sand but contain thin, discontinuous bands of finer texture. These soils commonly occupy the more sloping positions above the Boyer soils. The Ceresco and Cohoctah soils formed in loamy sand to fine sandy loam waterlaid sediments. The somewhat poorly drained Ceresco soils occupy slightly higher positions on the bottom land than the poorly drained and very poorly drained Cohoctah soils.

Minor soils of this association are the well drained Oakville soils, the moderately well drained Perrin soils, the somewhat poorly drained Wasepi soils, the poorly drained Gilford soils, and the poorly drained and very poorly drained Sloan soils.

The native vegetation on nearly level to gently sloping outwash and in terrace positions is soft maple, beech, elm, oak, and variable amounts of red pine and white pine. On river banks and river bottoms, the vegetation is dominantly hardwoods, including ash, birch, cottonwood, elm, and hickory.

Upland soils of this association, mainly Spinks and Boyer, are moderately low to low in available moisture capacity and natural fertility, and are subject to soil blowing when cultivated. Many areas of these soils are severely limited for cultivated crops. Some areas, principally in Montrose Township, are used for apple orchards and small fruit. Other areas are used for cultivated crops, especially those adjacent to the finer textured soils of the till plain. Large areas have been abandoned for cropland, and some have been planted to pine. Other areas are used as sites for houses and home gardens. If irrigated, the less sloping upland soils are suitable for growing vegetables and small fruit.

The river-bottom soils, mainly Ceresco and Cohoctah, have a seasonal high water table and are subject to flooding. Many areas have meandering stream channels or steep riverbanks that make them unsuitable for farming. Some of the larger areas that are less subject to flooding are planted to crops. If properly managed, these areas are suited to corn, spring-planted grains, and mixtures of grasses and legumes. The largest amount of acreage is woodland, and most areas are suitable for wildlife habitat.

Upland soils, mainly Spinks and Boyer, are suitable sources of fill material, and are only slightly limited for highways, streets, and residential development. Septic tank disposal fields normally function well because these soils are well drained. River-bottom soils, mainly Ceresco and Cohoctah, are severely limited for residential and recreational use because of the high water table and the hazard of flooding.

Descriptions of the Soils

This section describes the soil series and mapping units of Genesee County. The approximate 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 a mapping unit, it is necessary to read the description of the unit and also the description of the soil series to which it belongs. Following the soil name in the description of each mapping unit is the symbol used to identify that unit on the detailed soil map at the back of this publication.

Each soil series contains a description of the soil profile that is considered typical for all mapping units of the series. If the profile for a given mapping unit differs from this typical profile, the differences are stated in the description of the mapping unit unless they are apparent from the name. In describing the mapping units, some of the major limitations or hazards that affect the management of crops or pasture are mentioned.

Each soil series contains two descriptions of the soil profile that is considered typical for all mapping units of the series. The first description is brief and is useful mostly to those who need to identify soils by their appearance. The second profile, in smaller print, is much more detailed and is useful to scientists, engineers, and others who need to make studies of soil origin and behavior.

Allendale Series

The Allendale series consists of nearly level soils that formed in sandy deposits 18 to 42 inches thick over clayey material. These soils have a fluctuating water table and are somewhat poorly drained. They are on sandy lake plains in the northwestern part of the county, chiefly in Montrose and Vienna Townships. In this county the Allendale soils were mapped

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

Soil	Acres	Percent
Arkport loamy fine sand, 0 to 2 percent slopes	1,339	0.3
Arkport loamy fine sand, 2 to 6 percent slopes	1,119	.3
Arkport loamy fine sand, 6 to 12 percent slopes	165	(1)
Au Gres loamy sand, 0 to 6 percent slopes	2,331	.6
Au Gres loamy sand, loamy substratum, 0 to 6 percent slopes	2,053	.5
Borrow pits	962	.2
Boyer loamy sand, 0 to 2 percent slopes	3,481	.8
Boyer loamy sand, 2 to 6 percent slopes	5,079	1.2
Boyer loamy sand, 6 to 12 percent slopes	1,106	.3
Boyer loamy sand, 12 to 18 percent slopes	419	.1
Breckenridge-Brevort complex	2,049	.5
Brevort loamy sand	1,405	.3
Brookston loam	32,807	8.0
Carlisle muck	4,123	1.0
Carlisle and Linwood mucks	3,175	.8
Celina loam, 6 to 9 percent slopes	2,874	.7
Celina-Conover loams, 0 to 2 percent slopes	1,791	.4
Celina-Conover loams, 2 to 6 percent slopes	23,904	5.8
Celina-Owosso sandy loams, 2 to 6 percent slopes	10,381	2.5
Ceresco fine sandy loam	4,379	1.0
Cohoctah silt loam	2,261	.5
Colwood silt loam	2,332	.6
Conover loam, 0 to 2 percent slopes	74,917	18.2
Conover loam, 2 to 6 percent slopes	37,648	9.1
Conover-Metamora sandy loams, 0 to 2 percent slopes	6,963	1.7
Conover-Metamora sandy loams, 2 to 6 percent slopes	4,101	.9
Croswell sand, 0 to 6 percent slopes	2,034	.5
Del Rey sandy loam, 0 to 2 percent slopes	379	(1)
Del Rey silt loam, 0 to 2 percent slopes	10,497	2.6
Del Rey silt loam, 2 to 6 percent slopes	12,591	3.1
Edwards muck	1,099	.3
Fox sandy loam, 0 to 2 percent slopes	717	.2
Fox sandy loam, 2 to 6 percent slopes	292	(1)
Gilford sandy loam	4,160	1.0
Granby loamy sand	3,920	.9
Gravel pits	970	.2
Kibbie fine sandy loam, 0 to 2 percent slopes	2,591	.6
Kibbie fine sandy loam, 2 to 6 percent slopes	587	.1
Lake beaches	51	(1)
Lamson loamy fine sand	656	.2
Landes fine sandy loam	888	.2
Lenawee silty clay loam	2,842	2.1
Linwood muck	821	.2
Lupton muck	5,005	1.2
Made land	1,118	.3
Markey muck	1,170	.3
Metamora sandy loam, 0 to 2 percent slopes	6,017	1.4
Metamora sandy loam, 2 to 6 percent slopes	1,399	.3
Metea loamy sand, 0 to 2 percent slopes	1,660	.4
Metea loamy sand, 2 to 6 percent slopes	5,046	1.2
Metea loamy sand, 6 to 12 percent slopes	572	.1
Miami loam, 2 to 6 percent slopes	1,177	.3
Miami loam, 6 to 12 percent slopes	17,500	4.3
Miami loam, 12 to 18 percent slopes	4,180	1.0
Miami loam, 18 to 25 percent slopes	2,197	.5
Miami clay loam, 6 to 12 percent slopes, eroded	292	(1)
Miami clay loam, 12 to 18 percent slopes, eroded	591	.1
Miami clay loam, 18 to 25 percent slopes, eroded	370	(1)
Miami sandy loam, sandy substratum, 0 to 2 percent slopes	760	.2
Miami-Metea complex, 2 to 6 percent slopes	5,757	1.4
Miami-Metea complex, 6 to 12 percent slopes	3,561	.9
Miami-Metea complex, 12 to 18 percent slopes	624	.1
Minoa loamy fine sand, 0 to 2 percent slopes	2,084	.5
Morley silt loam, 2 to 6 percent slopes	3,652	.9
Morley silt loam, 6 to 12 percent slopes	798	.10
Oakville fine sand, 0 to 6 percent slopes	4,965	1.2
Oakville fine sand, 6 to 12 percent slopes	421	.1
Oakville fine sand, loamy substratum, 0 to 6 percent slopes	2,580	.6
Perrin loamy sand, 0 to 2 percent slopes	1,219	.3
Perrin loamy sand, 2 to 6 percent slopes	245	(1)
Pinconning-Allendale loamy fine sands, 0 to 2 percent slopes	3,875	.9
Rifle muck	574	.1
Sebewa loam	1,522	.4
Selfridge loamy sand, 0 to 2 percent slopes	5,638	1.4
Selfridge loamy sand, 2 to 6 percent slopes	1,162	.3
Sisson fine sandy loam, 2 to 6 percent slopes	646	.2
Sisson fine sandy loam, 6 to 12 percent slopes	340	(1)
Sloan silt loam	2,833	.7
Sloan silt loam, occasionally flooded	923	.2
Spinks loamy sand, wet subsoil variant, 0 to 2 percent slopes	724	.2
Spinks-Oakville loamy sands, 0 to 2 percent slopes	2,190	.5
Spinks-Oakville loamy sands, 2 to 6 percent slopes	7,094	1.7
Spinks-Oakville loamy sands, 6 to 12 percent slopes	2,891	.7
Spinks-Oakville loamy sands, 12 to 18 percent slopes	624	.2
Tuscola silt loam, 0 to 2 percent slopes	195	(1)
Tuscola silt loam, 2 to 6 percent slopes	977	.2
Wallkill silt loam	324	(1)
Wasepi sandy loam, 0 to 2 percent slopes	2,274	.6
Wasepi sandy loam, loamy substratum, 0 to 2 percent slopes	997	.2
Urban areas and miscellaneous land	17,138	4.4
Total	412,160	100.0

[1] Less than 0.1 percent.

only in a complex with the Pinconning soils. This complex is described under the Pinconning series.

In a typical profile, the surface layer is very dark grayish-brown loamy fine sand about 8 inches thick. The upper 17 inches of the subsoil consists of dark yellowish-brown, pale-brown, and light brownish-gray, very friable loamy fine sand and fine sand that contain yellowish-brown and strong-brown mottles. The lower 4 inches of the subsoil is light brownish-gray silty clay that is very firm and has yellowish-brown mottles. Underlying the subsoil is light brownish-gray silty clay that has brownish-yellow mottles. This layer is very firm and has a high lime content.

Because these soils are nearly level and are sandy, surface water runs off very slowly and rainfall is readily absorbed. The high water table early in the growing season sometimes delays tillage and planting. Permeability is moderately rapid in the upper sandy layers but slow in the underlying clayey material. Where the clayey material is near the surface, tile drainage does not work well. If these soils are drained, they tend to be droughty because of the sandy upper layers. They hold a moderate amount of moisture for plant growth and are moderate in natural fertility.

Most areas of Allendale soils are drained and are farmed with surrounding finer textured soils. A few areas, once farmed, are now idle. Wetness is the main limitation. If they are drained, these soils warm up earlier in spring and can be tilled and planted earlier than surrounding soils. Because of the slowly permeable clayey material, tile lines generally require backfilling.

Typical profile of Allendale loamy fine sand, 0 to 2 percent slopes, in a cultivated field, SE¼SE¼ sec. 11, T. 9 N., R. 5 E., Montrose Township:

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

B21hir—8 to 14 inches, dark yellowish-brown (10YR 4/4) loamy fine sand; massive to weak, medium, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.

B22ir—14 to 22 inches, pale-brown (10YR 6/3) fine sand; few, coarse, prominent, strong-brown (7.5YR 5/8) mottles; weak, medium, subangular blocky structure; very friable; few reddish-brown (5YR 4/4) chunks of cemented material; slightly acid; clear, wavy boundary.

A2—22 to 25 inches, light brownish-gray (10YR 6/2) fine sand; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; very friable; slightly acid; abrupt, wavy boundary.

IIBt—25 to 29 inches, light brownish-gray (10YR 6/2) silty clay; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; weak, medium, angular blocky structure; very firm; mildly alkaline.

IIC—29 inches, light brownish-gray (10YR 6/2) silty clay; common medium, distinct, brownish-yellow (10YR 6/8) mottles; massive; very firm; calcareous.

The thickness of the Ap horizon ranges from 6 to 10 inches. The texture of the Ap and B2 horizons is fine sand, loamy fine sand, or loamy sand. In uncultivated areas a very dark gray (10YR 3/1) A1 horizon, 4 to 6 inches thick, overlies a thin, discontinuous, lighter colored A2 horizon. The color of the B21hir horizon ranges from dark yellowish brown (10YR 4/4) to brown (7.5YR 5/4) or dark brown (7.5YR 4/4). The B22ir horizon contains small amounts of reddish-brown (5YR 4/4) or yellowish-red (5YR 4/6) ortstein chunks of various sizes and shapes.

The combined thickness of the A and B horizons is 18 to 42 inches, and this is the depth from the surface to the calcareous silty clay. In places 5 to 8 inches of sandy loam overlies the silty clay. In some areas the texture of the IIB and IIC horizons is heavy silty clay loam. The reaction of the A and B horizons ranges from medium acid to mildly alkaline.

Allendale soils have coarser textured Ap and B2 horizons than Metamora soils. They have more fine sand in the A horizon and the upper B horizon than Selfridge soils and have a finer textured C horizon.

Arkport Series

The Arkport series consists of nearly level to sloping, well-drained soils that formed in water-laid fine sand on lake plains and outwash plains. In places these soils occur between soils on outwash plains and soils on till plains.

In a typical profile, the surface layer is dark grayish-brown loamy fine sand about 7 inches thick. The upper 21 inches of the subsoil consists of yellowish-brown and light yellowish-brown, very friable loamy fine sand. The lower 5 inches of the subsoil consists of brown, friable very fine sandy loam. Underlying the subsoil is pale-brown, loose very fine sand that is neutral in reaction.

Runoff ranges from slow on the nearly level areas to moderate on the sloping areas. Permeability is moderate or moderately rapid. Natural fertility is moderate. Available moisture capacity is moderate, and there is rarely enough moisture for optimum crop growth during dry summers. Because of the sandy texture, there is risk of soil blowing in exposed cultivated fields.

Most level or gently sloping areas of these soils have been farmed, but many are now idle. Sloping areas are mostly idle or remain as woodland. Low natural fertility and lack of moisture are the main limitations to the use of these soils for crops. Control of soil blowing is needed in some areas. Where irrigation water is available, these soils are well suited to vegetables, small fruit, and other specialty crops.

Typical profile of Arkport loamy fine sand, 0 to 2 percent slopes, in an idle field, SW¼SE¼ sec. 18, T. 9 N., R. 6 E., Vienna Township:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loamy fine sand; weak, medium, granular structure; very friable, neutral; abrupt, smooth boundary.

B2—7 to 12 inches, yellowish-brown (10YR 5/6) loamy fine sand; weak, medium, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.

A'2—12 to 28 inches, light yellowish-brown (10YR 6/4) loamy fine sand; weak, medium, subangular blocky structure; very friable; neutral; abrupt, wavy boundary.

B'2t—28 to 33 inches, brown (7.5YR 5/4) very fine sandy loam; very small amounts of light yellowish-brown (10YR 6/4) loamy fine sand fill cracks and completely coat some peds; moderate, medium, subangular blocky structure; friable; neutral; abrupt, wavy boundary.

C—33 to 48 inches, pale-brown (10YR 6/3) very fine sand; few, very thin (1/8 to 1/4 inch), discontinuous bands of brown (7.5YR 5/4) very fine sandy loam; single grain; loose; neutral.

The color of the A horizon is dark brown (10YR 3/3) or very dark grayish brown (10YR 3/2) in wooded areas. The texture of the profile is generally fine sand and very fine sand, but in places medium sand occurs in the lower B horizon and in the C horizon. Discontinuous strata of fine sandy loam to silt loam up to 3 inches thick also occur in the lower B and C horizons in some areas. The combined thickness of the A and B horizons ranges from 33 to 60 inches. The reaction of these horizons is generally slightly acid or neutral.

Arkport soils contain more fine sand and very fine sand than Spinks soils. Although Arkport and Minoa soils formed in similar material, Arkport soils are less mottled and better drained.

Arkport loamy fine sand, 0 to 2 percent slopes (ArA).—This soil has the profile described as typical of the series. The soil occupies nearly level areas above major drainage channels, mainly in the northwestern part of the county. In some areas this soil is underlain, at a depth of 40 inches or more, by limy very fine sand and silt or silt loam.

Droughtiness and soil blowing are the main limitations if this soil is used for crops. Therefore, supplying organic matter and conserving moisture are important. Small grains and other drought-resistant or early maturing crops generally grow better than corn on this soil. Many areas are now idle or serve as homesites, and some are used for orchards. Where irrigation water is available, this soil can be used for vegetables, small fruit, or other specialty crops. Capability unit IIIs–3 (4a).

Arkport loamy fine sand, 2 to 6 percent slopes (ArB).—This soil is mainly on uplands. In many places it occurs between the higher, more loamy soils and the lower, sandy and gravelly soils on outwash. Elsewhere it is on low sandy ridges on till plains. Typically it has simple, short to medium slopes and is dissected by random shallow waterways. Areas of this soil range from 20 to 60 acres in size. In some places this soil is underlain at a depth of 40 inches or more by limy very fine sand and silt or silt loam. Seepage occurs near the margins of this soil during spring.

Most areas have been cultivated. Hazard of water erosion is only slight, but soil blowing is a more common hazard on unprotected areas. Droughtiness and the risk of soil blowing are the main limitations to the use of this soil for crops. Supplying organic matter regularly and conserving moisture are important. Small grains and other drought-resistant or early maturing crops grow better than corn on this soil. Many areas are now idle or are used as homesites, and some are used for orchards. Where irrigation water is available, this soil can be used for vegetables, small fruit, and other specialty crops. Capability unit IIIs–4 (4a).

Arkport loamy fine sand, 6 to 12 percent slopes (ArC).—This soil commonly occupies positions between the finer textured soils on uplands and the sandy and gravelly soils on river terraces and in glacial drainage channels. Less extensive areas are on narrow, sandy ridges bordering the glacial lake plains in the northwestern part of the county. Typical areas have simple, short to medium slopes and are dissected by shallow waterways.

On the rim of side slopes and on the crest of ridges between waterways, the surface layer is thinner than elsewhere. In places the pale-brown or yellowish-brown plow layer is a mixture of the original surface layer and small amounts of the upper part of the subsoil. These spots have lower organic-matter content and natural fertility than less eroded areas. Seep spots are common on lower slopes in spring.

Most areas of this soil have been farmed. Slope, uncontrolled runoff, and risk of erosion are the main limitations. Organic-matter content, natural fertility, and available moisture capacity have been lowered by erosion, and there is a risk of additional erosion if this soil is intensively cultivated. Row crops can be grown, however, if the cropping system includes more years of sod crops than row crops and if the soil is otherwise well managed. Capability unit IIIe–9 (4a).

Au Gres Series

The Au Gres series consists of somewhat poorly drained, sandy soils that formed in thick, sandy outwash on the lake plain in the northwestern part of the county.

In a typical profile, the surface layer is very dark gray loamy sand about 8 inches thick. The subsoil extends to a depth of about 35 inches. The upper 6 inches of the subsoil consists of dark reddish-brown, very friable loamy sand that has strong-brown mottles. This is underlain by 10 inches of yellowish-brown, loose sand that has strong-brown and reddish-brown mottles and contains a few chunks of cemented soil material. The lower part of the subsoil is pale-brown, loose sand that has yellowish-brown mottles. The underlying material is light brownish-gray, loose sand.

Au Gres soils have rapid permeability, slow runoff, and low available moisture capacity. Natural fertility is low. Most cultivated crops are poorly suited to these soils.

Most areas of Au Gres soils consist of abandoned cropland or are second-growth woodland. Wetness, low fertility, and low available moisture capacity are the main limitations for crops. Undrained areas have a high water table early in the growing season. This retards plant growth and sometimes delays planting in spring. When the water table is lowered, crops lack enough moisture for good growth. If drained, these soils are easily farmed, but the organic-matter content and fertility are difficult to maintain because of the sandy texture. The soils are well suited to blueberries because they are acid and have a high water table.

Typical profile of Au Gres loamy sand, 0 to 6 percent slopes, in an idle field, SE¼NW¼ sec. 16, T. 9 N., R. 5 E., Montrose Township:

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

B21h—8 to 14 inches, dark reddish-brown (5YR 3/4) loamy sand; common, medium, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium, subangular blocky structure; very friable; very strongly acid; abrupt, wavy boundary.

B22—14 to 24 inches, yellowish-brown (10YR 5/4) sand; common, medium, distinct, reddish-brown (5YR 4/4) and strong-brown (7.5YR 5/6) mottles; single grain; some small, weakly cemented ortstein chunks; loose; strongly acid; clear, wavy boundary.

B3—24 to 35 inches, pale-brown (10YR 6/3) sand; common, coarse, faint, yellowish-brown (10YR 5/6) mottles; single grain; loose; medium acid; clear, wavy boundary.

C—35 to 42 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; medium acid.

Uncultivated areas of these soils have a very dark gray (10YR 3/1) or black (10YR 2/1) A1 horizon that is 2 to 4 inches thick and overlies a lighter colored A2 horizon. The texture of the A horizon is loamy sand or loamy fine sand. In places the Bh horizon ranges to dark brown (7.5YR 4/4) in color and contains red (2.5YR 4/6), dark-red (2.5YR 3/6), or yellowish-red (5YR 4/6) ortstein chunks of various sizes and shapes. Mottling begins at a depth of 10 to 15 inches. In places the soils are underlain by clay loam or silty clay loam at a depth of 42 to 66 inches. The A and B horizons range from slightly acid to very strongly acid, and the C horizon ranges from medium acid to neutral.

The Au Gres and Croswell soils formed in similar material, but the Au Gres soils are more poorly drained. They are better drained than Granby soils.

Au Gres loamy sand, 0 to 6 percent slopes (AsB).—This somewhat poorly drained soil occupies broad areas on sandy plains, only a few feet above the poorly drained Granby soils. It has the profile described as typical of the series. Most areas have a nearly uniform surface and range from 10 to 25 acres in size. The slope exceeds 3 percent in only a few places.

A small amount of brown or reddish-brown subsoil material that has been mixed into the plow layer gives this soil a spotty appearance in cultivated fields.

Included in mapping are small areas of the moderately well drained Croswell soils on the slightly higher sandy knolls.

Because of droughtiness at times during the growing season, wetness in spring, and low natural fertility and organic-matter content, this soil is poorly suited to cultivated crops. It is better suited to trees or as wildlife areas. The acidity and the seasonal high water table are favorable for commercial blueberry production. Capability unit IVw-2 (5b).

Au Gres loamy sand, loamy substratum, 0 to 6 percent slopes (AuB).—This is a somewhat poorly drained soil on sandy plains. Its slope exceeds 3 percent in only a few places. In many areas this soil is between the deep, sandy Oakville and Croswell soils and the finer textured, poorly drained Brookston and Lenawee soils. It is most extensive on the lake plains in the northwestern part of the county. Areas of this soil are 10 to 40 acres or more in size.

The plow layer has a spotty appearance in cultivated fields where the original surface layer and part of the brown or dark-brown subsoil have been mixed by plowing. Unlike the soil described in the typical profile, this soil has a clay loam or silty clay loam substratum at a depth of 42 to 66 inches. A layer of loamy coarse sand or coarse sandy loam 3 to 5 inches thick overlies the substratum in places.

The loamy substratum enables this soil to store more moisture than other Au Gres soils, especially for deep-rooted crops or trees. An excessive amount of water is present in spring and following periods of heavy rainfall. Natural fertility and organic-matter content are low.

This soil is poorly suited to cultivated crops. If crops are grown, those that are drought resistant or early maturing generally do better than other crops. Soil acidity and the seasonal high water table are favorable for blueberry production. Capability unit IVw-2 (5b).

Borrow Pits

Borrow pits (Bp) are areas where the original soil profile has been destroyed by removal of soil material. This material has been used as fill for roads and building sites. It includes all types of soil material except gravel. Gravel pits are shown separately on the soil map at the back of this survey and are described elsewhere in this section.

Borrow pits of varying size occur throughout the county. The larger ones are outlined on the soil map. The smaller ones, generally less than 2 acres in size, are shown on the map by spot symbols.

Included in mapping are small areas of poorly drained soils that have a surface layer rich in organic matter. The surface layer has been removed and used as topsoil for landscaping. Capability unit VIIIs-1 (Sa).

Boyer Series

The Boyer series consists of well-drained, nearly level to moderately steep soils that formed in sandy and loamy deposits. Nearly level and gently sloping areas are on outwash plains and river terraces. The steeper areas are on uplands, on terrace escarpments, and along drainage channels. These soils are most extensive on the gravelly flats and benches along the Flint River and its major tributaries.

In a typical profile, the surface layer is dark-brown loamy sand about 7 inches thick. The upper 11 inches of the subsoil is yellowish-brown, very friable loamy sand. The lower 15 inches consists of dark-brown, friable sandy loam and firm, light sandy clay loam. It is underlain by yellowish-brown and brownish-gray, stratified sand and gravel at a depth of about 33 inches. This material is loose and has a high lime content.

Boyer soils have moderately low natural fertility, moderately low available moisture capacity, and moderately rapid permeability. They rarely hold enough moisture for optimum growth of crops, especially during dry summer months.

Most of the level to sloping areas of these soils are farmed, but some are in orchards or pine plantations. Where these areas are farmed, there is risk of soil blowing unless windbreaks, stripcropping, minimum tillage, and other conservation measures are used. If irrigation water is available, the less sloping areas are well suited to vegetables, small fruit, and other specialty crops. Generally, however, Boyer soils are better suited to crops that resist drought and mature early. Many of the steeper areas of these soils have been farmed but are now idle.

Typical profile of Boyer loamy sand, 2 to 6 percent slopes, in a cultivated field, NW¼SW¼ sec. 14, T. 8 N., R. 5 E., Flushing Township:

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

B1—7 to 18 inches, yellowish-brown (10YR 5/8) loamy sand; weak, fine, granular structure; very friable; many fine roots; slightly acid; clear, wavy boundary.

B21—18 to 26 inches, dark-brown (7.5YR 4/4) sandy loam; weak, fine, subangular blocky structure; friable; medium acid; clear, wavy boundary.

B22t—26 to 33 inches, dark-brown (7.5YR 4/4) light sandy clay loam; moderate, fine, subangular blocky structure; firm; slightly acid; abrupt, irregular boundary.

IIC—33 to 42 inches, dark yellowish-brown (10YR 4/4) and light brownish-gray (10YR 6/2), stratified sand and gravel; single grain; loose; calcareous.

The Ap horizon is very dark grayish brown (10YR 3/2) in some areas. The texture is loamy sand, coarse loamy sand, or sandy loam. The B21 horizon is sandy loam or gravelly sandy loam, and the B22t horizon is heavy sandy loam or light sandy clay loam.

The combined thickness of the A and B horizons varies within short distances but commonly ranges from 24 to 36 inches. The combined thickness of the B21 and B22t horizons ranges from 5 to 15 inches. The reaction of the A and B horizons is medium acid to neutral.

Although Boyer and Perrin soils formed in similar material, Boyer soils are better drained and are not mottled in the B2 horizon. Boyer soils are finer textured than Spinks soils and are coarser textured than Fox soils.

Boyer loamy sand, 0 to 2 percent slopes (BrA).—This is a well-drained soil on gravelly benches above the major stream channels. It occupies slightly higher positions than the nearby more poorly drained Perrin and Wasepi soils. Most areas are long, narrow, and parallel to the stream channels and range from 40 to 80 acres in size. The principal areas are along the Flint River, the Shiawassee River, and their major tributaries.

Runoff is slow, and there is little or no water erosion. Shortage of moisture for crops during the growing season is the major limitation. Control of soil blowing is a problem where large areas are tilled and left exposed. Using crop residue and planting cover and green-manure crops are ways of adding organic matter to the soil and controlling soil blowing.

Under good management this soil is suited to corn, small grain, potatoes, forage, and many other crops. It is well suited to vegetables, small fruits, and other specialty crops if irrigation water is available. Capability unit IIIs–3 (4a).

Boyer loamy sand, 2 to 6 percent slopes (BrB).—This soil has the profile described as typical for the series. It occurs mostly on gravelly benches above the major stream channels, but some undulating areas are in glacial drainage channels and on gravelly ridges of the till plain. This soil is slightly above the more poorly drained Perrin and Wasepi soils. Most areas are long, narrow, and parallel to the stream channels. Many areas are only 10 to 20 acres in size, but a few are as large as 80 acres or more.

The plow layer is generally dark brown or very dark grayish brown. In some small eroded areas, where the surface layer and part of the subsoil have been mixed through tillage, the plow layer is brown or yellowish brown and has a lower organic-matter content. In these areas there is a surface accumulation of fine gravel. In local areas this soil is underlain by loamy till or loamy water-laid sediments.

Included in areas mapped as this soil are small areas of well-drained Spinks and Fox soils. The Spinks soils are sandier than the Boyer soils and slightly lower in natural fertility and available moisture capacity. The Fox soils are higher in natural fertility and available moisture capacity than the Boyer soils.

If this soil is cultivated, there is risk of water erosion on the steeper parts, and there is an even greater risk of soil blowing on unprotected areas. Lack of sufficient moisture for crops during the growing season is a major limitation. Under good management this soil is suited to corn, small grains, potatoes, and forage crops. It is well suited to vegetables, small fruit, and other specialty crops if irrigation water is available. Capability unit IIIs–4 (4a).

Boyer loamy sand, 6 to 12 percent slopes (BrC).—This soil generally occupies short terrace slopes or breaks on the less sloping gravelly plains. It also occurs on side slopes of glacial drainage channels and on narrow sandy and gravelly ridges in areas of outwash. It commonly occurs with the more gently sloping Boyer and Spinks soils.

In some eroded spots the original surface layer and part of the subsoil have been mixed by plowing, and the plow layer is brown with random spots of dark brown. These eroded spots have lower natural fertility and organic-matter content than less eroded areas. Included in mapping are minor areas of the sandier Spinks soils, which have slightly lower natural fertility and available moisture capacity than this soil.

Because of the steeper slopes, this Boyer soil has more runoff and less moisture available for plants than the more nearly level Boyer soils. The risk of water erosion is also greater. More intensive management is needed to maintain natural fertility and supply organic matter. Using crop residue and planting cover or green-manure crops are ways of providing organic matter and controlling erosion. Under careful management this soil is suited to corn, small grains, potatoes, and forage crops. Capability unit IIIe–9 (4a).

Boyer loamy sand, 12 to 18 percent slopes (BrD).—This well-drained soil occupies side slopes of ridges and drainage channels. The slopes are generally smooth, except in random drainageways, and normally do not exceed 300 feet in length. Most areas range from 5 to 15 acres in size, though some are as large as 40 acres.

The depth to limy coarse sand and gravel is more variable in this soil than in less sloping Boyer soils. This depth is generally less than 33 inches, and in places it is only a little more than 24 inches.

Included in mapping are a few brown or yellowish-brown, moderately eroded spots where some gravel is on the surface. These spots have lower natural fertility and organic-matter content than this Boyer soil. Also included are small random areas of the finer textured Miami soils.

Runoff is rapid, and there is a moderately severe risk of water erosion if this soil is intensively cultivated. Because of steeper slopes and greater runoff, this soil has less water available for crops than other Boyer soils. It is poorly suited to row crops. Capability unit IVe–9 (4a).

Breckenridge Series

The Breckenridge series consists of level or depressional soils that have a high water table and are poorly drained. These soils formed in sandy and loamy deposits over loamy material that is limy and has a high clay content. The depth to this finer textured material is 18 to 42 inches. Breckenridge soils occupy lake plains and till plains throughout the county. In this county they were mapped only in a complex with the Brevort soils.

In a typical profile, the surface layer is very dark brown sandy loam about 9 inches thick. The subsoil is stratified gray loamy sand and sandy loam to a depth of about 23 inches and is gray light sandy clay loam below that depth. The upper part of the subsoil has grayish-brown mottles and is friable. The lower part has yellowish-brown mottles and is firm. Underlying the subsoil at a depth of about 37 inches is very firm, calcareous, grayish-brown clay loam that has yellowish-brown mottles.

Breckenridge soils commonly receive runoff from higher soils. Runoff is slow, and the lowest areas are ponded. Permeability is moderately rapid in the upper part of these soils but is moderately slow in the finer textured underlying material. The subsoil is gray because it is wet for long periods. The high water table restricts root growth and makes operation of machinery difficult. If they are drained, these soils have moderately high available moisture capacity and fertility.

Drained areas of these soils are used for crops. Undrained areas are used mainly for pasture or as woodland. Wetness is the major limitation. These soils dry out slowly in spring and after heavy rainfall. Consequently, planting is delayed in spring and harvesting is difficult if rain is excessive in fall. After the soils are drained, however, they are easily worked and kept in good tilth. They are well suited to cultivated crops commonly grown in the county.

Typical profile of a Breckenridge sandy loam having slopes of 0 to 2 percent in a cultivated field, SW¼SW¼SW¼ sec. 32, T. 9. N., R. 5 E. Montrose Township:

Ap—0 to 9 inches, very dark brown (10YR 2/2) sandy loam; weak, medium, granular structure; very friable; abundant fine roots; high organic-matter content; mildly alkaline; abrupt, wavy boundary.

B1g—9 to 23 inches, stratified gray (10YR 5/1) loamy sand and sandy loam; few, medium, faint, grayish-brown (10YR 5/2) mottles; weak medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B2g—23 to 37 inches, gray (10YR 5/1) light sandy clay loam; many, coarse, distinct, yellowish-brown (10YR 5/8) mottles; weak, medium to coarse, subangular blocky structure; firm; mildly alkaline; abrupt, smooth boundary.

IICg—37 to 48 inches, grayish-brown (10YR 5/2) clay loam; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; very firm; calcareous.

The color of the Ap horizon ranges from very dark brown to very dark gray (10YR 3/1) or black (10YR 2/1). The B1g horizon contains thin seams and strata of sand in some areas. The B2g horizon is heavy sandy loam in places. The depth to the IIC horizon ranges from 24 to 42 inches. In some areas a layer of very coarse sand or fine gravel 3 to 5 inches thick overlies the IIC horizon. The reaction of the A and B horizons is slightly acid to mildly alkaline.

The Breckenridge soils are more poorly drained and have a grayer B horizon than the Metamora soils. They are finer textured than the Pinconning soils but are coarser textured than the Lenawee soils.

Breckenridge-Brevort complex (0 to 2 percent slopes) (Bt).—The soils in this complex have a dark-colored surface layer and are poorly drained. They occupy broad flats, natural drainage channels, and depressions. The Breckenridge soils make up about 60 percent of the complex, the Brevort soils 25 percent, and other soils about 15 percent. The Breckenridge soils typically consist of 18 to 42 inches of sandy loam over clay loam or silty clay loam. The Brevort soils are coarser textured in their surface layer and subsoil than the Breckenridge soils, and their subsoil is thinner. Underlying the Brevort soils is clay loam or silty clay loam.

Included with the soils of this complex are minor areas of the finer textured Brookston soils in slight depressions and drainageways. Also included, where the complex adjoins sandy outwash, are small areas of the more gravelly Gilford soils.

Wetness is the major limitation to the use of this complex for crops. Drainage can be improved by use of surface ditches and tile drains, although some areas are difficult to drain because suitable outlets are lacking. The depth and spacing of tile depend on the depth to the finer textured underlying material. In places tile trenches cave in because the upper layers are sandy and unstable. These soils warm up and dry out slowly in spring, and farming operations are delayed. Small depressions remain wet longer than adjacent areas, and these wet depressions delay cultivation after heavy rainfall. Drained areas are used for corn, field beans, and forage crops. Capability unit IIw–8 (3/2c).

Brevort Series

The Brevort series consists of level or depressional, poorly drained soils that formed in sandy deposits overlying loamy material that has a high lime content. The depth to the loamy material is 18 to 40 inches. Brevort soils occupy till plains and lake plains, and in many areas they are next to more sandy soils on outwash plains. In this county Brevort soils were mapped alone and also in a complex with the Breckenridge soils. For a description of the complex, see the Breckenridge series.

In a typical profile, the surface layer is very dark grayish-brown loamy sand about 6 inches thick. The subsoil is light brownish-gray, very friable loamy sand about 3 inches thick. Underlying this layer, and extending to a depth of about 37 inches, is grayish-brown loose sand and loamy coarse sand that contain brownish-yellow mottles. Below the sand is gray, firm clay loam that has yellowish-brown mottles and a high lime content.

Surface water runs off these soils very slowly or is ponded, and runoff from higher soils adds to the wetness. The gray color of the subsoil indicates that the soils are wet for long periods. Water moves rapidly through the upper sandy layers but moderately slowly through the finer textured underlying material. Undrained areas have a water table at a depth of less than 12 inches during spring. This delays tillage and planting and hinders the growth of plant roots. Natural fertility is low. Available moisture capacity is low.

Drained areas are used for crops. Many fields are drained only by random surface ditches. Some areas were once used for crops but are now idle, are in permanent pasture, or have reverted to open stands of trees and brush.

Typical profile of Brevort loamy sand (0 to 2 percent slopes) in a wooded area, NW¼SW¼ sec. 6, T. 8 N., R. 6 E., Mt. Morris Township:

A1—0 to 6 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, medium, granular structure; very friable; high organic-matter content; slightly acid; abrupt, wavy boundary.

B2—6 to 9 inches, light brownish-gray (10YR 6/2) loamy sand; common, coarse, faint, brownish-yellow (10YR 6/8) mottles; weak, medium, subangular blocky structure; very friable; neutral; abrupt, wavy boundary.

C1g—9 to 24 inches, grayish-brown (10YR 5/2) sand; common, coarse, distinct, brownish-yellow (10YR 6/6) mottles; single grain; loose; mildly alkaline; gradual, smooth boundary.

C2g—24 to 37 inches, grayish-brown (10YR 5/2) loamy coarse sand; common, coarse, distinct, brownish-yellow (10YR 6/8) mottles; single grain; loose; very friable; mildly alkaline; abrupt, wavy boundary.

IIC3g—37 to 48 inches, gray (N 5/0) clay loam; common, medium, prominent, yellowish-brown (10YR 5/8) mottles; massive; firm; calcareous.

In some depressions there is a layer of muck as much as 10 inches thick overlying the mineral soil. The texture of the A1 and B horizons ranges from loamy sand to fine sand or loamy fine sand. The texture of the C1 and C2 horizons is dominantly sand or loamy sand. The depth to the calcareous IIC horizon ranges from 18 to 40 inches but is commonly 30 to 40 inches. A layer of very coarse sand or fine gravel 5 to 8 inches thick overlies the IIC horizon in some areas. The reaction of the upper sandy horizons ranges from slightly acid to mildly alkaline.

Brevort and Selfridge soils formed in similar material, but Brevort soils are more poorly drained. Brevort soils are coarser textured than Breckenridge soils.

Brevort loamy sand (0 to 2 percent slopes) (Bv).—This is a poorly drained soil on broad flats, in natural drainage channels, and in depressions. The most extensive areas are on the sandy lake plains in the northwestern part of the county. Smaller areas occur throughout the rest of the county.

The surface layer is generally dark colored, although in a few spots it is reddish brown and weakly cemented. These spots occur at random and average ¼ to ½ acre in size.

Included in mapping are minor areas of sandy, poorly drained Granby soils in depressions and poorly drained, more loamy Breckenridge and Brookston soils on till plains.

Wetness, especially early in the growing season, is the main limitation if this soil is used for crops. During dry summers, when the water table is lower, this soil tends to be more droughty than nearby soils that are more loamy. It can be drained by tile or drainage ditches. Tiling is easier late in summer when the water table is lower. If drained, this soil can be used for corn, field beans, soybeans, and forage crops. Capability unit IIIw–10(4/2c).

Brookston Series

The Brookston series consists of level or slightly depressional, poorly drained soils on till plains and low moraines. These soils formed in loamy till that has a high lime content.

In a typical profile, the surface layer is very dark brown loam about 10 inches thick. The subsoil is firm, gray clay loam that has brown, grayish-brown, and yellowish-brown mottles. The underlying material, beginning at a depth of about 51 inches, is gray loam that has yellowish-brown mottles. It is friable and has a high lime content.

Runoff is very slow, and at times the soils are ponded. Permeability is moderate or moderately slow. Available moisture capacity and fertility are high in drained areas. The gray color of the subsoil indicates that it has been saturated for long periods.

Most large areas have been drained and are used for crops. Smaller areas that lack drainage outlets are in permanent pasture or woodlots. Most crops grown in the county are suitable after tile drains and open ditches have been installed. If drained, the soils are easily worked and are not difficult to keep in good tilth. If they are not drained, planting and tillage are delayed in spring and fall until farm machinery no longer bogs down.

Typical profile of Brookston loam (0 to 2 percent slopes) in a cultivated field, NW¼NW¼ sec. 28, T. 8 N., R. 5 E., Flushing Township:

Ap—0 to 10 inches, very dark brown (10YR 2/2) loam; moderate, medium, granular structure; friable; high organic-matter content; neutral; abrupt, wavy boundary.

B21g—10 to 32 inches, gray (10YR 5/1) light clay loam; few, medium, faint, brown (10YR 5/3) mottles; moderate, coarse, subangular blocky structure; firm; some very dark brown (10YR 2/2) coatings on ped faces in upper part; neutral; gradual, wavy boundary.

B22tg—32 to 51 inches, gray (10YR 5/1) clay loam; many, fine, distinct, grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/4) mottles; moderate, coarse, subangular blocky structure; firm; neutral; clear, wavy boundary.

Cg—51 to 60 inches, gray (10YR 5/1) loam; many, fine, distinct, yellowish-brown (10YR 5/4) mottles; massive; friable; calcareous.

The Ap horizon ranges in color from very dark grayish brown (10YR 3/2) to very dark brown (10YR 2/2) or black (10YR 2/1); ranges in thickness from 10 to about 12 inches; and is dominantly loam or silt loam in texture. The B2 horizons are mainly clay loam or silty clay loam but in places contain thin layers of sand, loamy sand, or sandy loam. The C horizon is dominantly loam or light clay loam, but it ranges to light silty clay loam in some areas.

The combined thickness of the A and B horizons is 30 to 60 inches or more, and this is the depth to calcareous material. The A and B horizons range from slightly acid to mildly alkaline.

Brookston soils are more poorly drained and have a grayer B horizon than Conover soils. They are somewhat coarser textured in the surface layer than soils of the Lenawee series.

Brookston loam (0 to 2 percent slopes) (Bw).—This soil is on broad flats on the till plains and in depressions on the more sloping uplands. It has the profile described as typical of the series.

Included with this soil in mapping are areas where the surface layer is as much as 18 inches thick because local material has washed into the depressions. In some areas, particularly in broad glacial drainage channels, the lower subsoil contains thin layers of loamy sand or sandy loam. Also included are small areas of somewhat poorly drained Conover soils and dominantly poorly drained Breckenridge and Lenawee soils. The Breckenridge are somewhat coarser textured than the Brookston soils, and the Lenawee are somewhat finer textured.

Most areas of this soil are drained. Corn, field beans, and soybeans are the main crops. The tilth is damaged if this soil is tilled or trampled by livestock when it is wet. Unless it is drained, it dries and warms up slowly in spring. Tile drainage is relatively easy to install and is successful in most areas. The soil is stable, and both tile and drainage ditches are easy to maintain. Small depressions and drainageways stay wet longer than adjacent areas after a rain. In some low places frost injures crops in spring or prevents them from maturing in fall. Capability unit IIw–4 (2.5c).

Carlisle Series

The Carlisle series consists of level and slightly depressional, organic soils that formed in well decomposed to moderately well decomposed woody and fibrous organic material. These soils are on till plains and moraines. They are most extensive in swales and swampy depressions of rolling uplands in the eastern part of the county. In this county Carlisle soils were mapped separately and in an undifferentiated unit with Linwood soils.

In a typical profile, the surface layer is black muck about 15 inches thick. The second layer is black, mucky peat that is about 11 inches thick and contains partly decomposed woody fragments. The underlying layers, to a depth of 48 inches or more, consist of dark-brown, partly decomposed peat that ranges to brown, raw, fibrous peat as depth increases.

Because these soils occupy low positions, they have little surface runoff and are ponded in the lowest areas, especially in spring and after heavy rainfall. They have moderately rapid permeability after the water table is lowered. Available moisture capacity is high. Natural fertility is low. These soils commonly have a low content of phosphorus, potassium, and some micronutrients.

Wetness and low natural fertility are the main limitations to the use of these soils for crops. Control of soil blowing is a problem if large areas are exposed by cultivation. Weed control, spraying, planting, and harvesting are hindered unless the water table is lowered by drainage, but some areas lack suitable outlets. Frost damage to crops is a hazard in some years. The largest acreage of Carlisle soils remains as woodland. A few large areas are used for commercial production of sod for landscaping. A smaller acreage has been drained by open ditches for crops and permanent pasture.

Typical profile of Carlisle muck (0 to 2 percent slopes) in a wooded area, NE¼SE¼ sec 13, T. 9 N., R.7 E., Thetford Township:

1—0 to 15 inches, black (10YR 2/1) muck; moderate, medium, granular structure; slightly acid; gradual, smooth boundary.

2—15 to 26 inches, black (10YR 2/1) mucky peat; weak, coarse, granular structure; many partly decomposed woody fragments; slightly acid; gradual, smooth boundary.

3—26 to 36 inches, dark-brown (7.5YR 3/2) partly decomposed peat; finely fibrous; slightly acid; gradual, wavy boundary.

4—36 to 48 inches +, brown (7.5YR 5/4) peat; finely to coarsely fibrous; slightly acid.

The color of the upper horizons is very dark brown (10YR 2/2) or black (10YR 2/1). The lower horizons are dominantly brown (7.5YR 5/4), dark brown (7.5YR 3/2), or dark reddish brown (5YR 2/2). In places the material below the first horizon is thinly layered and slightly compressed. The depth to the coarsely fibrous raw peat generally exceeds 30 inches. The reaction of the profile ranges from medium acid to neutral.

Carlisle soils formed in more decomposed, less acid deposits than Rifle soils. They formed in somewhat less decomposed, more acid deposits than Lupton soils.

Carlisle muck (0 to 1 percent slopes) (Cc).—Carlisle muck is most extensive in drainage channels and swampy depressions of the more sloping uplands in the eastern part of the county. One of the largest areas is in an old glacial channel on the east side of Davison Township.

Included in mapping are areas in which the muck is overlain by as much as 6 inches of lighter colored mineral soil material that washed from adjacent uplands. Also included are minor areas of poorly drained mineral soils where the muck borders uplands.

Improved drainage is needed for the production of crops, and tile and open ditches can be used to remove water or maintain the water level as needed for general farm crops or truck crops. Carlisle muck is not well suited to wheat, oats, or other cereal crops that might lodge or go down as a result of the high organic-matter content. On the larger cultivated areas, soil blowing must be controlled. Under intensive management this muck is well suited to truck crops. A few large areas are used for commercial sod production (fig. 3). Capability unit IIIw–15 (Mc).

Carlisle and Linwood mucks (0 to 1 percent slopes) (Cd).—Carlisle and Linwood mucks were mapped together as an undifferentiated unit in the southern part of the county. These mucks formed in a mixture of woody and fibrous organic material. The Carlisle muck formed in organic material more than 42 inches deep,

Figure 3.—**Irrigation of Merion bluegrass in area of Carlisle muck in Davison Township.**

and the Linwood muck formed in organic material 12 to 42 inches deep over loamy till. These mucks occur as basinlike depressions in hilly uplands; as long narrow strips in ancient, glacial valleys; and as slackwater areas bordering lakes, streams, and rivers. Carlisle muck is dominant, but there are small areas of only Linwood muck.

In places the muck is overlain by thin layers of lighter colored mineral material that washed from higher soils. Though generally medium acid to neutral, the reaction of the organic layers ranges to mildly alkaline. In some places a narrow strip of poorly drained mineral soil occurs between the muck and the surrounding uplands.

In intensively cultivated areas the organic material shrinks and subsides as a result of oxidation. In some areas the Linwood muck probably had more than 42 inches of organic material before it was drained and cultivated. If the organic material shrinks, there is risk of lower productivity. Keeping the water table at the highest level feasible for the crops to be grown minimizes shrinking and thinning of the organic layers.

Row crops, truck crops, and sod are grown where these soils have been cleared and drained. Wetness and the risk of frost damage are the major limitations. Other limitations are subsidence, soil blowing, and seasonal flooding. Protection in the form of windbreaks and shelterbelts is needed in large, cleared areas. Capability unit IIIw–15 (Mc, M/3c).

Celina Series

The Celina series consists of moderately well drained, nearly level to sloping soils that formed in loamy till that has a high lime content. These soils are on till plains and low moraines. They occur throughout the county but are most extensive in the more strongly sloping uplands in the eastern and

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southeastern parts. In this county Celina soils were mapped separately and in complexes with Conover and Owosso soils.

In a typical profile, the surface layer is dark grayish-brown loam about 7 inches thick. This layer is underlain by about 5 inches of brown loam. The subsoil is about 16 inches thick and is friable. The upper 13 inches of the subsoil is dark yellowish-brown clay loam that has yellowish-brown mottles. The lower 3 inches consists of yellowish-brown light clay loam that has pale-brown and yellowish-brown mottles. The underlying material, beginning at a depth of about 28 inches, is brown loam that has light brownish-gray and brownish-yellow mottles. This layer is friable and has a high lime content.

These soils have moderately high natural fertility. Available moisture capacity is moderately high, and permeability is moderate or moderately slow. The soils are easy to work and have few limitations for crops. The more strongly sloping areas are subject to erosion if cropped intensively, but erosion is easily controlled. Most areas are farmed.

Typical profile of a Celina loam, having slopes of 2 to 6 percent, in a cultivated field in the center of NW¼ sec. 33, T. 7 N., R. 5 E., Clayton Township:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loam, moderate, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—7 to 12 inches, brown (10YR 5/3) loam; weak, medium, subangular blocky structure; friable; medium acid; clear, wavy boundary.

B21t—12 to 25 inches, dark yellowish-brown (10YR 4/4) clay loam; moderate, medium, subangular blocky structure; firm; patchy dark-brown (7.5YR 4/4) clay films on ped faces; medium acid; clear, wavy boundary.

B22t—25 to 28 inches, yellowish-brown (10YR 5/4) light clay loam; common, medium, distinct, pale-brown (10YR 6/3) and yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; firm, neutral; clear, wavy boundary.

C—28 to 42 inches, brown (10YR 5/3) loam; common, medium, distinct, light brownish-gray (10YR 6/2) and brownish-yellow (10YR 6/8) mottles; massive; friable; calcareous.

Areas that have not been farmed have a very dark grayish-brown (10YR 3/2) A1 horizon 3 to 5 inches thick. The A2 horizon is very thin or absent in some areas. There is a thin B1 horizon of heavy loam or light clay loam in places. The color of the B horizon ranges from dark brown (10YR 4/3) to yellowish brown (10YR 5/4) or dark yellowish brown (10YR 4/4). The texture of the B2 horizon is heavy loam to clay loam or silty clay loam. The B3 horizon is absent in some areas. The depth to the calcareous C horizon ranges from 20 to 42 inches. The texture of this horizon is dominantly loam or light clay loam but ranges to silt loam or heavy silt loam, especially where the B horizons are silty clay loam. Mottling occurs at a depth of 15 to 30 inches. The reaction of the A and B horizons is neutral to medium acid. The B3 horizon, if present, is neutral to mildly alkaline.

Although Celina and Miami soils formed in similar material, Celina soils are more mottled and more poorly drained. They are better drained than nearby Conover soils and have a somewhat lighter colored Ap horizon. They are coarser textured than Morley soils.

Celina loam, 6 to 9 percent slopes (CeC).—This is a moderately well drained soil on uplands. It commonly occurs between the well-drained Miami soils upslope and the somewhat poorly drained Conover soils in drainage channels and on foot slopes. Some areas of this soil are on side slopes of drainage channels within larger, gently sloping areas of Celina and Conover loams mapped as a complex. The slopes are mostly 100 to 200 feet long. Shorter slopes are shown on the map by hashure symbols.

The surface layer is commonly dark grayish brown, but pale-brown or brown eroded spots occur on some of the steeper upper slopes where the surface layer and a small amount of the subsoil have been mixed by plowing. In these eroded spots the soil is cloddier and has lower organic-matter content and natural fertility than in uneroded areas. Also, the depth to the limy underlying material is commonly less, or about 20 to 24 inches. Included in mapping are small areas of Miami soils on upper slopes and in narrow interdrainage divides. Many of these included areas are eroded.

Most areas of this mapping unit are small but are farmed intensively with more gently sloping adjoining soils. Erosion is the main limitation. The eroded spots tend to crust and have poor tilth. Controlling erosion and returning crop residue to the soil are desirable management practices. Corn, small grains, and forage crops are grown on this soil. Capability unit IIIe–5 (2.5a).

Celina-Conover loams, 0 to 2 percent slopes (ClA) — These soils formed in loamy till on till plains. The Celina loams make up almost 65 percent of this complex, and the Conover loams, almost 35 percent. The moderately well drained Celina soils occupy gentle ground swells and slightly undulating positions. The somewhat poorly drained Conover soils are in a network of narrow random drainageways and depressions that remain wet in spring and after heavy rainfall. Many areas of soils in this complex are 75 to 100 acres or more in size.

These soils are somewhat coarser textured than is typical of either series. The texture of the subsoil is dominantly heavy loam or light clay loam. The depth to the limy underlying material is greater than 28 inches and in places is nearly 42 inches. Included in mapping are some areas that have a sandy loam or fine sandy loam surface layer and many areas in which these soils are underlain at a depth below 48 inches by sandy loam, loamy sand, or sand containing thin sandy bands of loam.

The soils of this complex can be used intensively for cultivated crops and forage. Because the soils are nearly level, there is little risk of water erosion. Random tile drainage dries up the wet spots and allows earlier planting of crops. Large areas are planted to corn, small grains, and field beans and to alfalfa and other forage crops. Capability unit I–1 (2.5a, 2.5b).

Celina-Conover loams, 2 to 6 percent slopes (ClB).—These soils are on till plains and uplands throughout the county but are most extensive in its eastern and southeastern parts. The Celina loams make up about 50 percent of the complex; Conover loams 30 percent; and included soils 20 percent.

The major soils formed in loamy till. The slope dominantly ranges from 3 to 6 percent. The Celina loams are moderately well drained and occupy broad areas on hilltops and on side slopes of ridges above the Conover loams. These are undulating to choppy areas that include ridges, knolls, random wet spots, and depressions. The darker, somewhat poorly drained Conover loams occupy foot slopes, drainageways, and depressions.

The included soils in this complex are steeper phases of Celina and well-drained Miami soils that occur on short side slopes and in drainageways. Also included are areas in which the plow layer and subsoil are fine sandy loam or silt loam and areas in which there are strata of loamy sand or sandy loam in the lower part of the subsoil and in the substratum. There are also small, eroded spots on knolls and upper side slopes in which the brown or yellowish-brown plow layer is a mixture of the original surface layer and a small amount of the subsoil. These spots are more cloddy and have a lower organic-matter content than less eroded areas.

The soils of this complex can be used for growing row crops and forage. Because of the slope, however, there is some runoff and risk of erosion if these soils are intensively cultivated. Most slopes are complex, and this makes terracing, contour stripcropping, and other conservation practices difficult. Organic matter should be added, especially on eroded areas. Random tiling of the Conover soils allows earlier planting of crops. Corn, small grains, and forage are the main crops grown. Capability unit IIe–2 (2.5a, 2.5b).

Celina-Owosso sandy loams, 2 to 6 percent slopes (CmB).—These soils are on uplands in the eastern and southeastern parts of the county. The Celina soils make up about 50 percent of the complex; Owosso soils 25 percent; and included soils 25 percent. The slope is dominantly 3 to 5 percent. The Celina soils formed in loamy till. They are moderately well drained and occupy the higher, undulating positions of the complex. The Owosso soils formed in sandy deposits over loamy till and occupy the foot slopes, slight depressions, and low saddles between knolls.

Included in areas mapped as this complex are small areas of the somewhat poorly drained Conover soils in drainageways and depressions and a few areas of poorly drained Brookston soils in closed depressions. These small, wet spots are less than 2 acres in size and are indicated by wet-spot symbols on the soil map.

The soils of this complex can be worked over a wide range of moisture content. They dry out earlier in spring than nearby soils that are more loamy. Because of the slope, there is some runoff and risk of erosion under intense cultivation. The slopes are generally complex, which makes terracing, contour stripcropping, and other conservation practices difficult. Random tiling of the included wet spots allows earlier tillage and planting. Corn, small grains, and forage are the main crops grown on these soils. Capability unit IIe–2 (2.5a, 3/2a).

Ceresco Series

The Ceresco series consists of somewhat poorly drained soils on bottom land. These soils formed in loamy sand to fine sandy loam deposited by water. They are the most extensive soils on the flood plains of the Flint River and its tributaries.

In a typical profile, the surface layer is very dark grayish-brown fine sandy loam about 11 inches thick. The underlying material, to a depth of about 23 inches, is friable yellowish-brown fine sandy loam that has light brownish-gray mottles. The material below 23 inches is friable, light brownish-gray, stratified loamy sand and sandy loam that has yellowish-brown mottles. At a depth of about 29 inches, this material grades to grayish-brown, stratified sand and loamy sand that are moderately alkaline.

Ceresco soils are moderately permeable and have moderate available moisture capacity and natural fertility. Because of their low, nearly level relief, surface water runs off very slowly, and they are subject to flooding, especially in spring. The gray mottling in the underlying soil layers indicates that these soils are saturated for long periods. This saturation restricts the downward growth of plant roots.

These soils require artificial drainage if they are used for cultivated crops. Drainage is difficult, however, because of the risk of seasonal flooding and the lack of suitable outlets. Some areas are so dissected by meandering stream channels that they are too small or irregular in shape for farming. In places steep riverbanks hinder the movement of farm machinery to and from the bottom land. A few areas are cultivated or used for pasture, but most areas remain as woodland that consists mainly of elm, ash, hickory, and cottonwood.

Typical profile of Ceresco fine sandy loam in idle cropland, SE¼NE¼ sec. 21, T. 7 N., R. 8 E., Davison Township:

Ap—0 to 11 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; moderate, medium, granular structure; friable; moderately high organic-matter content; mildly alkaline; abrupt, wavy boundary.

C1—11 to 23 inches, yellowish-brown (10YR 5/8) fine sandy loam; few, fine, distinct, light brownish-gray (10YR 6/2) mottles; moderate, medium, subangular blocky structure; friable; mildly alkaline; gradual, wavy boundary.

C2g—23 to 29 inches, light brownish-gray (10YR 6/2) stratified loamy sand and sandy loam; common, medium, distinct, yellowish-brown (10YR 5/4–5/8) mottles; weak, medium to coarse, subangular blocky structure; friable; mildly alkaline; gradual, wavy boundary.

C3g—29 to 48 inches, grayish-brown (10YR 5/2) stratified sand and loamy sand; common, coarse, faint, yellowish-brown (10YR 5/4–5/8) mottles; single grain; loose; thin lenses of silt; mildly alkaline.

The color of the Ap horizon is very dark gray (10YR 3/1) or dark brown (10YR 3/3) in places. This horizon ranges from fine sandy loam to silt loam in texture and is as much as 15 inches thick in places. The texture of the C1 and C2g horizons is fine sandy loam, loamy fine sand, or stratified sandy loam and loamy sand. The depth to mottling ranges from 10 to 16 inches. The C3g horizon is commonly coarser textured than the overlying horizons. It is dominantly sand, loamy sand, or stratified coarse sand and gravel. In many places it contains lenses and layers of silt, silt loam, or silty clay loam up to 5 inches thick. The reaction of the A1, C1, and C2g horizons ranges from neutral to moderately alkaline. The C3g horizon is generally mildly alkaline and in places it is calcareous.

Although Ceresco and Cohoctah soils formed in similar material, Ceresco soils are lighter colored and better drained.

Ceresco fine sandy loam (0 to 1 percent slopes) (Cn).—This is the most extensive soil on flood plains of the major streams throughout the county. It commonly is on the second bottom that lies only a few feet above the immediate flood plain. In the broad river valleys, this soil lies between the better drained Landes soils on the natural levees next to the streams and the poorly drained Cohoctah soils in the meandering channels at the edge of the stream bottom. Some areas of this soil are long and narrow. Other areas are so broken by meandering stream channels that they are too small or irregular in shape for tillage with modern farm machinery.

Flooding early in spring and the lack of drainage outlets are the major limitations in the management of this soil. A few of the larger areas are cleared of trees and used for corn, small grains, forage, and other crops. Some are used for permanent pasture. Most areas are used as woodland and as wildlife habitat. Capability unit IIIw–12 (L–2c).

Cohoctah Series

The Cohoctah series consists of poorly drained or very poorly drained, level or slightly depressional soils on flood plains. These soils formed in loamy fine sand or fine sandy loam deposited by water on the bottom land of the Flint River and its tributaries.

In a typical profile, the surface layer is very dark brown silt loam about 13 inches thick. The subsoil, to a depth of 27 inches, is friable, dark-gray very fine sandy loam that has dark yellowish-brown mottles. Underlying the subsoil, and extending to a depth of about 36 inches, is gray, very friable loamy very fine sand that has dark-gray and dark yellowish-brown mottles. The material at a depth below 36 inches is gray very fine sand that grades to loose, light brownish-gray coarse sand at a depth below 43 inches.

Cohoctah soils are moderately permeable and have moderate available moisture capacity and natural fertility. Because of their low, level relief, water runs off these soils very slowly, and they are ponded for long periods. These soils are subject to spring flooding that frequently extends into the growing season.

Because of the high water table and annual flooding, these soils are seldom used for crops. They are difficult to drain because of the lack of outlets. They are used mainly as woodland, as wildlife habitat, or as recreation areas. The present vegetation consists mostly of elm, ash, soft maple, and swamp white oak.

Typical profile of Cohoctah silt loam (0 to 1 percent slopes) in a wooded area, SE¼SE¼ sec. 17, T. 9 N., R. 6 E, Vienna Township:

A1—0 to 13 inches, very dark brown (10YR 2/2) silt loam; moderate, medium, granular structure; friable; neutral; clear, smooth boundary.

B1g—13 to 27 inches, gray (10YR 5/1) very fine sandy loam; common, medium, distinct mottles of dark yellowish brown (10YR 4/4); weak, medium, subangular blocky structure; very friable; mildly alkaline; clear, wavy boundary.

C1g—27 to 36 inches, gray (10YR 5/1) loamy very fine sand; common, medium, distinct mottles of dark gray (10YR 4/1) and dark yellowish brown (10YR 4/4); weak, medium, subangular blocky structure; very friable; mildly alkaline; clear, wavy boundary.

C2g—36 to 43 inches, gray (10YR 5/1) very fine sand; single grain; loose; mildly alkaline; abrupt, wavy boundary.

C3g—43 to 48 inches, light brownish-gray (2.5YR 6/2) coarse sand; single grain; loose; calcareous.

The color of the A horizon ranges from very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) to very dark brown (10YR 2/2). This horizon ranges from sandy loam or fine sandy loam to silt loam and is generally 8 to 13 inches thick. In a few places, the A horizon is underlain by a dark A12 horizon, and the total thickness of the A horizon is as much as 18 inches. The thickness and sequence of the soil horizons vary from place to place because of the mixed origin of the soil material.

Above a depth of 30 inches, the texture of the C horizons is loamy fine sand, loamy very fine sand, sandy loam, or fine sandy loam. Below this depth the texture is loamy sand, sand, or coarse sand, and in places there are strata of silt loam, silty clay loam, or fine gravel. The reaction of the horizons above 30 inches ranges from slightly acid to mildly alkaline. Below this depth the reaction is mildly alkaline or moderately alkaline, and in places the soils are calcareous.

Cohoctah and Ceresco soils formed in similar material, but Cohoctah soils have a grayer C horizon and are more poorly drained. Cohoctah soils formed in coarser sediments than Sloan soils.

Cohoctah silt loam (0 to 1 percent slopes) (Co).—This soil is on flood plains of the major streams throughout the county. Most areas are in narrow abandoned stream channels and oxbows at the edge of the flood plains. This is the lowest and most poorly drained soil on the flood plains. It commonly lies only a few feet below the Ceresco soils on second bottoms.

Included in mapping are minor areas of the poorly drained Brookston and Sloan soils in the narrower drainage channels. Also included are small areas of muck on broad flood plains downstream.

This Cohoctah soil is flooded early in spring and remains ponded for long periods during the growing season. Very few areas are used for crops. A small acreage is used for permanent pasture. Most areas are used as woodland and as wildlife habitat. Capability unit IIIw–12 (L–2c).

Colwood Series

The Colwood series consists of poorly drained or very poorly drained, level and slightly depressional soils that formed in stratified fine sand and silty material. These soils are on lake plains and till plains. They are widely distributed but are most extensive on the lake plain in the northwestern part of the county.

In a typical profile, the surface layer is very dark brown silt loam about 10 inches thick. The subsoil is about 24 inches thick and is friable. The upper 8 inches of the subsoil consists of gray silt loam that has light yellowish-brown mottles. The lower 16 inches consists of gray, heavy silt loam that contains yellowish-brown mottles. The underlying material at a depth of more than about 34 inches is grayish-brown silt loam that has yellowish-brown mottles. This layer is friable and has a high lime content.

Because these soils are level or nearly level, runoff is very slow or is ponded. Some areas receive runoff from higher soils. Permeability is moderate. The gray color of the subsoil indicates that these soils are saturated for long periods. This saturation restricts root growth and frequently delays planting and tillage. The available moisture capacity and natural fertility are high.

Unless these soils are drained, they are too wet for cultivated crops. They can be drained by tile or open ditches, but open ditches or tile trenches cave in readily because of the sand and silt. Most large areas, however, are drained and used for crops. If drained, these soils are suited to all crops grown in the county. Smaller areas lacking drainage outlets are in permanent pasture or woodland.

Typical profile of Colwood silt loam (0 to 2 percent slopes) in a cultivated area, NE¼NW¼ sec. 34, T. 9 N., R. 7 E., Thetford Township:

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

B1g—10 to 18 inches, gray (10YR 5/1) silt loam; few, fine, distinct, light yellowish-brown (10YR 6/4) mottles; weak, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B2g—18 to 34 inches, gray (10YR 5/1) heavy silt loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; firm; neutral; abrupt, wavy boundary.

Cg—34 to 42 inches, grayish-brown (10YR 5/2) silt loam; few, medium, distinct, yellowish-brown (10YR 5/8) mottles; massive; friable; calcareous.

A layer of muck as much as 10 inches thick overlies the surface in the slight depressions. The Ap horizon is 10 to 12 inches thick. It ranges from very dark grayish brown (10YR 3/2) to very dark brown (10YR 2/2) or black (10YR 2/1) in color and is loamy fine sand, fine sandy loam, or silt loam in texture.

The texture and thickness of the B and C horizons vary, depending on the sequence of the deposited layers. The B horizon is commonly less than 2 in chroma. The texture of the B2g horizon is heavy fine sandy loam, heavy silt loam, or light silty clay loam. The thickness of the A and B horizons combined ranges from 28 to about 42 inches. The C horizon is stratified in some places and consists of very fine sand and silt, very fine sandy loam, and silt loam and thin strata of silty clay loam. The reaction of the A and B horizons is slightly acid to neutral.

Colwood soils are more stratified than Brookston soils. They also formed in coarser textured material and have a coarser textured Bg horizon. They have a grayer B horizon than Kibbie soils and are more poorly drained.

Colwood silt loam (0 to 2 percent slopes) (Cp).—This level soil generally is in broad drainage channels. Most areas are as much as one-eighth of a mile wide and 1 to 2 miles long. The slopes are generally less than 1 percent. The small depressional areas account for only a small acreage of this soil.

The plow layer normally consists of very dark brown silt loam, but it is fine sandy loam in small included areas. Also included in mapping are some slight depressions in which there is a layer of mucky material 3 to 5 inches thick on the surface. Included also are areas where a mucky surface layer, 8 to 10 inches thick, directly overlies limy very fine sand and silt without the intervening mineral surface layer and subsoil. Presumably, these inclusions were once areas of shallow muck that has subsided as a result of artificial drainage. Other inclusions consist mostly of poorly drained mineral soils. On the till plain, these are the slightly finer textured Brookston soils; and on the lake plain, they are the finer textured Lenawee soils and the stratified, sandier Lamson soils.

Wetness, especially early in the growing season, is the major limitation. Installing tile is easiest during dry periods. Special material is needed to keep the fine sand and silty material from clogging tile drains. If adequately drained and fertilized, this soil is suited to intensive cultivation. Corn, soybeans, and field beans are the major crops grown. Capability unit IIw–6 (2.5c).

Conover Series

The Conover series consists of somewhat poorly drained, nearly level to undulating soils on till plains. These soils formed in loamy material that has a high lime content. Broad areas extend from the eastern border to the western border through the central part of the county.

In a typical profile (fig. 4), the surface layer is very

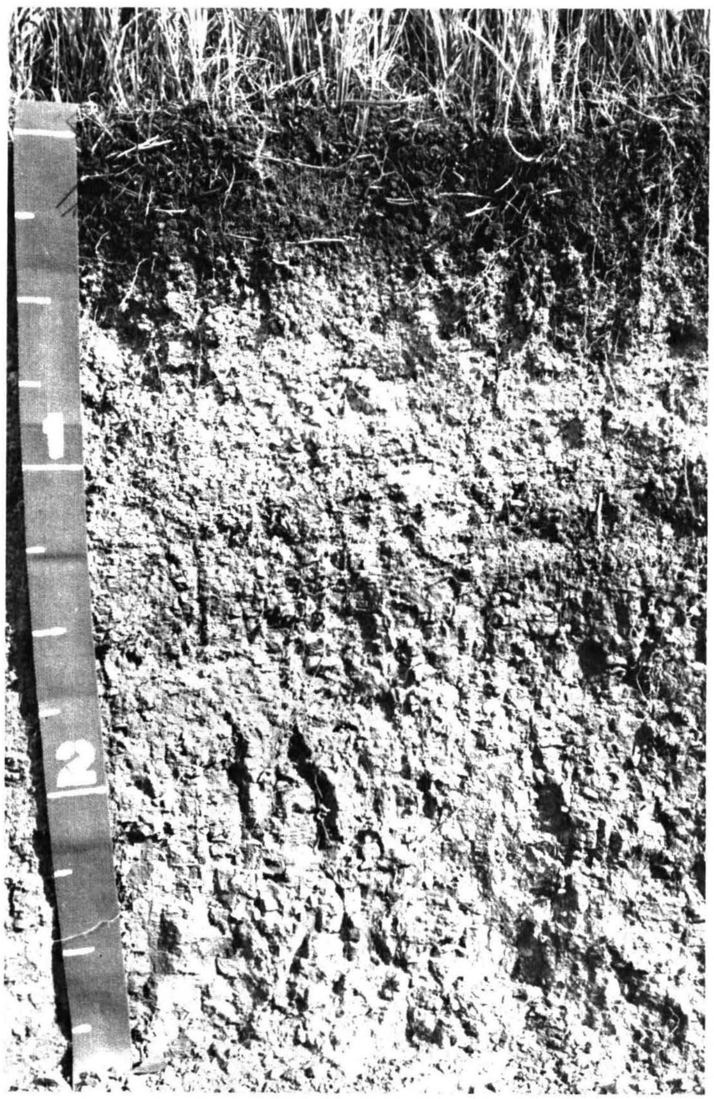

Figure 4.—Profile of somewhat poorly drained Conover loam, 0 to 2 percent slopes.

dark grayish-brown loam about 7 inches thick. The subsurface layer is about 4 inches thick and consists of light brownish-gray, friable loam that has brownish-yellow mottles. The subsoil is about 19 inches thick. It is brown and yellowish-brown, firm clay loam that has light brownish-gray, brownish-gray, and brownish-yellow mottles. The underlying material, beginning at a depth of about 30 inches, is brown, heavy loam that has grayish-brown and yellowish-brown mottles. This layer is firm and has a high lime content.

Runoff is slow or very slow, and surface water from adjacent soils collects on these soils. Permeability is moderate. Available moisture capacity and fertility are high.

Most areas have been cleared, drained, and used for crops. Without drainage, Conover soils are wet in spring and after heavy rainfall. After drainage, they are easy to work and keep in good tilth.

Typical profile of Conover loam, 0 to 2 percent slopes, in a cultivated field, SW¼NW¼NW¼ sec. 18, T. 7 N., R. 5 E., Clayton Township:

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

A2—7 to 11 inches, light brownish-gray (10YR 6/2) loam; few, medium, faint, brownish-yellow (10YR 6/8) mottles; moderate, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21t—11 to 17 inches, brown (10YR 5/3) light clay loam; common, medium, distinct, light brownish-gray (10YR 6/2) and yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; firm; neutral; clear, wavy boundary.

B22t—17 to 30 inches, yellowish-brown (10YR 5/4) clay loam; common, medium, distinct, light brownish-gray (10YR 6/2) mottles; moderate, medium, subangular blocky structure; firm; dark-brown (10YR 4/3) clay films on many ped faces; neutral; abrupt, wavy boundary.

C—30 to 42 inches, brown (10YR 5/3) heavy loam; common, medium, faint, grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; firm; calcareous.

The A horizons range from sandy loam to silt loam. The Ap horizon is dark brown (10YR 3/3) in some areas. The B21t horizon commonly is heavy loam or light clay loam, but in some areas it is silty clay loam. Mottles with chromas of 2 or less occur throughout the B21t and B22t horizons. The C horizon is loam, silt loam, or light clay loam.

The combined thickness of the A and B horizons ranges from 20 to about 40 inches. The reaction in these horizons ranges from medium acid to neutral.

Conover, Miami, and Celina soils formed in similar material, but Conover soils are more poorly drained and highly mottled. Conover soils are better drained and are brighter colored in the B horizon than Brookston soils.

Conover loam, 0 to 2 percent slopes (CvA).—This soil is on broad till plains. It has the profile described as typical of the series.

Included with this soil in mapping are areas where the surface layer is fine sandy loam or silt loam; areas where thin layers of loamy sand or sandy loam are in the lower subsoil and underlying material; and near drainage channels, areas that contain small amounts of gravel. Also included are minor areas of the somewhat poorly drained Brookston soils (fig. 5). The Brookston soils dry out more slowly in spring than this soil and delay farming. Farm machinery easily bogs down in the Brookston soils, and crops drown out during wet periods.

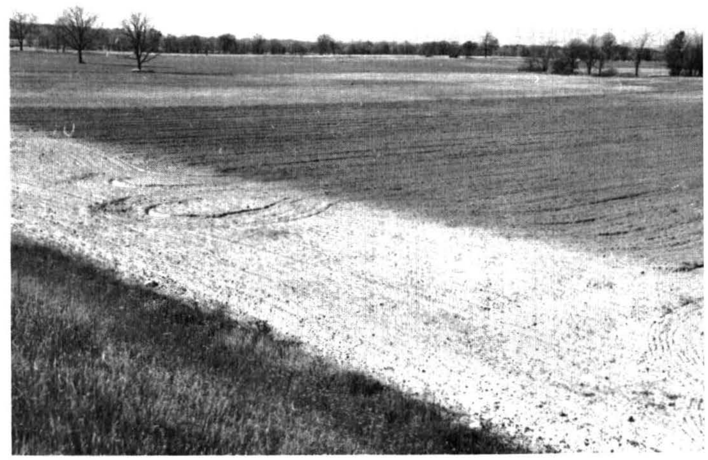

Figure 5.—**Typical landscape of Conover and associated Brookston soils. Conover soils are in the foreground, and the darker colored Brookston soils are in the background.**

Where it has been drained, this is one of the better soils in the county for corn, sugar beets, field beans, soybeans, small grains, and forage. Without drainage, by use of shallow waterways and tile, the soil is wet in spring. If it is tilled when wet, it puddles and dries out cloddy and hard. Capability unit IIw-4 (2.5b).

Conover loam, 2 to 6 percent slopes (CvB).—This is a gently sloping or undulating soil on till plains and foot slopes in the more rolling uplands. The slopes range from 2 to 6 percent but are dominantly between 2 and 4 percent. The slopes are generally complex and less than 100 feet in length. Areas of this soil are marked by many random drainageways and, in places, by closed depressions.

Included with this soil in mapping are small areas of Celina soils, on low knolls and the sides of drainageways, and minor areas of coarser textured Metamora soils. The plow layer is thinner and lighter colored than typical where this soil surrounds Celina soils.

Most areas of this soil are intensively cultivated. Corn, field beans, and soybeans are the main crops. Small grains and forage are important in some areas. Runoff is less of a problem on this soil than on Conover loam, 0 to 2 percent slopes, but a complete drainage system is difficult to install because the slopes are complex. Random tile and surface drains help remove excess water. If the soil is tilled when wet, it puddles and dries out cloddy and hard. Capability unit IIw-5 (2.5b).

Conover-Metamora sandy loams, 0 to 2 percent slopes (CwA).—The nearly level soils of this complex are on till plains. The Conover soil makes up about 55 percent of this complex; the Metamora soil about 35 percent; and other soils 10 percent. The Conover soil has a sandy surface layer and formed in loamy till. The Metamora soil formed in sandy and loamy deposits 18 to 42 inches thick over loamy till. Both soils are somewhat poorly drained. Areas of this complex are most extensive on broad interdrainage divides and on foot slopes bordering the more sloping uplands.

The plow layer of these soils is very dark grayish brown. Both soils contain variable amounts of gravel in the surface layer and subsoil. More gravel occurs in areas bordering drainage channels than elsewhere.

Included with these soils in mapping are minor areas of somewhat poorly drained Selfridge soils, which are coarser textured than these soils and more droughty. Also included, in shallow drainageways and wet depressions, are Brookston soils. These Brookston soils dry slowly in spring and delay tillage and planting.

A few random areas are used as woodlots, but most of this soil complex is intensively cultivated. Corn, small grains, and forage are the main crops. Surface water drains off slowly, and shallow waterways are needed in places. Tile drainage helps to remove excess moisture. When drained, the soils of the complex warm up and dry out earlier in spring than nearby more loamy soils. The soils of this complex are easy to work and to keep in good tilth. Capability unit IIw-4 (2.5b, 3/2b).

Conover-Metamora sandy loams, 2 to 6 percent slopes (CwB).—The gently sloping soils in this complex are on till plains, commonly in rather narrow areas bordering drainage channels and on foot slopes below more sloping uplands. Slopes are relatively smooth except in the random drainage channels; they are dominantly in the range of 2 to 5 percent, but the full range is 2 to 6 percent. The Conover soil makes up about 50 percent of this unit; the Metamora soil about 25 percent, and other soils 25 percent.

The Conover soil has a surface layer and subsurface layer of sandy loam. These two layers combined are about 15 inches thick. The Metamora soil formed in sandy and loamy deposits 18 to 42 inches thick over loamy material. Small amounts of gravel occur in both soils. The plow layer of both is mainly very dark grayish brown.

As this complex was mapped, the Conover soil in some places has thin loamy sand or sandy loam layers in the lower subsoil and in the underlying material. Also included are small areas of Celina and Owosso soils, which are on low knolls and ridges and are better drained than the major soils of this complex. Mapped areas also include small areas of Selfridge soils. These are somewhat poorly drained soils that are coarser textured than the major soils of this complex; they border shallow drainageways and wet depressions. Small wet areas in this complex are shown by the special map symbol for wet spots.

Most of this complex is intensively cultivated. Corn, field beans, and soybeans are the major crops. Small grain and forage are important in some areas. When drained, soils of this complex warm up earlier in spring than nearby more loamy soils. After they are drained, they are easy to work and to keep in good tilth. Surface water drains from this complex faster than from nearly level Conover soils or Conover-Metamora soils. Some areas, however, are difficult to drain. In these, random tile and surface drains help to remove excess water, especially from low spots. Capability unit IIw-5 (2.5b, 3/2b).

Croswell Series

The Croswell series consists of moderately well drained, level to gently sloping sandy soils on outwash plains, sandy lake plains, and till plains.

In a typical profile, the surface layer is dark grayish-brown sand about 7 inches thick. The subsoil is about 29 inches thick. It consists of dark-brown, loose sand that becomes light yellowish brown as depth increases. The lower part of the subsoil has yellowish-brown mottles. The underlying material is at a depth of about 36 inches or more. It is pale-brown, loose sand that has yellowish-brown and brownish-yellow mottles.

Croswell soils are rapidly permeable, have very slow runoff, and have low available moisture capacity. They generally do not supply enough moisture for cultivated crops and are subject to soil blowing.

These soils are severely limited by low fertility and low available moisture capacity during most of the growing season. Soil blowing is a risk if these soils are cultivated. If they can be irrigated, they are suited to vegetables, small fruit, and other specialty crops. Most areas that were once cleared for farming are now idle, are in pine plantations, or are second-growth woodland. The present vegetation consists of grass and open stands of aspen, oak, and wild cherry.

Typical profile of Croswell sand, 0 to 6 percent slopes, in abandoned cropland, NW¼NE¼ sec. 20, T. 9 N., R. 5 E., Montrose Township:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) sand; single grain; loose; slightly acid; abrupt, smooth boundary.

B21ir—7 to 14 inches, dark-brown (7.5YR 4/4) sand; single grain; loose; slightly acid; clear, wavy boundary.

B22ir—14 to 25 inches, yellowish-brown (10YR 5/6) sand; single grain; loose; slightly acid; clear, smooth boundary.

B3—25 to 36 inches, light yellowish-brown (10YR 6/4) sand; few, coarse, faint, yellowish-brown (10YR 5/6) mottles; single grain; loose; slightly acid; clear, smooth boundary.

C—36 to 48 inches, pale-brown (10YR 6/3) sand; common, coarse, distinct, yellowish-brown (10YR 5/6) and brownish-yellow (10YR 6/6) mottles; single grain; loose; neutral.

In undisturbed areas there is a very dark brown (10YR 2/2) A1 horizon 2 to 4 inches thick and a discontinuous light brownish-gray (10YR 6/2) A2 horizon 1/4 to 1 inch thick. The texture of the A and B horizons is sand or fine sand. The color of the Bir horizon ranges from dark brown (7.5YR 4/4) to dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/6). The reaction of the A and B horizons is generally slightly acid, although the A horizon is commonly medium acid in undisturbed areas. Mottling begins at a depth of 18 to 38 inches. The C horizon, to a depth of 48 inches or more, is slightly acid or neutral.

Croswell and Oakville soils formed in similar material, but Croswell soils have a fluctuating water table and are not so well drained as Oakville soils. They are lighter colored and better drained than nearby Au Gres soils.

Croswell sand, 0 to 6 percent slopes (CxB).—This is a moderately well drained soil on sandy flats and low ridges. The slope is generally less than 2 percent but is slightly more on the sides of drainageways. Slightly below this soil are the somewhat poorly drained Au Gres soils and the poorly drained Granby soils. This soil is most extensive on the sandy lake plains in the northwestern part of the county.

In uncultivated areas the surface layer is very dark brown. In cultivated areas, however, some erosion is common, and small amounts of the dark-brown subsoil have been mixed with the plow layer. Included in mapping are areas where there are thin layers of sandy loam or silty clay loam in the underlying material.

Most of the acreage is abandoned cropland. Some areas support trees of poor quality. This soil is not well suited to cultivated crops, because of its low natural fertility and low available moisture capacity. It is subject to soil blowing if cultivated. This soil is better suited to small grains and other early maturing crops than to corn or soybeans. Where water is available for irrigation, this soil is suited to vegetables, small fruit, and other specialty crops. Capability unit IVs–2 (5a).

Del Rey Series

The Del Rey series consists of somewhat poorly drained, nearly level to gently sloping loamy soils on lake plains and till plains. These soils formed in silty clay loam containing thin layers of very fine sand, silt, and silt loam. They are extensive in Gaines Township south of Swartz Creek and in the northern and northwestern parts of the county.

In a typical profile, the surface layer is very dark grayish-brown silt loam about 9 inches thick. The subsurface layer is grayish-brown, firm, heavy silt loam about 6 inches thick. It has brownish-yellow mottles. The subsoil is about 17 inches thick and consists of grayish-brown, firm silty clay loam that has grayish-brown and yellowish-brown mottles. The underlying material begins at a depth of about 32 inches and is light brownish-gray silty clay loam containing thin layers of very fine sand and silt. This layer is firm and has a high lime content.

Because these soils are nearly level to gently sloping, runoff is slow or very slow and some depressions are ponded. Permeability is moderately slow to slow. Wetness early in the growing season hinders plant growth. Moreover, these soils are subject to crusting and compaction if tilled when wet. The resulting poor tilth commonly reduces growth of crops. There is also a slight risk of erosion on the more strongly sloping areas if they are intensively cultivated. These soils have a moderately high available moisture capacity and natural fertility.

Most areas have been farmed. Excess moisture in the subsoil and difficulty in maintaining tilth are the main limitations. Under good management these soils are suited to all crops grown in the county.

Typical profile of Del Rey silt loam, 0 to 2 percent slopes, in a cultivated field, SE¼NE¼ sec. 17, T. 9 N., R.6 E., Vienna Township:

Ap—0 to 9 inches, very dark grayish-brown (10YR 4/2) silt loam; moderate, medium, granular structure; friable; neutral; abrupt, smooth boundary.

A2—9 to 15 inches, grayish-brown (10YR 5/2) heavy silt loam; few, medium, distinct mottles of brownish yellow (10YR 6/8); moderate, fine, angular blocky structure; firm; some gray (10YR 5/1) silt coatings on ped faces and along old root channels; slightly acid; clear, wavy boundary.

B2t—15 to 28 inches, grayish-brown (10YR 5/2) silty clay loam; many, medium, faint mottles of brown (10YR 5/3) and yellowish brown (10YR 5/8); moderate, medium, angular blocky structure; firm; neutral; clear, wavy boundary.

B3—28 to 32 inches, grayish-brown (10YR 5/2) silty clay loam; common, medium, distinct mottles of yellowish brown (10YR 5/8) and brownish yellow (10YR 6/8); moderate, medium, angular blocky structure; firm; mildly alkaline.

C—32 to 42 inches, light brownish-gray (10YR 6/2) silty clay loam; common, medium, distinct mottles of yellowish brown (10YR 5/6); weak, medium, platy structure to weak, medium, angular blocky structure; firm; layers of very fine sand and silt 1/8 to 1 inch thick; calcareous.

The color of the Ap horizon is typically dark grayish brown (10YR 4/2) but ranges from very dark grayish brown to pale brown (10YR 6/3) or light brownish gray (10YR 6/2) when dry. The texture of the A1 and A2 horizons is dominantly silt loam but ranges to sandy loam in some areas. The B2 horizon is silty clay loam to light silty clay. The C horizon, which commonly occurs at a depth of 24 to 36 inches, is silty clay loam and contains thin strata of very fine sand, silt, and silt loam. Mottling occurs at a depth of 8 to 15 inches. The reaction of the A and B horizons ranges from slightly acid to mildly alkaline.

Del Rey soils are finer textured than Conover soils. They formed in the same kind of material as Lenawee soils but have a brighter colored B horizon and are better drained.

Del Rey sandy loam, 0 to 2 percent slopes (DlA).—This soil is on the finer textured till plains and borders of lake plains. In many places it occupies the smooth lower positions in a dominantly undulating landscape. These lower areas average only 10 to 25 acres in size. The larger areas are in the slightly higher and better drained parts of broad drainage channels. This soil is widely distributed in the county but accounts for only a small acreage. The plow layer is generally very dark grayish-brown sandy loam.

Included in mapping are some areas in which the plow layer is fine sandy loam; some areas in which there are thin strata of very fine sand and silt in the subsoil; and a few areas in which there are thin layers of medium to coarse sand in the underlying material. Also included are minor areas of the somewhat poorly drained Metamora soils and the poorly drained Lenawee soils. The Metamora soils are coarser textured and slightly more droughty than this Del Rey soil. The Lenawee soils occur as wet spots that dry out slowly.

Because the soil is nearly level, there is no erosion hazard. Removal of excess moisture from the subsoil is the main need in management. Runoff and some eroded soil material are received from adjoining uplands. If this soil is drained, however, it is easier to work and to keep in good tilth than the nearby Del Rey silt loam. If it is drained and fertilized, it is suitable for intensive cultivation. Corn, small grains, and forage are the major crops grown. Capability unit IIw–2 (1.5b).

Del Rey silt loam, 0 to 2 percent slopes (DrA).—This soil occurs as broad areas on lake plains and their borders. It has the profile described as typical of the series. The slope is commonly less than 1 percent. Included in mapping are low, wet spots of Lenawee soils. Because these spots become ponded and dry out slowly, tillage is frequently delayed. Also included are spots of sandy Allendale soils on low, smooth, sandy ridges and knolls. Where this Del Rey soil adjoins these sandier spots, the surface layer is loamy fine sand or fine sandy loam and the areas were mapped as inclusions. The plow layer of this Del Rey soil is very dark grayish-brown silt loam, but it has a lighter gray appearance in plowed fields.

This soil has moderately slow permeability and very slow runoff. Because of the clayey material, backfilling with straw or other porous material is needed in tile drainage systems. Parallel ditching or bedding helps to remove surface water and allows earlier spring planting. If this soil is tilled when wet, the structure is destroyed and the plow layer clods. Preparing a good seedbed is difficult because the soil is thin. Most areas, however, are intensively farmed, and under good management this soil is well suited to corn, sugar beets, beans, and forage crops. Capability unit IIw–2 (1.5b).

Del Rey silt loam, 2 to 6 percent slopes (DrB).—This is the dominant soil in the undulating areas of the heavier textured till plains and borders of lake plains. Typical areas have short, complex slopes, wet depressions, and random drainageways that empty into well-defined drainage channels. The slope is dominantly less than 5 percent. Major areas of this soil occur in the southern part of Gaines Township and in Thetford and Vienna Townships in the northern part of the county.

The plow layer is very dark grayish-brown silt loam. On the more convex ridges and knolls, the plow layer is somewhat thinner, contains less organic matter, and is a lighter brown than elsewhere in this mapping unit. The plow layer and subsoil are nearly free of gravel. The depth to the limy underlying material is commonly less than in nearly level Del Rey soils. On the many low, rounded knolls and ridges, the limy material is at a depth of only 24 inches.

Most areas are intensively cultivated. Corn, beans, and small grains are the principal crops. Forage crops are important in some areas. In places, past cropping practices have lowered the organic-matter content and destroyed the soil structure. Removing excess moisture from the subsoil and keeping the soil in good tilth are the major needs in management. Because of the gentle slope, there is more runoff and greater risk of erosion than on the less sloping Del Rey soils. A complete tile system is difficult to lay out in some areas, however, because of the undulating relief. Random tile and surface drains help to remove excess water in these areas. Capability unit IIw–3 (1.5b).

Edwards Series

The Edwards series consists of level or slightly depressional, organic soils on till plains and moraines. These soils formed in woody or mixed woody and fibrous organic material. The organic layers are underlain by marl at a depth of 12 to 42 inches. These soils occur at random throughout the county but are not extensive.

In a typical profile, the surface layer is very dark gray muck about 8 inches thick. The second layer is dark-gray or reddish-gray muck about 6 inches thick. The third layer consists of 8 inches of very dark gray muck containing seams and a few chunks of dark reddish-brown and reddish-yellow marl. This is underlain at a depth of about 22 inches by gray marl containing many shell fragments. This material has a very high lime content and extends to a depth of several feet.

Because the Edwards soils commonly occupy the lowest positions in the landscape, they have very slow runoff and are ponded in some areas early in the growing season. The organic layers are rapidly permeable, but the underlying marl is variable. This restricts the downward movement of water, even in many areas that are artificially drained. The water table is at the surface in spring and early in summer unless these soils are artificially drained. Natural fertility is low. The content of phosphorus, potassium, and some micronutrients is generally low.

Edwards soils are difficult to drain because of the presence of marl at a shallow depth and a lack of drainage outlets. Soil blowing is a hazard where these soils are exposed by cultivation. A few areas that are drained by random shallow ditches are used for pasture. The largest acreage remains covered by trees, mainly elm and soft maple. Some aspen, alder, and willow grow around open areas of marsh grasses and wetland shrubs.

Typical profile of Edwards muck (0 to 1 percent slopes) in a wooded area, SW¼SE¼ sec. 31, T. 6 N., R. 7 E., Grand Blanc Township:

1—0 to 8 inches, very dark gray (5YR 3/1) well-decomposed muck; weak to moderate, medium, granular structure; friable; mildly alkaline; clear, wavy boundary.

2—8 to 14 inches, dark-gray (10YR 4/1) to reddish-gray (5YR 5/2) muck containing many fine, partly decomposed stems; weak, medium, granular structure; friable; mildly alkaline; gradual, wavy boundary.

3—14 to 22 inches, very dark gray (5YR 3/1) muck containing seams and a few chunks of dark reddish-brown (2.5YR 3/4) and brownish-yellow (10YR 6/8) marl; massive; mildly alkaline; abrupt, wavy boundary.

IICg—22 to 48 inches, gray (10YR 6/1) marl containing many shell fragments; massive; strongly calcareous.

The color of the surface layer ranges from very dark gray (5YR 3/1) to black (10YR 2/1). The upper horizons are slightly compacted in some places. The organic layers tend toward a weak, coarse, prismatic structure in some areas. The total thickness of the organic layers ranges from 15 to 28 inches. The purity and color of the underlying marl are variable.

In kind and thickness of organic material, Edwards soils are similar to Linwood and Markey soils but are underlain by a different kind of mineral material. Edwards soils have thinner organic layers than Lupton or Rifle soils.

Edwards muck (0 to 1 percent slopes) (Ed).—This soil is in swamps or swales and in a few areas of slack water surrounding lakes. It occurs at random throughout the more sloping uplands in the eastern and southern parts of the county. Most areas are only 10 to 25 acres in size, and the total acreage is small.

Included in mapping are some areas in which there is a thin layer of loamy mineral soil on the surface. Also included are small areas where the underlying marl is thin or discontinuous, and the thin muck directly overlies limy sand or coarse sand. In a few places layers of marl are interbedded with layers of colloidal muck.

Most of the acreage is wooded or in native pasture. A few areas adjoining deeper muck are used for cultivated crops. Tile drainage is seldom attempted. If this soil is drained, the organic layers shrink. Plant growth is then limited by the extremely high content of lime and the low nutrient level of the underlying marl. Capability unit IVw–6 (M/mc).

Fox Series

The Fox series consists of deep, well-drained, level to gently sloping loamy soils on outwash plains, terraces, valley trains, and moraines. These soils formed in deposits of loamy, silty, and sandy outwash 24 to 42 inches thick over calcareous sand and gravel. They are in the southern part of the county, mainly along the Shiawassee River and its tributaries.

In a typical profile, the surface layer is dark-brown sandy loam about 7 inches thick. It is underlain by a subsurface layer of brown, friable sandy loam about 6 inches thick. The subsoil is about 23 inches thick. The upper 11 inches of the subsoil consists of dark-brown, firm, light sandy clay loam. The lower part is reddish-brown, very firm, heavy sandy clay loam that grades to gravelly loam as depth increases. Thick layers of sand and fine gravel underlie the subsoil at a depth of 36 inches. This material is loose and has a high lime content.

Fox soils have slow runoff and moderate permeability. They can be tilled throughout a wide range of moisture content. They are ready for tillage early in spring, and they dry out quickly after rain. Crusting of the plow layer is seldom a limitation, especially if minimum tillage is practiced and crop residue is returned to the soil. The available moisture capacity is moderate, and moisture is not adequate for crop growth during extreme drought. Natural fertility is moderate.

If well managed, these soils are suited to most crops grown in the county. Most of the acreage has been cleared and farmed. Corn, small grains, and forage crops are commonly grown on the more nearly level areas. The gently sloping areas are used for pasture or as woodland, and they are better suited to small grains, pasture, and forage crops than to row crops.

Typical profile of Fox sandy loam, 2 to 6 percent slopes, in a cultivated field, NE¼SE¼SW¼ sec. 29, T. 5 N., R. 6 E., Fenton Township:

Ap—0 to 7 inches, dark-brown (10YR 4/3) sandy loam; very fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2—7 to 13 inches, brown (10YR 5/3) sandy loam; weak, coarse, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21t—13 to 24 inches, dark-brown (7.5YR 4/4) light sandy clay loam; moderate, medium, subangular blocky structure; firm; slightly acid; gradual, wavy boundary.

B22t—24 to 34 inches, reddish-brown (5YR 4/4) heavy sandy clay loam; strong, medium, subangular blocky structure; very firm; medium acid; abrupt, irregular boundary.

B3—34 to 36 inches, reddish-brown (5YR 5/3) gravelly loam; weak, fine, subangular blocky structure; firm; neutral; abrupt, broken boundary.

IIC—36 to 40 inches, brown (10YR 5/3) stratified sand and fine gravel; single grain; loose; calcareous.

The A horizon is very dark grayish brown (10YR 3/2) in wooded areas and is 3 to 6 inches thick. In places the texture of the A2 horizon is light sandy loam, and in places the color is light gray (10YR 7/2) or light brownish gray (10YR 6/2). Also, this horizon contains isolated chunks of material from the B21 horizon. In most areas tongues of the B22 horizon extend downward into the IIC horizon. These tongues vary in number and thickness, and some extend to a depth of 2 to 3 feet. In some areas the texture of the B2 horizon is clay loam or gravelly clay loam. The B3 horizon is not always present. The texture of the IIC horizon is sand and gravel in many areas. The content of gravel ranges from only 1 percent to as much as 20 percent. The depth to the IIC horizon ranges from 24 to 42 inches. The reaction of the A and B horizons ranges from medium acid to neutral.

Fox soils have a finer textured B horizon than Boyer soils. They have more gravel in the B horizon than Miami soils and are underlain by sand and gravel at a depth of 24 to 42 inches.

Fox sandy loam, 0 to 2 percent slopes (FoA).—This soil occurs on outwash plains and upland plateaus. It adjoins the steeper, finer textured Miami soils on uplands and is near the coarser textured Boyer and Spinks soils on gravelly river terraces.

The plow layer is typically dark-brown sandy loam, but in small depressions the soil is covered with several inches of loamy material that washed in from higher areas. The gravel content varies but does not interfere with cultivation.

This nearly level soil has little runoff and only a slight risk of erosion. It has moderate natural fertility and available moisture capacity. The supply of moisture is sometimes inadequate during long dry spells. Also, there is a risk of soil blowing if large areas are exposed by cultivation. Tilth is easily maintained. Returning crop residue helps to maintain the content of organic matter and to improve the available moisture capacity.

Most areas are used for crops. A few areas are idle, in native pasture, or woodland. This soil is well suited to corn, small grains, and forage crops. Capability unit IIs–2 (3a).

Fox sandy loam, 2 to 6 percent slopes (FoB).—This soil has the profile described as typical of the series. It occurs mostly on river terraces and on undulating uplands. Some areas are in broad glacial drainage channels and on fan-shaped deltas at the base of moraines.

The plow layer is generally dark-brown sandy loam. Included in mapping, however, are small eroded spots that are lighter brown in color and lower in organic-matter content; small depressions that have several inches of washed-in material on the surface; minor areas of Miami soils on small, rounded knobs and knolls; and small wet spots that dry out slowly. The content of gravel varies but does not interfere with cultivation.

Because of the gentle slope, there is some risk of erosion if this soil is intensively cultivated. Many areas have complex slopes, which make terracing, contour stripcropping, and other conservation practices difficult. There is also risk of soil blowing on large, exposed areas. Natural fertility and available moisture capacity are moderate. The moisture supply is sometimes inadequate for crop growth during dry summer weather. Cover crops and green-manure crops supply organic matter and help control erosion. Returning crop residue to the soil is also beneficial. Most areas are intensively cultivated. Corn and small grains are the main crops grown. Forage crops are important in some areas. Small areas are in permanent pasture or are wooded. Capability unit IIe-3 (3a).

Gilford Series

The Gilford series consists of poorly drained, level or depressional sandy and loamy soils. These soils are underlain at a depth of 24 to 42 inches by stratified sand and gravel. They occupy glacial drainage channels and outwash plains and are most extensive along the major streams.

In a typical profile, the surface layer is very dark brown sandy loam about 10 inches thick. The subsoil is about 26 inches thick. It consists of grayish-brown or light brownish-gray, friable and very friable, coarse sandy loam and loamy coarse sand and has brownish-yellow and yellowish-brown mottles. Light brownish-gray stratified coarse sand and gravel underlie the subsoil at a depth of about 36 inches. This material is loose and has a high lime content.

Because these soils are level and have a sandy texture, runoff is very slow, and water ponds in the deeper depressions. Unless these soils are artificially drained, the water table fluctuates between the surface and a depth of 3 feet. The gray color of their subsoil indicates that these soils are saturated for long periods. They have moderately rapid permeability, however, and are easily drained. They have moderately low available moisture capacity and natural fertility. Because they are sandy, they tend to be droughty if artificially drained.

Wetness is the main limitation to the use of these soils for crops. Tile drainage and open ditches help to remove excess water and permit earlier tillage and planting. After these soils are drained, they tend to be droughty. The larger areas have been cleared of trees and are farmed. Smaller areas that lack suitable drainage outlets are used for pasture or are second-growth woodland.

Typical profile of Gilford sandy loam (0 to 2 percent slopes) in an idle field, NW¼NW¼ sec. 22, T. 8 N., R. 5 E., Flushing Township:

Ap—0 to 10 inches, very dark brown (10YR 2/2) sandy loam; moderate, medium, granular structure; very friable; mildly alkaline; abrupt, smooth boundary.

B21g—10 to 21 inches, grayish-brown (10YR 5/2) coarse sandy loam; few, fine, distinct, brownish-yellow (10YR 6/6) mottles; weak, medium, subangular blocky structure; very friable; mildly alkaline; gradual, wavy boundary.

B22g—21 to 29 inches, light brownish-gray (10YR 6/2) coarse sandy loam; common, medium, distinct, brownish-yellow (10YR 6/8) mottles; weak, medium, subangular blocky structure; friable; mildly alkaline; clear, wavy boundary.

B3g—29 to 36 inches, light brownish-gray (10YR 6/2) loamy coarse sand; common, coarse, faint, light yellowish-brown (10YR 6/4) and yellowish-brown (10YR 5/8) mottles; single grain; very friable; mildly alkaline; abrupt, wavy boundary.

IICg—36 to 48 inches, light brownish-gray (2.5Y 6/2) stratified coarse sand and gravel; common, coarse, faint, yellow (2.5Y 7/8) mottles; single grain; loose; calcareous.

A layer of muck 5 to 7 inches thick overlies the surface in the deeper depressions. There is also a very dark grayish-brown (10YR 3/2) A12 horizon 3 to 5 inches thick in some areas. The texture of the A and B horizons is loamy sand, sandy loam, or coarse sandy loam. In places these horizons consist of weakly stratified loamy sand and sandy loam. The depth to the calcareous sand and gravel is dominantly 30 to 42 inches but ranges from 24 to 42 inches. The reaction of the A and B horizons ranges from neutral to moderately alkaline.

Gilford soils have a grayer B horizon and are more poorly drained than Wasepi soils. They are finer textured in the upper part of the profile than Granby soils.

Gilford sandy loam (0 to 2 percent slopes) (Gd).—This is a poorly drained soil that occurs mostly on gravelly flats and benches bordering the Flint River. It commonly occupies the lower areas or channels on river terraces next to the escarpment of adjoining terraces. Minor areas are in the narrow, well-defined channels that drain into the river. The larger areas are elongated and are roughly parallel to the terrace edge. They range from 40 to 80 acres in size.

Included in mapping are areas that have 5 to 7 inches of mucky material overlying the mineral soil; areas that are slightly better drained and have a thin, yellowish-brown layer in the upper part of the subsoil; and some areas, chiefly in Montrose Township, where clay loam or silty clay loam occurs at a depth below 42 inches. Also included are areas of poorly drained Breckenridge soils in which the finer textured underlying material is at a depth of less than 42 inches. Other inclusions are small areas of poorly drained, sandier Granby soils.

Most of this soil is farmed. The rest is idle cropland or woodland. Wetness is the main limitation. Some areas lack suitable outlets and are difficult to drain. If this soil is drained and fertilized, it is suited to corn, beans, small grains, and forage crops. Capability unit IIIw-6 (4c).

Granby Series

The Granby series consists of poorly drained, level or slightly depressional sandy soils on outwash plains. These soils formed in medium to coarse sand and have a high water table. They are widely distributed but are most extensive in the northern and northwestern parts of the county.

In a typical profile, the surface layer is loamy sand about 14 inches thick. The surface layer is very dark brown in the upper half and very dark gray in the lower half. It is underlain to a depth of about 42 inches by grayish-brown, loose sand that has brownish-yellow mottles. Below this layer is light brownish-gray, loose sand that extends to a depth of 48 inches.

Runoff is very slow, and low areas are ponded. Most of the rainfall is readily absorbed, however, and permeability is rapid. The water table is near the surface in spring and early in summer unless these soils are artificially drained. Because of their sandy nature, these soils have low available moisture capacity and natural fertility. If the water table is lowered, they lack enough moisture for plant growth, especially during dry periods in summer.

Wetness early in the growing season is the main limitation to the use of these soils for crops. Tile drainage and open ditches help to lower the water table and allow earlier tillage and planting, but some areas lack suitable outlets. After these soils are drained, they tend to be droughty. Some areas have been drained by surface ditches and are used for crops. Other areas, once used for crops, are now idle and are reverting to aspen, soft maple, marsh grasses, and wetland shrubs.

Typical profile of Granby loamy sand (0 to 2 percent slopes) in a cultivated field, NE¼NW¼NW¼ sec. 1, T. 8 N., R. 5 E., Flushing Township:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loamy sand; weak, medium, granular structure; very friable; neutral; gradual, smooth boundary.

A1—7 to 14 inches, very dark gray (10YR 3/1) loamy sand; few, fine, distinct, grayish-brown (10YR 5/2) mottles in lower part; weak, coarse, granular structure; very friable; neutral; abrupt, wavy boundary.

C1g—14 to 42 inches, grayish-brown (10YR 5/2) sand; coarse, medium, distinct, brownish-yellow (10YR 6/8) mottles; single grain; loose; some very dark gray (10YR 3/1) organic coatings on individual sand grains in upper part; neutral; clear, wavy boundary.

C2g—42 to 48 inches, light brownish-gray (10YR 6/2) sand; single grain; loose; mildly alkaline.

The color of the A horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) or black (10YR 2/1). In some areas the texture of this horizon is mucky loamy sand or loamy fine sand. The combined thickness of the Ap and A1 horizons ranges from 8 to 15 inches. In some areas there are layers and lenses of loamy sand or light sandy loam, up to 3 inches thick, in the C1g and C2g horizons. The reaction to a depth of 42 inches ranges from slightly acid to mildly alkaline. The soil material below this depth is calcareous in places.

Granby soils are more poorly drained than Au Gres soils, and they are coarser textured than Gilford soils.

Granby loamy sand (0 to 2 percent slopes) (Gm).—The most extensive areas of this soil consist of broad flats on sandy lake plains. Smaller areas are in drainage channels and swales throughout the uplands. This soil commonly occupies the lowest positions adjoining Oakville, Spinks, and other sandy soils that are better drained.

The plow layer is normally very dark brown or very dark grayish-brown loamy sand that has a high organic-matter content. Included in mapping are areas in which a thin layer of muck overlies the surface layer. On small knolls the plow layer contains some of the subsoil, which is dark brown or dark reddish brown and is weakly cemented. In some places, chiefly in Montrose Township, clay loam or silty clay loam is present below a depth of 42 inches. Where this loamy material is at a depth of less than 42 inches, inclusions of the Brevort soils occur.

This Granby soil is poorly suited to crops unless it is drained. Many areas have been drained by open ditches and used for crops, but a large acreage is now idle. A few areas are irrigated and used for commercial sod production. Some areas are used for small grains and forage crops. Capability unit IIIw-11 (5c).

Gravel Pits

Gravel pits (Gr) are areas from which the overlying soil layers have been removed and gravel containing a variable amount of sand has been excavated. Gravel pits are scattered throughout the county but are most extensive on the gravelly terraces bordering the Flint River and its tributaries.

Gravel is used mainly as fill material for highway construction and in the manufacture of concrete products. The gravel pits vary considerably in size. The larger pits are outlined on the map. The smaller ones, generally less than 2 acres in size, are shown by spot symbols. Some of the pits contain water. They provide a source of water for irrigation and are suitable for recreational use. Capability unit VIIIs-1 (Sa).

Kibbie Series

The Kibbie series consists of somewhat poorly drained, nearly level to gently sloping or undulating soils that formed in water-laid deposits of fine sand and silt. These soils are on lake plains and till plains, mostly in the central and northwestern parts of the county.

In a typical profile, the surface layer is very dark grayish-brown fine sandy loam about 8 inches thick. The subsurface layer is yellowish-brown, very friable loamy fine sand that is about 6 inches thick and has brownish-yellow mottles. The subsoil is about 18 inches thick. The upper 10 inches of the subsoil consists of yellowish-brown, friable fine sandy loam that contains grayish-brown and brownish-yellow mottles. The lower 8 inches is grayish brown, friable heavy silt loam that has yellowish-brown mottles. The underlying material, beginning at a depth of about 32 inches, is gray silt loam that grades to stratified silt, fine sand, and very fine sand as depth increases. This material has yellowish-brown mottles. It is friable and has a high lime content.

Because Kibbie soils are in low positions, they have very slow runoff and a seasonal high water table. They are moderately permeable. The gray mottles in the subsoil indicate that these soils are saturated for long periods, and this saturation hinders the growth of plant roots. It also delays spring tillage and planting, because the soils are too wet for the operation of farm machinery. The available moisture capacity and natural fertility are moderately high. After these soils are drained, they are easily worked and kept in good tilth.

Because of the seasonal high water table, artificial drainage is generally required for cultivated crops. Tile trenches readily cave in, however, and the fine sandy and silty material seeps into tile lines unless precautions are taken. If these soils are drained, they are suited to all cultivated and forage crops commonly grown in the county. Most areas have been drained and are used for crops.

Typical profile of Kibbie fine sandy loam, 0 to 2 percent slopes, in a cultivated field, SW¼SE¼ sec. 4, T. 8 N., R. 7 E., Genesee Township:

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

A2—8 to 14 inches, yellowish-brown (10YR 5/6) loamy fine sand; common, medium, faint, brownish-yellow (10YR 6/6) mottles; weak, medium, subangular blocky structure; very friable; neutral; abrupt, wavy boundary.

B21t—14 to 24 inches, yellowish-brown (10YR 5/4) fine sandy loam; many, coarse, faint, grayish-brown (10YR 5/2), yellowish-brown (10YR 5/8), and brownish-yellow (10YR 6/8) mottles; weak, medium, subangular blocky structure; friable; neutral; abrupt, wavy boundary.

IIB22g—24 to 32 inches, grayish-brown (10YR 5/2) heavy silt loam; many, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; mildly alkaline; abrupt, wavy boundary.

IIC1g—32 to 48 inches, gray (10YR 5/1) silt loam; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, platy structure; friable; calcareous.

IIC2—48 to 58 inches, yellowish-brown (10YR 5/4), stratified silt, fine sand, and very fine sand; many, coarse, faint, yellowish-brown (10YR 5/6) mottles; weak, medium, platy structure; friable; calcareous.

The color of the Ap horizon is very dark brown (10YR 2/2) in some areas. The texture of the Ap and A2 horizons is fine sandy loam, loamy fine sand, or silt loam. The texture and thickness of the B and C horizons vary. The texture of the B21 horizon ranges from fine sandy loam to silt loam. The B22g horizon is heavy fine sandy loam, heavy silt loam, or light silty clay loam. The depth to mottling ranges from 7 to 15 inches. The reaction of the A and B horizons ranges from slightly acid to mildly alkaline.

The depth to the C horizon is generally 28 to 42 inches but ranges from 18 to 48 inches. The texture of the C horizon is dominantly stratified silt, fine sand, and very fine sand, but this horizon contains thin layers and lenses of heavy silt loam, clay loam, or silty clay loam in some areas.

Kibbie and Colwood soils formed in similar material, but Kibbie soils are better drained. Kibbie soils are coarser textured and more stratified than Conover soils. They formed in finer textured material than Minoa soils.

Kibbie fine sandy loam, 0 to 2 percent slopes (KfA).—This soil has the profile described as typical of the series. The largest areas of this soil adjoin the finer textured Del Rey soils on lake plains and lake-plain borders. Small areas adjoin the somewhat poorly drained Conover soils on till plains. This soil is most extensive in the northwestern part of the county.

The plow layer is generally very dark grayish-brown fine sandy loam, but the mapped areas include small areas that have a silt loam surface layer. Also included are minor areas of Minoa soils. Other inclusions are spots of Colwood soils in drainageways and depressions. These spots delay tillage because they remain wet longer than surrounding soils.

Wetness is a limitation, especially early in spring. Runoff is very slow, and surface drainage is needed in many areas. Ditchbanks and tile trenches cave in readily, however, because of the fine sandy and silty material. Tile is easier to install during dry periods. Special material is needed to keep the sandy soil from clogging the tile drains. If drained, this soil is suited to corn, beans, sugar beets, small grains, and forage crops. Capability unit IIw–6 (3b).

Kibbie fine sandy loam, 2 to 6 percent slopes (KfB).—This soil occurs mostly in areas between lake plains and till plains. It occupies the short, smooth side slopes of drainage channels in many places and is most extensive in the central and northwestern parts of the county.

The plow layer is generally very dark grayish-brown fine sandy loam, but small areas that have a silt loam surface layer are included in mapping. Also included are small areas of moderately well drained Tuscola soils on low knolls and ridges and wet spots of Colwood soils in shallow, random drainageways. These wet spots delay tillage and planting because they dry out slowly in spring.

Laying out a complete drainage system is difficult in the undulating areas. Random tile and surface drains help to remove excess water from drainageways and wet spots, but tile trenches cave in readily because of the sandy and silty soil material. Special material is needed to keep the sandy soil from clogging the drains. Tile is easier to install during dry periods. Providing an adequate supply of organic matter is more difficult, especially on the knolls and ridges, than on the more nearly level Kibbie soil. The principal crops grown are corn and field beans, although small grains and forage are important in some areas. Capability unit IIw–5 (3b).

Lake Beaches

Lake beaches (La) are narrow strips of sand and gravel along the larger lakes, principally in Fenton Township. These beaches are subject to wave action. After the material is deposited by waves, it is reworked, sorted, and carried from one place to another by wind and water. Because of this periodic movement, no soil profile has developed.

In addition to sand and gravel, the beach material contains a few stones and boulders. In places the sandy material is underlain by finer textured till or water-laid deposits.

Because the lake level fluctuates seasonally, these beaches are periodically covered by water. Some areas are stabilized and have a sparse stand of trees and grass. Lake beaches are used intensively for recreation and as homesites. Capability unit VIIIs-1 (Sa).

Lamson Series

The Lamson series consists of poorly drained or very poorly drained, level or slightly depressional soils on lake plains and till plains. These soils formed in water-laid fine sand, very fine sand, and loamy sand. They are not extensive and occur at random in the central and northwestern parts of the county.

In a typical profile, the surface layer is black loamy fine sand about 9 inches thick. The subsoil extends to a depth of about 42 inches. The upper part of the subsoil is grayish-brown, very friable loamy fine sand that is underlain by grayish-brown, loose very fine sand that has yellowish-brown mottles. The lower part of the subsoil is grayish-brown loose fine sand that is mottled with yellowish-brown and light yellowish-brown. The underlying material is gray, loose very fine sand.

Because these soils are in low positions, runoff is very slow or is ponded, and the water table is high, especially early in the growing season. The gray color of the subsoil indicates that these soils are saturated for long periods. This saturation restricts root growth and frequently delays planting and tillage. Permeability is moderately rapid, however, and these soils are easily drained by tile or open ditches. They are moderately low in available moisture capacity and natural fertility. Crops sometimes lack adequate moisture during dry periods in summer.

Unless they are artificially drained, most areas of these soils are too wet for cultivated crops. Open ditches and tile trenches cave in readily because of the sandy soil material. Most large areas are drained and used for crops. Smaller areas that lack drainage outlets are in permanent pasture or woodland.

Typical profile of Lamson loamy fine sand in idle cropland, NW¼NE¼ sec. 4, T. 9 N., R. 7 E., Thetford Township:

Ap—0 to 9 inches black (10YR 2/1) loamy fine sand; weak, medium, granular structure; very friable; slightly acid; gradual, wavy boundary.

B21g—9 to 15 inches, brown (10YR 5/3) loamy fine sand containing some very dark gray (10YR 3/1) material; weak, medium, granular structure; very friable; slightly acid; abrupt, wavy boundary.

B22g—15 to 30 inches, grayish-brown (10YR 5/2) very fine sand; few, medium, distinct, light yellowish-brown (10YR 6/4) mottles; single grain; loose; few very dark gray (10YR 3/1) organic stains in upper part; slightly acid; clear, wavy boundary.

B23g—30 to 42 inches grayish-brown (10YR 5/2) fine sand; common, medium, distinct, yellowish-brown (10YR 5/6) and light yellowish-brown (10YR 6/4) mottles; single grain; loose; neutral; abrupt, wavy boundary.

Cg—42 to 60 inches, gray (10YR 5/1) very fine sand; single grain; loose; calcareous.

A layer of muck 3 to 5 inches thick overlies the A horizon in the slight depressions. The A horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2) in color and from 7 to 9 inches in thickness. The B2g and Cg horizons vary in texture and thickness. Their texture is generally fine sand, loamy fine sand, or loamy sand, but in many areas the Cg horizon contains discontinuous strata of fine sandy loam, silt loam, or silty clay loam 1 to 3 inches thick. In some areas the texture of the soil material below a depth of 30 inches is sand or loamy sand. The reaction of the A and B2g horizons is slightly acid or neutral. The horizons below 30 inches are neutral to moderately alkaline and may be calcareous.

Lamson and Minoa soils formed in similar material, but Lamson soils have a grayer C horizon and are more poorly drained. They contain more fine sand and very fine sand than Granby soils.

Lamson loamy fine sand (0 to 2 percent slopes) (Lb).—This is a poorly drained to very poorly drained soil that occurs mostly on broad flats of sandy lake plains in the northwestern part of the county. Elsewhere, it is in small depressions and drainageways in moraines and till plains. The slope is dominantly less than 1 percent. Individual areas are as large as 40 acres or more on the sandy lake plains and range in size from 5 to 15 acres on till plains and moraines.

Included in mapping are depressions that have 3 to 5 inches of mucky material on the surface. Also included are minor areas of the poorly drained Granby and Gilford soils. The Granby soils are coarser textured than the Lamson soil, and the Gilford soils are somewhat finer textured. These included soils occur as wet spots in drainageways.

If drained, this Lamson soil is suited to corn, soybeans, and other cultivated crops. Many of the smaller areas are farmed with adjoining soils. A few undrained areas are idle or remain wooded.

Drainage and maintenance of fertility are the major management requirements. Installation of tile is easiest during dry periods. Special material is needed to keep the fine, sandy material from clogging tile drains. Capability unit IIIw-6 (4c).

Landes Series

The Landes series consists of nearly level, well drained to moderately well drained sandy soils on river bottoms. These soils formed in water-laid loamy sand, sandy loam, and fine sandy loam on bottom lands along the Flint River, Swartz Creek, and other major streams in the county.

In a typical profile, the surface layer is very dark grayish-brown fine sandy loam about 11 inches thick. The subsoil is about 19 inches thick. The upper 7 inches of the subsoil consists of yellowish-brown, friable loamy fine sand. The lower 12 inches of the subsoil is brown, massive, friable fine sandy loam that has yellowish-brown mottles. It is underlain at a depth of 30 inches by grayish-brown loamy fine sand that contains yellowish-brown mottles. This material is loose and has a high lime content.

These low-lying, sandy soils have only slight runoff. They absorb rainfall readily, are moderately permeable, and hold a moderate amount of moisture for plants. These soils are slightly higher than other soils on river bottoms and are subject to only occasional flooding. They are moderate in natural fertility and are easily tilled.

A few of the larger areas of Landes soils are farmed. Many areas are too small to be farmed with modern machinery. A few areas are in permanent pasture. The largest acreage, however, remains as woodland that consists mainly of elm, ash, hickory, cottonwood, and thornapple.

Typical profile of Landes fine sandy loam (0 to 2 percent slopes) in idle cropland, NE¼NE¼ sec. 7, T. 9 N., R. 6 E., Vienna Township:

Ap—0 to 11 inches very dark grayish-brown (10YR 3/2) fine sandy loam; moderate, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

B2—11 to 18 inches, yellowish-brown (10YR 5/4) loamy fine sand; weak, medium, subangular blocky structure; friable; neutral; clear, wavy boundary.

B3—18 to 30 inches, brown (10YR 5/3) fine sandy loam; common, medium, faint, yellowish-brown (10YR

5/6) mottles; massive; friable; neutral; clear, wavy boundary.

C1—30 to 50 inches, grayish-brown (10YR 5/2) loamy fine sand; common, coarse, distinct, yellowish-brown (10YR 5/8) mottles; single grain; very friable; neutral; clear, wavy boundary.

C2—50 to 60 inches, light brownish-gray (2.5Y 6/2) sand; single grain; loose; calcareous.

The texture, to a depth of 30 inches or more, is dominantly fine sandy loam or sandy loam. The texture below this depth is loamy sand, sand, or coarse sand. In a few places the color of the A horizon is dark grayish brown, and in places the texture is loamy fine sand or silt loam. This horizon is 6 to 10 inches thick. The texture and thickness of the B and C horizons vary. Mottling begins at a depth of 18 to 28 inches in moderately well drained areas. The reaction is generally neutral to mildly alkaline to a depth of 30 inches. The material below this depth is generally calcareous.

Although Landes and Ceresco soils formed in similar material Landes soils are better drained.

Landes fine sandy loam (0 to 2 percent slopes) (Ld).—This soil is on natural levees along active streams and on second bottoms adjoining flood plains. It is slightly higher on flood plains than the more poorly drained Ceresco and Cohoctah soils.

Although most areas are nearly level, some small, gently sloping areas on short breaks between the second bottoms and flood plains were included in mapping.

This soil is subject to flooding early in spring, but floodwater recedes quickly once the stream level is restored. Lack of sufficient moisture is a limitation during dry periods in summer. Most areas are in woodland. A few of the larger areas are farmed with soils on uplands and used for corn and forage crops. Capability unit IIw-9 (L-2a).

Lenawee Series

The Lenawee series consists of poorly drained, level or depressional loamy soils on lake plains and till plains. These soils formed in silty clay loam containing thin layers and lenses of very fine sand, silt, and silt loam. They occur principally in the southern part of Gaines Township and in the northern part of the county in Montrose and Vienna Townships.

In a typical profile, the surface layer is very dark grayish-brown silty clay loam about 7 inches thick. The subsoil is about 38 inches thick and consists mostly of gray, very firm silty clay loam or heavy silty clay loam that has yellowish-brown and brownish-yellow mottles. The underlying material is gray silty clay loam that has brownish-yellow mottles and contains thin layers of very fine sand and silt. It is very firm and has a high lime content.

Runoff is very slow or is ponded on these level or nearly level soils. Permeability is moderately slow or slow because of the high content of fine silt and clay. These soils have a grayish subsoil, which indicates they are saturated for long periods. Because the soils dry out slowly in spring, tillage and planting are delayed. If they are tilled when wet, they puddle and dry out cloddy and hard. Thus, keeping good tilth is a problem. Pastures should not be grazed when these soils are wet, because trampling by cattle compacts the surface layer and damages the soil structure. These soils have high natural fertility and available moisture capacity.

Removing excess water and keeping good tilth are the main needs in management. Drainage by tile and open ditches helps to remove excess water and allows more timely field operations with less risk of damage to soil structure. If drained, these soils are suited to most cultivated and forage crops grown in the county.

Typical profile of Lenawee silty clay loam (0 to 2 percent slopes) in a cultivated field, NE¼NE¼ sec. 15, T. 9 N., R. 5 E, Montrose Township:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silty clay loam; few, fine, faint, gray (10YR 5/1) and yellowish-brown (10YR 5/6) mottles; moderate, medium, granular structure; firm; slightly acid; abrupt, smooth boundary.

B21g—7 to 10 inches, grayish-brown (10YR 5/2) silty clay loam; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; medium to fine, angular blocky structure; very firm; patchy, very dark grayish-brown (10YR 3/2) organic coatings on some ped faces; slightly acid; clear, smooth boundary.

B22g—10 to 25 inches, gray (10YR 5/1) heavy silty clay loam; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; moderate, medium, angular blocky structure; very firm; slightly acid; clear, smooth boundary.

B3g—25 to 45 inches, gray (10YR 5/1) silty clay loam, common, medium, prominent, brownish-yellow (10YR 6/8) mottles; moderate, medium, angular blocky structure; very firm; grayish-brown (10YR 5/2) very fine sand or silt coatings on some ped faces; some segregated lime; neutral in upper part to mildly alkaline in lower part; clear, smooth boundary.

C—45 to 60 inches, gray (N 6/0) silty clay loam; common, medium, distinct, brownish-yellow (10YR 6/8) mottles; massive; very firm; 1/8-inch to 1/2-inch lenses and coatings of very fine sand and silt; lime streaks; calcareous.

A layer of muck 5 to 7 inches thick overlies the surface in some depressions. The Ap horizon ranges from very dark grayish brown (10YR 3/2) to very dark brown (10YR 2/2) or very dark gray (10YR 3/1) in some areas and is 7 to 10 inches thick. The texture of the Ap horizon is heavy silt loam in places. The texture of the B horizon is silty clay loam, heavy silty clay loam, or silty clay. In some areas the A and B horizons consist of weakly stratified clay loam and silty clay loam and contain lenses 1/2 to 1 inch thick of very fine sandy loam and silt loam. The B horizon generally has a moderate to strong, medium to fine, angular blocky structure. In places the C horizon has a weak or moderate, medium, platy structure.

The combined thickness of the A and B horizons ranges from 30 to 60 inches. The reaction of the A and B horizons ranges from slightly acid to mildly alkaline.

Lenawee and Del Rey soils formed in similar material, but Lenawee soils have a grayer B horizon and are more poorly drained. Lenawee soils are finer textured than Brookston and Colwood soils.

Lenawee silty clay loam (0 to 2 percent slopes) (Le).—This is a poorly drained soil on lake plains and till plains, mostly in the northwestern part of the county. It is more extensive on lake plains, where it occupies broad areas. Elsewhere it is in drainage channels within areas of undulating soils. Generally this soil occurs with the higher, somewhat better drained Del Rey soils.

The plow layer is typically very dark grayish-brown silty clay loam, but it ranges to silt loam in some included areas. In drainage channels the surface layer and upper subsoil contain strata of sandy loam or silt loam. Also included are some small areas that have an accumulation of muck or loamy mineral soil on the surface.

Wetness and poor tilth are the main limitations. This soil dries out slowly in spring and after heavy rainfall. If it is tilled when wet, the soil structure is destroyed, and the plow layer dries out cloddy. Tilth is then poor, and a good seedbed is difficult to prepare. Farm machinery readily bogs down during wet periods.

Because the subsoil is slowly permeable, backfilling with straw or other porous material improves the efficiency of tile drains. Parallel ditching or bedding helps to remove surface water and permits earlier tillage and planting. Most of this soil is intensively farmed. Under good management it is suited to corn, sugar beets, beans, and forage crops. Capability unit IIw–2 (1.5c).

Linwood Series

The Linwood series consists of very poorly drained, level or nearly level organic soils that formed in deposits of organic material, 12 to 24 inches thick, over loamy material. The organic material consists mainly of decomposed wood, grasses, and sedges. These soils occur in closed depressions on uplands, in wide strips along glacial drainageways, and in slack-water areas adjacent to lakes, streams, and rivers. They are most extensive among sloping soils on uplands in the eastern and southern parts of the county. In this county Linwood soils were mapped alone and in an undifferentiated unit with Carlisle soils.

In a typical profile, the surface layer is black muck about 12 inches thick. Below the surface layer, to a depth of about 32 inches, is dark-brown and dark reddish-brown, friable peat and muck containing some partly decomposed woody material. The underlying material consists of light olive-gray, stratified silt, fine sandy loam, and very fine sand. This material is friable and has a high lime content.

Because of their low relief, these soils have little runoff, and water ponds in the depressions during spring and after heavy rainfall. The organic layers have moderately rapid permeability, but the underlying loamy material has moderately slow permeability. The available moisture capacity is high, and there is normally enough moisture for plant growth. In undrained areas the water table is at or near the surface. These soils are low in phosphorus, potassium, and some micronutrients, and natural fertility is therefore low.

Many areas of Linwood soils have been cleared and are farmed. A large acreage, however, remains in swamp and woodland. Wetness is the major limitation to the use of these soils for crops. Tile drains and open ditches help to remove excess water. Controlling the level of the water table helps to regulate moisture content and to maintain the thickness of the organic layers, which shrink as the result of drainage. Soil blowing is a risk if these soils are cultivated.

Typical profile of Linwood muck (0 to 1 percent slopes), SE¼SE¼SE¼ sec. 13, T. 9 N., R. 7 E., Thetford Township:

1—0 to 12 inches, black (10YR 2/1) muck; weak, fine, granular structure; many woody fragments; friable; neutral; abrupt, smooth boundary.

2—12 to 21 inches, dark-brown (7.5YR 3/2) muck; moderate, fine, granular structure; many woody fragments; friable; slightly acid; clear, wavy boundary.

3—21 to 30 inches, dark reddish-brown (5YR 3/2) mixed woody and fibrous peat; fine, fibrous structure; firm; slightly acid; clear, wavy boundary.

4—30 to 32 inches, olive-gray (5Y 4/2) sedimentary peat; colloidal, gelatinous; neutral; abrupt, wavy boundary.

IICg—32 to 50 inches, light olive-gray (5Y 6/2), stratified silt, fine sandy loam, and very fine sand; massive; friable; calcareous.

In some areas the color of the surface horizon is very dark brown (10YR 2/2). The third horizon consists of well-decomposed muck in places. Layers of loamy sand or sandy loam, 3 to 5 inches thick, occur immediately above the IICg horizon in places. The depth to the IICg horizon ranges from 25 to 40 inches. The texture of this horizon is loam, silt loam, or light clay loam in some areas. The reaction of the organic material ranges from medium acid to neutral. The IICg horizon is normally calcareous, but the reaction is neutral or mildly alkaline in places.

Linwood soils are more acid than Markey soils, which are underlain by sandy material. They formed in thinner organic deposits than Carlisle and Lupton soils.

Linwood muck (0 to 1 percent slopes) (Lm).—This soil occupies low swales and swampy depressions on till plains and undulating uplands. On till plains it is commonly surrounded by Conover and Brookston soils. Most areas are only 10 to 15 acres in size.

Included in mapping are small areas in which a lighter colored mineral soil has washed in over the muck. Also included are minor areas of the poorly drained Brookston soils.

Wetness is the main limitation to the use of this soil for crops. Many areas lack drainage outlets. Some areas are farmed intermittently with adjacent mineral soils, depending on the height of the water table at planting time. Frost damage sometimes injures crops in spring or prevents them from maturing in fall. Farm machinery readily bogs down when this soil is wet. Thus, planting, harvesting, and weed control are seriously hampered. Capability unit IIw–10 (M/3c).

Lupton Series

The Lupton series consists of very poorly drained, level or nearly level organic soils that formed in decomposed woody and fibrous material on upland till plains and moraines. These soils are most extensive in drainage channels and swales among more strongly sloping soils. The larger areas are in the eastern and southern parts of the county.

In a typical profile, the surface layer is very dark gray muck about 12 inches thick. Below the surface layer, to a depth of about 28 inches, is dark reddish-brown muck. This muck is well decomposed in the upper part and grades to moderately decomposed in the lower part. The underlying layers, to a depth of 48 inches or more, consist of dark reddish-brown mucky peat. These layers contain more fibrous and less woody material than the overlying layers.

Because these soils are in very low positions in the landscape, they have very slow runoff, and the lowest areas are ponded in spring and after heavy rainfall. Permeability is moderately rapid if the water table is lowered. The available moisture capacity is high, and there is enough moisture for plant growth during the growing season. These soils have a low content of phosphorus, potassium, and some micronutrients, and their fertility is therefore low.

Wetness and low fertility are the main limitations to the use of these soils for crops. Soil blowing is a risk if large areas are exposed by cultivation. Tile drains and open ditches help to remove excess water, but some areas lack suitable outlets. Row crops are sometimes damaged by frost. A small acreage has been drained and is used for crops. Minor areas drained only by a few random surface ditches, are used for pasture. The largest acreage remains in woodland that consists mostly of elm, ash, white-cedar, alder, and soft maple.

Typical profile of Lupton muck (0 to 1 percent slopes) in a wooded area, SE¼SE¼ sec. 12, T. 9 N., R. 8 E., Forest Township:

1—0 to 12 inches, very dark gray (5YR 3/1) well-decomposed muck; weak, medium and coarse, granular structure; friable; mildly alkaline; gradual, wavy boundary.

2—12 to 28 inches, dark reddish-brown (5YR 3/2) muck; well-decomposed in upper part, grading to moderately decomposed in the lower part; weak, coarse, granular structure; friable; mildly alkaline; gradual, wavy boundary.

3—28 to 36 inches, dark reddish-brown (5YR 3/2–3/3) partly decomposed mucky peat; soft fibrous and woody material; mildly alkaline; gradual, wavy boundary.

4—36 to 48 inches, dark reddish-brown (5YR 3/3), finely fibrous mucky peat; soft; mildly alkaline.

The color of the upper two horizons ranges to very dark brown (10YR 2/2) or black (10YR 2/1). The third horizon is commonly dark brown (7.5YR 3/2) or dark reddish brown (5YR 3/2) and consists of mucky peat, peat, or sedimentary peat. The total thickness of the organic material ranges from 3 to 10 feet or more. The reaction of all horizons ranges from neutral to mildly alkaline. In places the organic material below a depth of 30 inches is calcareous colloidal muck containing shell fragments.

Lupton soils are more alkaline than Carlisle and Rifle soils. They formed in thicker organic deposits than Linwood and Markey soils.

Lupton muck (0 to 1 percent slopes) (Lu).—This soil occupies broad glacial drainage channels and swales in uplands in the eastern part of the county. Most areas are bordered by sloping or steeply sloping soils.

The surface layer is very dark gray or black muck. Included in mapping are narrow strips of Markey muck over sand and Linwood muck over loam. Also included are small areas of the poorly drained Gilford and Sebewa soils.

Drainage is needed for cultivated crops. Tile and open ditch drainage can be used. If this soil is drained, however, the organic material subsides or settles readily. Controlling the height of the water table helps to maintain the thickness of the organic material. This soil is commonly low in content of phosphorus, potassium, and some micronutrients. Because of its low position, crops on this soil can be damaged by frost. Soil blowing is a problem on large areas exposed by cultivation.

This soil is not well suited to small grains because of the high organic-matter content and the consequent risk of lodging or falling down. The lime content is generally too high for blueberry production. Under intensive management this soil is well suited to celery, carrots, onions, and other truck crops. Capability unit IIIw–15 (Mc).

Made Land

Made land (Md) consists of areas where the original soil layers have been destroyed by mixing or land shaping for development of a building site. Included are land fills over trash and refuse and other kinds of land fill. Capability unit VIIIs-1 (Sa).

Markey Series

The Markey series consists of very poorly drained, level or slightly depressional, organic soils that formed in decomposed mixed woody and fibrous material, including reeds, sedges, and grasses. Mildly alkaline or calcareous sandy material underlies the organic layers at a depth of 12 to 42 inches. These soils are on outwash plains and in swales and drainage channels. They occur among the sloping soils on uplands in the eastern and southern parts of the county.

In a typical profile, the surface layer is black, well-decomposed muck about 16 inches thick. Below the surface layer, to a depth of about 24 inches, is very dark brown, very friable peaty muck. Grayish-brown sand underlies the organic material. This sand is loose and has a high lime content.

Because they are level or slightly depressional, Markey soils have very slow runoff and are ponded in some of the lowest depressions and flats. They have moderately rapid permeability. In undrained areas a high water table in spring and early in summer restricts the growth of plant roots. Natural fertility is low, especially the content of phosphorus, potassium, and some micronutrients. The available moisture capacity is high. Frost is a hazard to crops in spring and in fall. The organic matter settles readily if these soils are drained and used for crops.

Most areas are wooded, a few areas are cultivated, and some are in permanent pasture. The native vegetation consists of elm, red maple, and wetland grasses and shrubs. Wetness and low fertility are the major limitations to the use of these soils for crops. Tile drains and open ditches help to remove excess water, but they often cave in because of the sandy material. Controlling the water table is a means of regulating the moisture content and reducing subsidence and loss of organic material. Control of soil blowing is important in cultivated areas.

Typical profile of Markey muck (0 to 1 percent slopes) in a wooded area, NE¼NW¼ sec. 33, T. 8 N., R. 7 E., Genesee Township:

1—0 to 16 inches, black (10YR 2/1), well-decomposed muck; moderate, medium, granular structure; very friable; mildly alkaline; clear, wavy boundary.

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2—16 to 24 inches, very dark brown (10YR 2/2) peaty muck; weak, coarse, granular structure; very friable; mildly alkaline; abrupt, wavy boundary.

IIC—24 to 42 inches, grayish-brown (10YR 5/2) sand; single grain; loose; calcareous.

The thickness of the organic material ranges from 20 to 30 inches. From 3 to 5 inches of marl overlies the IIC horizon in some areas. The texture of the IIC horizon is sand, coarse sand, or loamy sand. The reaction of the organic material ranges from neutral to mildly alkaline. The underlying sandy material is generally calcareous.

Markey soils have a thinner layer of organic material than Lupton soils. Unlike Edwards soils, they are underlain by sand rather than marl.

Markey muck (0 to 1 percent slopes) (Mk).—This soil occurs mainly in broad drainage channels, swales, and basins in uplands. It is near poorly drained Granby, Gilford, and Sebewa soils.

The surface layer is commonly black muck about 16 inches thick. Included in mapping are a few areas where slightly less than 12 inches of organic material overlies limy sand; small areas of the thicker Lupton muck are in the deeper parts of the channels at the base of side slopes; and areas of Edwards muck overlie marl along the shallow edge of channels and in narrow tributary drains.

Drainage is needed if this soil is used for cultivated crops. It can be drained by tile and open ditches. The organic material is less than 42 inches thick, however, and if the soil is drained, care must be taken to prevent thinning and settling of this material. This soil is low in content of phosphorus, potassium, and some micronutrients. If the organic material shrinks, fertility is even more difficult to maintain.

Because of the high organic-matter content and the risk of lodging and falling down, this soil is not well suited to small grains. Under good management, it is suited to corn, beans, sugar beets, and forage crops. Capability unit IVw–5 (M/4c).

Metamora Series

The Metamora series consists of nearly level or gently sloping, somewhat poorly drained soils on till plains, outwash plains, and river terraces. These soils formed in sandy and loamy deposits 18 to 42 inches thick over loamy material that has a high lime content. In this county Metamora soils are mapped separately and in a complex with Conover soils.

In a typical profile, the surface layer is very dark grayish-brown sandy loam about 8 inches thick. It is underlain by about 2 inches of brown, friable sandy loam that has light yellowish-brown mottles. The subsoil is about 16 inches thick. The upper 6 inches of the subsoil consists of yellowish-brown, friable sandy loam that has grayish-brown mottles. The lower 10 inches consists of dark yellowish-brown, firm, light sandy clay loam that has grayish-brown and yellowish-brown mottles. Underlying the subsoil is grayish-brown light clay loam that has yellowish-brown mottles. This material is firm and has a high lime content.

Permeability is moderately rapid in the upper layers but moderate to moderately slow in the lower, finer textured material. The available moisture capacity and fertility are moderate. A high water table during the early part of the growing season hinders plant growth and sometimes delays planting and tillage. After the soils dry out, they are easily worked and kept in good tilth.

Most areas of these soils are used for cultivated crops. The more gravelly terraces bordering the river are in trees and permanent pasture. Excessive wetness during spring is the major limitation, but this can be controlled by use of tile drains, surface drains, and open ditches. The more undulating areas, however, are difficult to drain. If these soils are drained, they are suited to most crops grown in the county.

Typical profile of Metamora sandy loam, 0 to 2 percent slopes, in a cultivated field, SE¼SE¼SW¼ sec. 18, T. 8 N., R. 6 E., Mt. Morris Township:

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

A2—8 to 10 inches, brown (10YR 5/3) sandy loam; few, medium, faint, light yellowish-brown (10YR 6/4) mottles; weak, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B1—10 to 16 inches, yellowish-brown (10YR 5/4) sandy loam; common, medium, distinct, grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; friable; neutral; gradual, wavy boundary.

B2t—16 to 26 inches, dark yellowish-brown (10YR 4/4) light sandy clay loam; common, medium, distinct, grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/6) mottles; moderate, coarse, subangular blocky structure; firm; neutral; abrupt, wavy boundary.

IICg—26 to 42 inches, grayish-brown (10YR 5/2) light clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; firm; calcareous.

The texture of the A horizon ranges from sandy loam to loamy fine sand or fine sandy loam. The color of the Ap horizon is very dark grayish brown (10YR 3/2) or very dark brown (10YR 2/2). In some places the texture of the B1 horizon is loamy sand, loamy coarse sand, or coarse sandy loam. The texture of the B2t horizon is heavy sandy loam or sandy clay loam in places, and the thickness ranges from 5 to 15 inches. There is a B3 or C1 horizon of sand, loamy sand, or loamy coarse sand 3 to 5 inches thick in places. The depth to the IIC horizon ranges from 18 to 42 inches but is dominantly 24 to 36 inches. The texture of the IIC horizon is loam or clay loam but ranges to silty clay loam, and in places it contains sandy strata up to 3 inches thick. The depth to mottling ranges from 7 to 15 inches. Varying amounts of gravel, as much as 3 inches in diameter, occur throughout the A and B horizons in some areas. Gravel is most common on the terraces bordering the Flint River.

Metamora soils have finer textured B1 and B2t horizons than Metea soils. They are coarser textured in the upper part of the B horizon than Conover soils. Although Metamora soils formed in the same kind of material as Owosso soils, they are more poorly drained and more highly mottled.

Metamora sandy loam, 0 to 2 percent slopes (MlA)—This soil occurs on till plains and on broad sandy and gravelly flats and benches bordering the Flint River. It has the profile described as typical of the series. The plow layer is very dark grayish-brown sandy loam. Most areas of this soil are 20 to 40 acres in size, but some of the larger areas are as much as 120 acres. This soil is widely distributed but is most extensive in the central and northwestern parts of the county. Much of it occurs within larger areas of the finer textured Conover soils.

Included in mapping are some areas in which the upper part of the subsoil consists of alternating layers of loamy sand and sandy loam, especially near the coarser textured Selfridge soils. The lower part of the subsoil is light sandy clay loam. In some areas the underlying limy, finer textured material consists of stratified silt loam and silty clay loam. Other inclusions are minor areas of somewhat poorly drained Conover and Wasepi soils. The Conover soils are finer textured than this Metamora soil and are in slightly lower positions. The Wasepi soils are slightly coarser textured but are in positions similar to those of the Metamora soil. In addition, there are random wet spots that dry out slowly in spring and after heavy rainfall.

Most of this soil has been cultivated. If drained and otherwise well managed, it is suited to corn, beans, small grains, forage, and all other crops grown in the county. Draining the soil and maintaining fertility are the main needs in management. Capability unit IIw–8 (3/2b).

Metamora sandy loam, 2 to 6 percent slopes (MlB).—This soil occurs on till plains and outwash plains. It occupies low, smooth ridges and knolls and short side slopes of drainageways. The dominant slopes are 2 to 4 percent. The plow layer is very dark grayish-brown sandy loam. Many areas are only 5 to 15 acres in size, but a few are 40 acres or more.

Included in mapping are areas in which the upper part of the subsoil consists of alternating layers of loamy sand and sandy loam, especially adjoining the Selfridge soils. The lower part of the subsoil is light sandy clay loam. In some areas the underlying limy, finer textured material consists of stratified silt loam and silty clay loam. Minor areas of Owosso and Conover soils are also included. The Owosso soils are well drained to moderately well drained. They formed in the same kind of material as the Metamora soil and are on upper slopes. The Conover soils are somewhat poorly drained. They are finer textured than the Metamora soil and are in shallow drainageways and depressions.

Most of this soil has been cultivated. A few areas are in permanent pasture and second-growth woodland. If drained, this soil is suited to corn, beans, small grains, and forage crops. Because of the seasonal high water table, tile drainage is generally beneficial. Capability unit IIw–8 (3/2b).

Metea Series

The Metea series consists of well drained and moderately well drained sandy soils that are nearly level to moderately steep. These soils formed in 18 to 42 inches of sand or loamy sand over loamy till that has a high lime content. They are on till plains throughout the county. In this county Metea soils are mapped separately and in a complex with Miami soils.

In a typical profile, the surface layer is dark grayish-brown loamy sand about 7 inches thick. The subsurface layer is brown, very friable loamy sand that is also about 7 inches thick. The upper 16 inches of the subsoil is yellowish-brown, very friable loamy sand. The middle 8 inches of the subsoil is yellowish-brown, very friable loamy sand that contains thin, dark-brown layers of sandy loam. The lower 5 inches of the subsoil is mildly alkaline, firm loam underlain by grayish-brown loam at a depth of about 43 inches. This material is firm and generally has a high lime content.

Runoff ranges from slow in nearly level areas to medium in sloping areas. Most of the rainfall is readily absorbed. The sandy upper layers have moderately rapid permeability, but the underlying loamy material has moderate permeability. This loamy material holds moisture and also keeps the sandy material above it moist, so that this otherwise droughty soil has moderate available moisture capacity. The moisture content, however, is rarely adequate for optimum plant growth during dry summers. Because of their sandy nature, these soils are low in natural fertility. They are subject to soil blowing and water erosion unless protected by small grains, hay, or winter cover crops.

Except for random woodlots, most areas have been cleared and are used for crops. Many areas are small and are farmed with adjoining finer textured soils. Some areas, once cultivated, are now idle.

Typical profile of Metea loamy sand, 2 to 6 percent slopes, in a cultivated field, NE¼SW¼ sec. 35, T. 6 N., R. 6 E., Mundy Township:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loamy sand; weak, medium, granular structure; very friable; slightly acid; abrupt, smooth boundary.

A2—7 to 14 inches, brown (10YR 5/3) loamy sand; weak, medium, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.

B1—14 to 30 inches, yellowish-brown (10YR 5/4) loamy sand; weak, medium, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.

B2t—30 to 38 inches, yellowish-brown (10YR 5/4) loamy sand containing discontinuous bands of dark-brown (10YR 4/3) sandy loam; 1/4 to 1 inch thick; weak, medium, subangular blocky structure; very friable; slightly acid; abrupt, wavy boundary.

IIB22—38 to 43 inches, yellowish-brown (10YR 5/4) loam; moderate, coarse, subangular blocky structure; firm; mildly alkaline; abrupt, wavy boundary.

IIC—43 to 48 inches, grayish-brown (10YR 5/2) loam; massive; firm; calcareous.

The texture of the A and B1 horizons is sand in some places. The color of the Ap horizon is very dark grayish brown (10YR 3/2) in some depressions. The B2 horizon, 3 to 10 inches thick, is loamy sand, sandy loam, or stratified loamy sand and sandy loam, and in a few places it is light sandy clay loam. The reaction of the sandy upper horizons is slightly acid or neutral.

The IIB horizon, 3 to 8 inches thick, generally has moderate to weak structure and is neutral to mildly alkaline. The texture of the IIC horizon is loam, clay loam, or silty clay loam. The IIB and IIC horizons are mottled only in moderately well drained areas.

Metea soils are coarser textured than Owosso soils. They are better drained than Selfridge soils, although they formed in material of similar texture.

Metea loamy sand, 0 to 2 percent slopes (MnA).—In most areas this soil is on sandy flats and low sandy ridges on till plains, where it is associated with Miami and Celina soils. Some areas occur between the till plains and the more sandy and gravelly outwash plains, and a few areas are on level benches above drainage channels. Most areas are 10 to 40 acres in size, although a few are as much as 80 acres or more.

The plow layer is typically dark grayish-brown loamy sand, but it has a spotty appearance in cultivated fields where a small amount of the subsoil has been mixed with the original surface layer. The upper part of the subsoil is brown or reddish-brown loamy sand in some areas. In many places the lower part of the subsoil has light brownish-gray or grayish-brown mottles, which indicate that it is moderately well drained. A layer of very coarse sand and fine gravel overlies the finer textured material in some places, especially where this soil borders major drainage channels.

This soil tends to be droughty, and crops lack enough moisture for optimum growth during dry weather. If large areas are left bare, soil blowing is a risk. Returning a considerable amount of organic matter to the soil helps to maintain fertility and to improve the storage of moisture. This soil is better suited to small grains, forage, and other early maturing or drought-resistant crops than to row crops. Capability unit IIIs-3 (4/2a).

Metea loamy sand, 2 to 6 percent slopes (MnB).—This soil has the profile described as typical of the series. It occupies low sandy ridges on till plains. Many areas of this soil are on foot slopes of the more rolling uplands. Miami and Celina soils are generally upslope from this soil. Conover and Metamora soils are downslope from it on till plains, and Boyer and Spinks soils are downslope on rolling uplands. Areas of this soil range from 10 to 40 acres in size. It is most extensive in the northeastern and eastern parts of the county.

The plow layer is dark grayish-brown loamy sand. In some areas, mainly on the till plains, the upper subsoil has been mixed with the original surface layer, and the plow layer has a spotty appearance in cultivated fields. The loamy sand is generally 30 to 40 inches thick but ranges to 48 inches in some places. Minor areas of the Miami soils on upper slopes are included in this mapping unit. Random seep spots occur near the margins of this soil early in spring.

This soil tends to be droughty, and crops rarely have enough moisture for optimum growth during dry periods in summer. In the more strongly sloping areas, there is a slight risk of erosion. If large areas are left bare, soil blowing is also a potential risk. Returning a considerable amount of organic matter to the soil helps to maintain fertility and to increase the storage of moisture. This soil is suited to small grains, forage, and other early maturing or drought-resistant crops. Capability unit IIIs-4 (4/2a).

Metea loamy sand, 6 to 12 percent slopes (MnC).—This soil occupies the side slopes of ridges and drainage channels on till plains. Most of the slopes are 100 to 200 feet in length and are uniform and smooth, except for those in a few shallow drainageways. Areas of this soil range from 10 to 20 acres in size and are widely distributed, but the total acreage is small.

The profile of this soil resembles the one described as typical of the series, except in woodland where the uneroded surface layer is very dark brown or very dark grayish brown. On upper slopes the surface layer is thinner than elsewhere. In places the plow layer contains a small amount of the yellowish-brown subsoil material. In this soil the depth to the limy, finer textured underlying material is generally less than is typical and approaches the minimum depth for the series.

On the shoulder of side slopes and extending downslope on interdrainage divides, small areas of the finer textured Miami soils are included in this mapping unit. Also included are small seep spots that remain wet until midsummer.

In the southern and eastern parts of the county, this soil is farmed with adjoining less strongly sloping soils. In these areas corn, small grains, forage, and other crops are grown. Other areas are abandoned cropland or are wooded. Because of its steeper slopes, this soil has more runoff and less moisture available for crops than the less strongly sloping soils. In managing it, cropping systems and conservation practices should be chosen that control erosion, maintain fertility, and supply adequate organic matter. Capability unit IIIe-9 (4/2a).

Miami Series

The Miami series consists of well-drained, nearly level to steep loamy soils on till plains and moraines. These soils have a moderately fine textured subsoil. They are the main soils on the undulating and rolling uplands in the eastern and southeastern parts of the county. In this county Miami soils are mapped separately and in complexes with Metea soils.

In a typical profile, the surface layer is dark grayish-brown loam about 8 inches thick. The subsurface layer is brown, friable loam about 4 inches thick. The subsoil is about 21 inches thick and consists of yellowish-brown, firm clay loam. Brown loam underlies the subsoil at a depth of about 33 inches. This material is friable and has a high lime content.

Runoff ranges from slow on gently sloping areas to very rapid on eroded, steeply sloping areas. The available moisture capacity and natural fertility are moderately high. These soils have moderate permeability and good drainage. They dry out quickly in spring. The eroded soils of this series have poorer tilth and lower fertility than the uneroded soils.

Excessive runoff and the risk of erosion are the main limitations in the use of these soils for crops. Most of the gently sloping and sloping areas are used for crops. The steeper areas are in permanent pasture or in woodland. Some of the steeper, eroded areas were once cultivated but are now idle. If these soils are protected from erosion, they are suited to most crops grown in the county.

Typical profile of Miami loam, 2 to 6 percent slopes, in a cultivated field, NW¼NW¼SE¼ sec. 35, T. 9 N., R. 8 E., Forest Township:

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

A2—8 to 12 inches, brown (10YR 5/3) loam; weak, medium, subangular blocky structure; friable; slightly acid; abrupt, wavy boundary.

B21—12 to 25 inches, yellowish-brown (10YR 5/6) clay loam; moderate, medium, subangular blocky structure; firm; brown (7.5YR 5/4), patchy clay films on some ped faces; medium acid; abrupt, wavy boundary.

B22t—25 to 33 inches, yellowish-brown (10YR 5/4) clay loam; moderate, medium, subangular blocky structure; firm; dark-brown (7.5YR 4/4) clay films on most ped faces and along fracture lines; slightly acid; abrupt wavy boundary.

C—33 to 48 inches, brown (10YR 5/3) loam; massive; friable; calcareous.

The color of the Ap horizon is dark brown (10YR 4/3), dark yellowish brown, brown, or yellowish brown. The texture of the Ap and A2 horizons is sandy loam, fine sandy loam, or clay loam in places. In some places the A2 horizon is thin or absent. The texture of the B21t horizon is heavy loam or light clay loam in some areas, and the texture of the B22t horizon is clay loam or silty clay loam. A few, small, dark yellowish-brown (10YR 4/4) or strong-brown (7.5YR 5/6) iron stains occur at random in the B horizon. The texture of the C horizon is loam, silt loam, or light clay loam.

Where not seriously eroded, the thickness of the solum and the depth to carbonates is generally 30 to 36 inches but ranges from 24 to 42 inches. A small amount of gravel up to 3 inches in diameter is distributed throughout the solum in many areas. The reaction of the A and B horizons is slightly acid or medium acid.

Miami soils are better drained than Celina and Conover soils. They are coarser textured than Morley soils.

Miami loam, 2 to 6 percent slopes (MoB).—This soil has the profile described as typical of the series. It is one of the dominant soils on uplands in the eastern and southern parts of the county. Typical areas of this soil are broad and undulating and are marked by narrow ridges and knolls with short to medium side slopes. Shallow drainageways and wet spots occur in many areas. This soil is generally upslope from the more poorly drained Conover and Celina soils.

The plow layer is dark grayish-brown loam in the smooth, convex areas. Included on the lower slopes, however, are small areas where the plow layer is sandy loam or fine sandy loam. On the narrow ridges and knolls and on the crest of interdrainage divides, this soil is thinner than elsewhere as a result of erosion. In some of these places, the upper part of the subsoil is mixed with the plow layer. Here the plow layer is browner and contains less organic matter than in uneroded areas. Thin layers of sandy loam are present in the lower subsoil and underlying material in some areas. A small amount of gravel and cobbles occurs throughout the soil in most places. In a few areas, the cobbles and stones and a few boulders have been removed.

This is one of the better soils in the county for crops, and most of it is farmed intensively. Corn, small grains, and forage are the main crops grown. Because of the gentle slopes, however, there is runoff and risk of erosion if this soil is cultivated. Use of contour stripcropping, terracing, and other conservation practices is difficult because of the complex slopes. Growing sod and green-manure crops and using crop residue are ways of supplying organic matter, maintaining fertility, and controlling erosion. Capability unit IIe–2 (2.5a).

Miami loam, 6 to 12 percent slopes (MoC).—This soil is mostly on uplands in the eastern and southern parts of the county. It commonly occurs with gently sloping or undulating Miami soils. Most areas of this soil are on side slopes of entrenched drainage channels. Other areas are on side slopes of ridges and hills. The slopes are slightly convex and are short to medium in length. Slopes shorter than 100 feet are shown on the map by hachure symbols. Most areas have many shallow surface drains. In places crossable gullies have formed and are actively eroding.

The plow layer is generally dark grayish-brown loam. On the upper rim of side slopes and on the crest of interdrainage hills, however, the plow layer is thinner than elsewhere and in places consists mainly of subsoil material. In these places the plow layer is brown or dark brown and contains less organic matter. The depth to the limy underlying material is commonly less than is typical of the series. It ranges from 24 to 30 inches.

Corn, small grains, and forage are the main crops grown. Some areas are wooded. Because of its steeper slopes, this soil has more runoff and risk of erosion than the less strongly sloping Miami loam. It also holds less moisture for crops. In some cultivated areas erosion has reduced the organic-matter content, the fertility, and the available moisture capacity. Contour tillage and stripcropping are difficult on the short, irregular slopes. Including grasses and legumes in the cropping system helps to control runoff and erosion. Returning crop residue to the soil is also beneficial. Capability unit IIIe–5 (2.5a).

Miami loam, 12 to 18 percent slopes (MoD).—This soil occupies the short side slopes of hills, entrenched drainage channels, swales, and closed depressions. The slopes are generally 100 to 200 feet long. Shorter slopes are shown on the map by hachure symbols. Most areas average between 10 and 15 acres in size. Shallow drainageways, some of which are actively eroding, occur at random throughout this mapping unit.

The plow layer is generally dark grayish-brown loam. The upper slopes are slightly steeper and generally more eroded than the lower slopes. In these more eroded areas, the plow layer is a mixture of the original surface soil and a small amount of the subsoil. It is brown or pale brown and has lower organic-matter content and fertility than less eroded areas. The depth to the limy underlying material varies more than in the less strongly sloping Miami loam. It commonly ranges from 24 to about 28 inches.

Most areas of this soil have been farmed, and many areas are slightly to moderately eroded as a result of past cropping. Organic-matter content and fertility have been reduced in these areas. Some cultivated areas have been abandoned. A few small areas are wooded. This soil is suited to hay and pasture or to trees. Because of the moderately steep slopes and consequent runoff, there is risk of severe erosion if it is cultivated. Capability unit IVe–4 (2.5a).

Miami loam, 18 to 25 percent slopes (MoE).—This soil occurs mostly on short side slopes of entrenched drainage channels near the Flint and Shiawassee Rivers and their tributaries. Elsewhere it is on steep slopes of swales and other depressions. Most of the slopes are 100 to 150 feet long. Shorter slopes are shown on the soil map by spot symbols. The degree of slope is generally 18 to 25 percent but is as much as 40 percent in some areas.

The plow layer is typically dark-brown or dark grayish-brown loam, but in places the texture is sandy loam or fine sandy loam. The subsurface layer is very thin or absent in most areas. The depth to the limy underlying material varies more than in the less sloping Miami soils. It is commonly less than is typical and approaches the minimum depth for the series.

Most areas of this soil are wooded, and except for a few unprotected areas, it is not eroded. Runoff is very rapid, however, and there is a risk of severe erosion if this soil is cultivated. The steep slopes also hinder operation of farm machinery. This soil should remain in woodland. Capability unit VIe–2 (2.5a).

Miami clay loam, 6 to 12 percent slopes, eroded (MpC2).—This soil is on side slopes of hills and drainage channels in uplands in the eastern and southern parts of the county. The slopes are generally short and in places are broken by many intermittent drainageways and by a few shallow gullies that are actively eroding. Most areas are small, but a few are as much as 40 acres in size.

Most of the original surface layer has been lost through erosion, and the plow layer consists mainly of subsoil material. This layer is dark-brown or dark yellowish-brown heavy loam or clay loam. The depth to the limy underlying material is commonly less than is typical and approaches the minimum for the series. In small areas it is 15 to 20 inches.

All of this soil has been cultivated, and it has been severely damaged by past cropping. Erosion has lowered the organic-matter content, fertility, and available moisture capacity. Consequently, the plow layer crusts more readily, there is more runoff, and risk of additional erosion is increased.

This soil is poorly suited to intensive cultivation. It can be cultivated occasionally in a long rotation under good management. Corn stalks and other crop residue, chopped and left on the field over winter, help to control erosion and improve the organic-matter content. Capability unit IVe–4 (2.5a).

Miami clay loam, 12 to 18 percent slopes, eroded (MpD2).—This soil is on side slopes of well-defined drainage channels, swales, and closed depressions. It is an inextensive, rolling soil on uplands in the eastern and southeastern parts of the county. The slopes are generally 100 to 200 feet in length. Shorter slopes are shown on the soil map by hachure symbols. Erosion rills and random shallow gullies, generally the result of annual cultivation, occur throughout this mapping unit.

Most of the original surface layer has been lost through erosion, and the plow layer now consists mainly of the dark-brown or dark yellowish-brown clay loam subsoil. The depth to the limy underlying material varies more in this soil than in the less strongly sloping Miami soils and is generally less than is typical of the series. In a few areas this depth is 15 to 20 inches. In some places soil material eroded from upper slopes has accumulated on foot slopes.

All areas of this soil have been used for crops, and some have been abandoned. Past cropping has severely damaged this soil. Erosion has depleted the organic matter and the fertility and has severely reduced the available moisture capacity. The plow layer tends to seal over under heavy rainfall, thus reducing the intake of water and increasing the amount of runoff. When the soil is dry, surface crusting hinders tillage and reduces germination of newly seeded crops. Because of the moderately steep slopes and the erosion, this soil is poorly suited to cultivated crops. The cropping system should consist mostly of hay and pasture crops. Capability unit VIe–2 (2.5a).

Miami clay loam, 18 to 25 percent slopes, eroded (MpE2).—This soil is on side slopes of entrenched drainage channels, swales, and other depressions. It occurs at random, mainly on rolling uplands in the eastern and southern parts of the county. The slopes are generally not more than 100 to 150 feet in length. Shorter slopes are shown on the soil map by hachure symbols. Shallow drainageways, some of which are actively eroding, occur throughout this mapping unit.

Erosion has reduced the thickness of the original surface layer. Consequently, the brown or yellowish-brown clay loam plow layer is a mixture of the original surface layer and the upper part of the subsoil. The depth to the limy underlying material varies more than in the less strongly sloping Miami soils. This material is at a depth of 18 to 24 inches.

All areas of this soil have been cropped, and some have been abandoned. Erosion has lowered the organic-matter content, the fertility, and the available moisture capacity. The plow layer tends to seal over under heavy rainfall, thus reducing the intake of water and increasing the amount of runoff. There is a severe risk of additional erosion if this soil is used for crops. It is suited to permanent pasture or to trees. Capability unit VIe–2 (2.5a).

Miami sandy loam, sandy substratum, 0 to 2 percent slopes (MsA).—This soil is on till plains adjoining coarser textured soils on outwash. It is not extensive and occurs mainly in a few large areas near Kearsley Creek in Genesee Township. Small areas occur at random elsewhere, mainly in the northern part of the county.

The plow layer is dark grayish-brown sandy loam or fine sandy loam. The subsoil is heavy loam or clay loam. Stratified sand and fine gravel underlie the subsoil at a depth of 40 to 66 inches, though the depth is somewhat less where this soil borders the coarser textured soils on outwash. In these areas the coarser textured Spinks and Boyer soils are included to a minor extent. The surface layer and subsoil are generally more acid than is typical of the series.

Because this soil is underlain by sand and gravel, it supplies only a moderate amount of moisture to crops. Lack of adequate moisture during extreme drought sometimes limits the growth of crops. There is also a risk of soil blowing if large areas are exposed by cultivation. This soil has no other major limitations for cultivated crops. A large acreage of it is within urban areas of the county, and most of the adjoining areas are abandoned. Capability unit IIs–2 (3a).

Miami-Metea complex, 2 to 6 percent slopes (MtB).—This complex consists of Miami sandy loam, Metea loamy sand, and other soils. These are the dominant soils on undulating uplands in the eastern and southern parts of the county. Most areas are large and have short to medium complex slopes that terminate in random drainageways and closed depressions. There are a few small areas, mainly on side slopes of drainage channels. The Miami soil makes up 50 percent of the complex; the

Metea soil 30 percent; and other soils 20 percent. The Miami soil formed in loamy till and occupies the higher positions on detached hills and knolls. The Metea soil formed in 18 to 30 inches of sandy material over loamy till and is on the lower slopes, in shallow drainageways, and around wet depressions.

The plow layer is generally dark grayish-brown sandy loam or loamy sand. On the short slopes bordering drainageways and on the upper convex parts of ridges and knolls where these soils are eroded, the plow layer includes a small amount of the subsoil material. In these eroded areas, the plow layer is brown or pale-brown loam and has lower organic-matter content and fertility than elsewhere. A small amount of gravel is present in the plow layer and subsoil. Minor areas of Spinks and Arkport soils are included in mapping where this complex borders glacial drainage channels. These included soils are droughtier and are lower in fertility than the dominant soils.

Except for random woodlots, most areas of this mapping unit are intensively farmed. Corn, small grains, and forage are the main crops grown. Some erosion is common if these soils are unprotected. Use of terracing and contour stripcropping is difficult in many areas because of the complex slopes. Cropping systems that help to control erosion and that supply organic matter are desirable. These soils dry out readily in spring. They are easy to work and to keep in good tilth. Capability unit IIe–2 (2.5a, 4/2a).

Miami-Metea complex, 6 to 12 percent slopes (MtC).—Miami sandy loam and Metea loamy sand are the dominant soils in this complex. The Miami soil makes up 60 percent of the complex; the Metea soil 25 percent; and other soils 15 percent. These are sloping or rolling soils in large areas on uplands. Typically, the slopes are complex because of the many narrow detached hills and knolls, the shallow drainageways, and random wet spots. Included in mapping are minor areas of Spinks soils on the lower side slopes of drainage channels. Other areas of this mapping unit are on short side slopes of entrenched drainage channels, swales, and depressions. The Miami soil formed in loamy till and is on the high, convex parts of the complex. The Metea soil formed in 18 to 24 inches of sandy material over loamy till in the saddles between knolls, on foot slopes, and around wet spots.

The plow layer is generally dark grayish-brown sandy loam or loamy sand, but on the rim of slopes, on knolls, and on the crest of interdrainage divides, this layer contains a small amount of the subsoil. Here the plow layer is loamier, is browner, and has a lower organic-matter content. Gravel has accumulated on the surface of the more severely eroded spots. Thin layers of sandy loam are present in the lower subsoil and underlying material in some areas. The depth to the limy underlying material ranges from 24 to 30 inches in the major soils.

Except for random woodlots, most areas have been cultivated. A small acreage is used for permanent pasture. Small grains and forage are the major crops grown. Increased runoff and the risk of erosion are the major limitations in the use of these soils for crops. Some cultivated areas are already eroded. Contour tillage and contour stripcropping are difficult in many areas because of the short, complex slopes. A cropping system that includes grasses and legumes helps to control runoff and erosion. Additional benefits can be obtained by returning crop residue to the soils. These soils dry out readily in spring. They are easy to work and to keep in good tilth. Capability unit IIIe–5 (2.5a, 4/2a).

Miami-Metea complex, 12 to 18 percent slopes (MtD).—Miami sandy loam makes up 75 percent of this complex, and Metea loamy sand makes up 25 percent. These soils are mostly on side slopes of ridges and entrenched drainage channels. Some areas are on terraces, escarpments, and slopes adjoining swales and closed depressions. In most places, except in random drainageways, slopes are simple, 100 to 150 feet long, and smooth. The Miami soil formed in loamy till and occurs on the upper slopes and on knolls. The Metea soil formed in 18 to 24 inches of sandy material over loamy till. It is in shallow drainageways, on foot slopes, and around wet depressions.

Most areas of these soils are woodland. They are too steep to be used intensively for crops. Because of the moderately steep slopes, runoff and risk of erosion are increased if these soils are cultivated. Conservation practices are difficult to apply in many areas because of the short or complex slopes. In these areas a high proportion of sod crops in the cropping system helps to control runoff and erosion. These soils are suited to hay and pasture or to trees. Capability unit IVe–4 (2.5a, 4/2a).

Minoa Series

In the Minoa series are somewhat poorly drained, nearly level soils on till plains and lake plains. These soils formed in water-laid fine sand, very fine sand, and loamy sand under a fluctuating water table.

In a typical profile, the surface layer is dark-brown loamy fine sand about 8 inches thick. The subsoil extends to a depth of about 35 inches and consists of alternate layers of yellowish-brown and light yellowish-brown loamy very fine sand and very fine sand. This material has grayish-brown and brownish-gray mottles and is very friable or loose. Underlying the subsoil, and extending to a depth of 48 inches, is light brownish-gray, loose sand that has a high lime content.

Because of the low, nearly level relief and the sandy texture of this soil, runoff is very slow and most of the rainfall is readily absorbed. The high water table early in the growing season restricts the growth of plant roots and sometimes delays tillage and planting. Permeability is moderately rapid, however, and these soils are easily drained. Tile trenches readily cave in, and the fine sandy material seeps into tile lines unless precautions are taken. Because of their sandy texture, these soils have moderately low natural fertility and available moisture capacity. If they are drained, they tend to be droughty. Crops sometimes lack adequate moisture for good growth during dry summer weather.

The larger areas are drained and used for crops The smaller areas are idle or are second-growth woodland. Wetness, low fertility, and low moisture supply are the major limitations. If these soils are drained, they are easily worked and produce moderate yields of most crops. They are better suited to early maturing crops than to row crops.

Typical profile of Minoa loamy fine sand, 0 to 2 percent slopes, in an idle field, NW¼NW¼ sec. 11, T. 6 N., R. 5 E., Gaines Township:

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

B1—8 to 12 inches, yellowish-brown (10YR 5/6) loamy very fine sand; few, fine, faint, grayish-brown (10YR 5/2) mottles; weak, medium, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.

B21—12 to 27 inches, light yellowish-brown (10YR 6/4) very fine sand; common, medium, distinct, grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/6) mottles; weak, coarse, subangular blocky structure; loose; slightly acid; clear, smooth boundary.

B22—27 to 35 inches, light brownish-gray (10YR 6/2) very fine sand; few, medium, faint, brownish-yellow (10YR 6/8) mottles; weak, coarse, subangular blocky structure; loose; neutral; abrupt, smooth boundary.

C—35 to 48 inches, light brownish-gray (10YR 6/2) sand; single grain, loose; calcareous.

The color of the Ap horizon ranges from dark brown (10YR 3/3) to very dark grayish brown (10YR 3/2). The texture and thickness of the B horizons vary. Individual horizons are fine sand, very fine sand, loamy fine sand, or loamy very fine sand. Gray mottles occur at a depth of 12 to 18 inches. Layers of fine sandy loam, silt loam, or silty clay loam up to 3 inches thick occur in the C horizon in some areas. The reaction of the A and B horizons is generally slightly acid or neutral, but it ranges to medium acid in individual horizons. The C horizon is generally neutral or mildly alkaline and is calcareous in some areas.

These soils are finer textured than Au Gres soils. They formed in coarser textured water-laid material than Kibbie soils.

Minoa loamy fine sand, 0 to 2 percent slopes (MuA).—This is a somewhat poorly drained soil on till plains and lake plains. It occurs in broad, irregularly sloping areas between shallow drainageways. The areas average between 20 and 40 acres in size, but some of the larger areas are as much as 80 acres or more. This soil occurs at random throughout the northern part of the county, but it is most extensive along the southern border of the glacial lake plain, principally in Thetford and Vienna Townships.

This soil varies mainly in texture. In places the subsoil and underlying material contain medium sand. In other places this soil is underlain at a depth below 30 inches by coarse or very coarse sand and some gravel. Thin, discontinuous layers of silt loam or silty clay loam occur in the lower subsoil and underlying material in some areas.

Included in mapping are the Arkport soils that occur on small, low knolls. These soils are sandy, have a light colored surface layer, and are somewhat better drained than the Minoa soil. Also included are small, wet pockets shown on the soil map by wet spot symbols.

Most areas of this soil have been farmed. Undrained areas are wet in spring and in fall. The water table is low during dry summer weather, and crop yields are low because of lack of moisture. Although natural fertility is moderately low, this soil can be used for commonly grown crops if it is adequately drained and fertilized. Capability unit IIIw–5 (4b).

Morley Series

The Morley series consists of well drained and moderately well drained, gently sloping or sloping soils on till plains and low moraines. These soils are loamy and contain much clay in the subsoil. In most areas they formed under a fluctuating water table and are only moderately well drained.

In a typical profile, the surface layer is dark grayish-brown, friable silt loam about 7 inches thick, and the subsurface layer is brown, friable silt loam about 4 inches thick. The subsoil is about 18 inches thick. The upper 7 inches of the subsoil consists of yellowish-brown silty clay loam. The lower part is brown, heavy silty clay loam that has grayish-brown and yellowish-brown mottles. The subsoil is very firm and has a blocky structure. Underlying the subsoil at a depth of about 29 inches is brown silty clay loam that has yellowish-brown mottles. This material is firm and has a high lime content.

Runoff varies according to slope and kind of vegetation. There is a risk of erosion, especially on the more sloping areas of these soils. Permeability is moderately slow, and the available moisture capacity is high. Natural fertility is moderately high, but the random eroded areas are lower in fertility, have poorer tilth, and are more difficult to farm.

Most areas of these soils are intensively farmed. A few random woodlots remain, especially on the stronger slopes. The risk of erosion is the major limitation in the use of these soils for crops. In eroded areas the surface layer forms a crust that restricts water intake. If these soils are cultivated, the plow layer becomes cloddy and hard. Areas already eroding can be improved by adding organic matter and controlling erosion. If well managed, these soils are suited to most crops grown in the county.

Typical profile of Morley silt loam, 2 to 6 percent slopes, in a cultivated field, SE¼NW¼, sec. 36, T. 9 N., R. 7 E., Thetford Township:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, medium, granular structure; friable; neutral; clear, smooth boundary.

A2—7 to 11 inches, brown (10YR 5/3) silt loam; moderate, medium, granular structure; friable; slightly acid; clear, wavy boundary.

B21t—11 to 18 inches, yellowish-brown (10YR 5/4) silty clay loam; moderate, medium, angular blocky structure; very firm; medium acid; clear, wavy boundary.

B22t—18 to 29 inches, brown (10YR 5/3) heavy silty clay loam; common, medium, faint, grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/4) mottles; weak, fine, angular blocky structure to massive; very firm; slightly acid.

C—29 to 42 inches, brown (10YR 5/3) silty clay loam; common, medium, faint, yellowish-brown (10YR 5/6) mottles; massive; firm; calcareous.

The color of the Ap horizon is generally dark grayish brown (10YR 4/2) but ranges to grayish brown (10YR 5/2) or brown (10YR 5/3) in eroded spots. The texture of the Ap and A2 horizons is dominantly silt loam or loam, but it ranges to heavy silt loam in small eroded areas, and in some places it is fine sandy loam. The texture of the B22 horizon is heavy silty clay loam or silty clay. The B21 horizon is faintly mottled in places, and the B22 horizon is distinctly mottled in moderately well drained areas.

The combined thickness of the A and B horizons and depth to carbonates range from 18 to 36 inches, depending on slope and degree of erosion. The reaction of the A and B horizons ranges from medium acid to neutral.

Morley soils are better drained and brighter colored than Del Rey soils. They are finer textured than Miami soils.

Morley silt loam, 2 to 6 percent slopes (MvB).—This soil has the profile described as typical of the series. It is on broad ridgetops and side slopes of ridges, generally upslope from the less strongly sloping, somewhat poorly drained Del Rey soils. The Del Rey soils occur in slight depressions and shallow drainageways and are the main inclusions in this mapping unit. These are darker colored soils that dry out more slowly in spring and after heavy rainfall. Some areas of Morley soil are on small, isolated ridges and knolls above the surrounding plain. The slopes are dominantly 4 to 6 percent. Shallow drainageways occur at random throughout this mapping unit.

The plow layer is typically dark grayish-brown silt loam, but in places this layer and the subsurface layer are fine sandy loam or loam. Some of the ridges, knolls, and rounded slopes between drainageways are eroded, and the plow layer contains a varying amount of the subsoil. These spots are brown or yellowish brown and have lower organic-matter content and fertility than the typical profile. Because they dry out cloddy and hard, a good seedbed is difficult to prepare. In most places this soil has faint to distinct mottling below a depth of 18 inches. In some places there are thin strata of very fine sand and silt in the limy underlying material.

Except for scattered woodlots, all of this soil is farmed. Corn, small grains, and forage are the main crops grown. Because of gentle slopes, there is some runoff and risk of erosion if this soil is intensively cultivated. Most of the slopes are complex, which makes use of terracing, contour stripcropping, and other conservation practices difficult. Keeping good tilth is also difficult, especially in eroded areas. Returning crop residue to the soil adds organic matter and improves tilth. Random tiling of the somewhat poorly drained included soils permits earlier planting of crops. Capability unit IIe–1 (1.5a).

Morley silt loam, 6 to 12 percent slopes (MvC).—This soil adjoins drainage channels, swales, and closed depressions. The slopes are dominantly 100 to 200 feet long. Shorter slopes are shown on the soil map by hachure spot symbols. Most areas average between 10 and 15 acres in size. Shallow drainageways, some of which are actively eroding, occur at random throughout this mapping unit. This soil commonly adjoins the more extensive, less strongly sloping Del Rey soils. Most of it is in the southern part of the county.

The surface layer is typically dark grayish-brown silt loam. In eroded areas on the upper rim of side slopes and on the crest of interdrainage ridges, the surface layer is thinner and the plow layer consists mostly of subsoil material. These eroded spots are brown or dark brown and contain less organic matter. The depth to the limy underlying material, which ranges from 24 to 29 inches, is commonly less than is typical of the series.

Most of this soil has been intensively farmed, and unprotected areas are eroded. Corn, small grains, and forage are the main crops grown. Because of the steeper slopes, runoff and the risk of erosion are greater than on the less strongly sloping Morley soil. Use of contour farming and stripcropping is difficult in many areas because the slopes are too short or too irregular. Keeping this soil in good tilth is difficult also, especially where it is eroded. Returning crop residue to the soil adds organic matter and improves tilth. Including a high proportion of sod crops in the cropping system reduces runoff and helps to control erosion. Capability unit IIIe–4 (1.5a).

Oakville Series

This series consists of well-drained, nearly level to sloping soils on outwash plains, glacial beach ridges, and other sandy upland areas. These soils formed in fine and medium sand. They are most extensive on the sandy benches or terraces bordering the major streams. In this county Oakville soils are mapped separately and also in a complex with Spinks soils.

In a typical profile, the surface layer is dark grayish-brown fine sand about 7 inches thick. The subsoil is about 23 inches thick and consists of loose fine sand that is yellowish brown in the upper 6 inches and light yellowish brown in the lower 17 inches. The underlying material is very pale brown, loose sand that extends to a depth of 60 inches.

Runoff is slow to medium, depending on the slope and the kind of vegetation, but these sandy soils readily absorb most of the rainfall. They are rapidly permeable and hold little moisture for plants. Moisture is inadequate for plant growth during dry summer weather. The natural fertility is low. Because they are loose and sandy, these soils are subject to soil blowing.

Lack of moisture, low natural fertility, and low organic-matter content limit the use of these soils for crops. Most of the acreage, once cleared for farming, is now abandoned. Some of it is in orchards or has been planted to pines. The rest is in second-growth oak, maple, beech, aspen, and other trees. Where a dependable source of irrigation water is available, these soils are well suited to vegetables, small fruit, and other specialty crops.

Typical profile of Oakville fine sand, 0 to 6 percent slopes, in an abandoned field, SE¼NW¼NE¼ sec. 21, T. 8 N., R. 7 E., Genesee Township:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) fine sand; weak, medium, granular structure; loose; slightly acid; abrupt, wavy boundary.

B21—7 to 13 inches, yellowish-brown (10YR 5/6) fine sand; weak, medium, subangular blocky structure; loose; slightly acid; gradual, wavy boundary.

B22—13 to 30 inches, light yellowish-brown (10YR 6/4) fine sand; single grain; loose; slightly acid; clear, wavy boundary.

C—30 to 60 inches, very pale brown (10YR 7/4) sand; single grain; loose; slightly acid.

In wooded areas there is a very dark grayish-brown

(10YR 3/2) or dark-brown (10YR 4/3) A1 horizon 1 to 3 inches thick. The color of the B21 horizon ranges from yellowish brown (10YR 5/4) to strong brown (7.5YR 5/6). The thickness of this horizon ranges from 4 to 12 inches. In a few areas the texture of the A and B21 horizons is loamy sand, and that of the B22 horizon is sand. A few, coarse, faint, yellowish-brown (10YR 5/6–5/8) or brownish-yellow (10YR 6/6) mottles occur in the C horizon in places. The reaction of the A and B horizons is dominantly slightly acid, but individual horizons range to medium acid.

Oakville soils lack the mottling that occurs in the lower B horizon of the Croswell soils, and they are better drained than those soils. They lack the thin, discontinuous, finer textured layers that are in the Spinks soils.

Oakville fine sand, 0 to 6 percent slopes (OaB).—This soil has the profile described as typical of the series. It commonly occupies the sandy benches and flats bordering the Flint River, the Shiawassee River, and other major streams throughout the county. Small areas are on ancient beach ridges and other sandy places on the till plains. This soil is generally nearly level but is slightly steeper on the short slopes between benches. Where this Oakville soil borders finer textured soils on uplands, minor areas of Metea and Arkport soils are included in mapping.

The plow layer is typically dark grayish-brown fine sand, but the texture is sand or loamy sand in some places. Soil blowing is slight on unprotected areas, and blowout spots occur at random. In some uncultivated areas, there is a thin, light-gray subsurface layer and a strong-brown upper subsoil layer. A few, thin, discontinuous bands of finer textured material are at a depth of 30 inches or more in some areas.

Droughtiness and low natural fertility severely limit the use of this soil for most cultivated crops. It is better suited to vegetables and small fruit. Soil blowing is a risk on large, exposed, cultivated areas. Capability unit IVs–2 (5a).

Oakville fine sand, 6 to 12 percent slopes (OaC).—This soil occupies sandy ridges and knolls on undulating to rolling uplands in the northeastern part of the county. Most areas average between 10 and 40 acres in size.

Most of the acreage is woodland or brushland. Small areas are planted to pine. Low available moisture capacity and a risk of erosion severely limit the use of this soil for cultivated crops or pasture. Moisture is generally adequate for trees, however, and idle areas are suited to reforestation. Capability unit IVs–2 (5a).

Oakville fine sand, loamy substratum, 0 to 6 percent slopes (OkB).—This soil occupies outwash plains and sandy lake plains throughout the county, but it is most extensive on the sandy lake plains in the northwestern part. It is generally nearly level. Most areas are 10 to 40 acres in size, but a few are 80 acres or more.

The plow layer is generally dark-brown or dark grayish-brown fine sand, but the texture ranges to sand or loamy sand in places. This soil has a substratum of clay loam or silty clay loam at a depth of 42 to 66 inches; but otherwise the profile is like the one described as typical. Soil blowing is slight on unprotected areas, and some of these have blowouts. Some level areas are mottled in the lower subsoil as a result of a fluctuating water table.

The loamy substratum enables this soil to store some moisture, especially for deep-rooted crops or trees. The moisture is seldom adequate for cultivated crops during dry summer weather. Soil blowing is a risk on large, exposed areas. If this soil is used for crops, it is better suited to oats, rye, and other early maturing crops than to corn or soybeans. If irrigation water is available, this soil is well suited to vegetables and small fruit. Generally, however, it is better suited to trees or as wildlife habitat. Capability unit IVs–2 (5/2a).

Owosso Series

The Owosso series consists of gently sloping, well-drained soils on till plains and moraines. These soils formed in sandy and loamy deposits 18 to 42 inches thick over loamy material that has a high lime content. In this county Owosso soils are mapped in a complex with Celina soils.

In a typical profile, the surface layer is dark grayish-brown, friable sandy loam about 7 inches thick. It is underlain by about 3 inches of light yellowish-brown, friable sandy loam. The subsoil, about 20 inches thick, consists of yellowish-brown, firm sandy loam. Brown loam underlies the subsoil at a depth of about 30 inches. This loam is friable, massive, and has a high lime content.

These soils are moderately permeable and have slow to medium runoff, depending on steepness of slopes and kind of vegetation. The available moisture capacity is generally adequate for crops during long periods of dry weather. These soils are moderate in natural fertility. They warm up early in spring and are easy to work and keep in good tilth.

Most areas of these soils are farmed. A few areas, once cultivated, are now idle. Some small, sloping areas remain in woodland. Erosion is a risk on sloping areas that are not protected from excessive runoff. These soils can be tilled over a wide range of moisture content. They are suited to most crops grown in the county.

Typical profile of Owosso sandy loam, 2 to 6 percent slopes, in a cultivated field, NE¼SE¼ sec. 24, T. 9 N., R. 8 E., Forest Township:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) sandy loam; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—7 to 10 inches, light yellowish-brown (10YR 6/4) sandy loam; very weak, medium, granular structure; friable; medium acid; clear, wavy boundary.

B1—10 to 30 inches, yellowish-brown (10YR 5/4) sandy loam; moderate, medium, subangular blocky structure; firm; neutral; abrupt, irregular boundary.

IIC—30 to 42 inches, brown (10YR 5/3) loam; massive; friable; calcareous.

In wooded areas the color of the undisturbed A1 horizon is dark brown (10YR 3/3) or very dark grayish brown (10YR 3/2). The A2 horizon ranges from pale brown (10YR 6/3) or light yellowish brown (10YR 6/4) to brown (10YR 5/3). The B1 horizon is yellowish brown (10YR 5/4) or dark yellowish brown (10YR 4/4). The texture of the B1 horizon is light sandy loam in places. In moderately well drained areas, mottling occurs in the B1 horizon, but it occurs more commonly in the IIB2t and IIC horizons. The IIBt horizon is present in some profiles and ranges in texture from heavy loam to clay and in thickness from 5 to 15 inches. The texture of the IIC horizon is loam or clay loam.

The combined thickness of the A and B horizons is 24 to 36 inches. The reaction of the A and B horizons ranges from medium acid to neutral.

Owosso and Metamora soils formed in similar material, but Owosso soils are better drained and less mottled. They are finer textured than Metea soils. They are coarser textured in the upper part of the B horizon than Miami and Celina soils.

Perrin Series

The Perrin series consists of moderately well drained, nearly level and gently sloping sandy and loamy soils on outwash plains and river terraces. These soils are underlain at a depth of 24 to 42 inches by limy, stratified sand and gravel. They are most extensive on the gravelly benches bordering the Flint River and its major tributaries.

In a typical profile, the surface layer is very dark grayish-brown loamy sand about 10 inches thick. The subsoil is about 28 inches thick. The upper 8 inches of the subsoil is very friable, yellowish-brown loamy sand. It is underlain by 10 inches of loose, light yellowish-brown loamy coarse sand that has brownish-yellow mottles. The lower 10 inches of the subsoil is friable, dark-brown coarse sandy loam that has brown and yellowish-brown mottles. It is underlain by grayish-brown, loose, stratified coarse sand and gravel that has a high lime content.

These soils have slow runoff and moderately rapid permeability. They also have a fluctuating water table, which provides temporary benefit to early maturing crops. Later in the growing season, however, the available moisture capacity is moderately low and is rarely adequate for optimum crop growth, especially during dry summer months. These soils can be worked over a wide range of moisture content. Natural fertility is moderately low.

Most areas of the Perrin soils have been farmed. A few areas are idle or are wooded. Because these soils are friable and are nearly level to gently sloping, they are easily worked and have only a slight risk of erosion, but they are subject to soil blowing. Planting cover and green-manure crops and using crop residue help to control soil blowing, conserve moisture, and improve fertility. These soils are well suited to crops that resist drought and mature early. If irrigation water is available, they are suited to vegetables, small fruit, and other specialty crops.

Typical profile of Perrin loamy sand, 0 to 2 percent slopes, in a cultivated field, SE¼SE¼ sec. 16, T. 8 N., R. 5 E., Flushing Township:

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

B1—10 to 18 inches, yellowish-brown (10YR 5/6) loamy sand; single grain to very weak, medium, subangular blocky structure; very friable; neutral; clear, wavy boundary.

B21—18 to 28 inches, light yellowish-brown (10YR 6/4) loamy coarse sand; common, coarse, faint, brownish-yellow (10YR 6/8) mottles; single grain; loose; neutral; clear, irregular boundary.

B22t—28 to 38 inches dark-brown (7.5YR 4/4) coarse sandy loam; common, medium, distinct, brown (10YR 5/3) and yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; friable; mildly alkaline; abrupt, wavy boundary.

IICg—38 to 48 inches, grayish-brown (10YR 5/2), stratified coarse sand and gravel; single grain; loose; calcareous.

The color of the Ap horizon ranges from very dark grayish brown (10YR 3/2) to dark brown (10YR 3/3) or very dark brown (10YR 2/2). The texture of this horizon is coarse loamy sand, but it is sandy loam in places. The texture of the B1 and B21 horizons ranges from loamy sand or loamy coarse sand to sandy loam. The B22t horizon is sandy loam, coarse sandy loam, or light sandy clay loam that ranges in thickness from 5 to 15 inches. The combined thickness of the A and B horizons and the corresponding depth to calcareous sand and gravel is 30 to 42 inches. The reaction of the A and B horizons generally ranges from slightly acid to mildly alkaline, but individual horizons are medium acid in some areas.

Perrin soils have a coarser textured B horizon than Fox soils. They are finer textured and commonly more poorly drained than Spinks soils. Perrin and Boyer soils formed in similar material, but Perrin soils are not so well drained.

Perrin loamy sand, 0 to 2 percent slopes (PeA).—This soil has the profile described as typical of the series. It is a moderately well drained soil on terraces and gravelly flats above the major streams, especially the Flint River and its tributaries. It is only slightly lower than the well-drained Boyer soils, and it adjoins the darker colored Wasepi and Gilford soils, which are in slight depressions and drainageways. Most areas of this soil are long, narrow, and generally parallel to stream channels. They range from 20 to 40 acres in size.

The plow layer is typically very dark grayish-brown loamy sand, although minor areas that have a sandy loam surface layer are included in mapping. The amount of fine gravel varies in this soil. but it is not enough to interfere with cultivation. Finer textured material occurs at a depth of 48 to 60 inches in places, principally in Flushing and Montrose Townships. Shallow drainageways and local depressions occupied by the Wasepi soils are also included in this mapping unit. These areas are wet and dry out slowly in the spring.

Shortage of moisture for crops during the growing season is the main limitation. Runoff is slow, and there is little or no risk of erosion, but soil blowing is a hazard in cultivated areas. Under good management this soil is suited to the crops commonly grown in the county. Corn, small grains, and forage are the main crops grown. Vegetables, small fruit, and other specialty crops grow well where irrigation water is available. Capability unit IIIs-3 (4a).

Perrin loamy sand, 2 to 6 percent slopes (PeB).—This is a moderately well drained soil on gravelly terraces and outwash areas above the major streams, especially the Flint River and its tributaries. Some areas of it are on the short slopes between terraces. Other areas are between the terraces and the more loamy soils on uplands. Minor areas are in ancient glacial drainage channels. The areas range from 10 to 25 acres in size.

The plow layer is typically very dark grayish-brown loamy sand, but minor areas that have a sandy loam surface layer are included in mapping. The amount of gravel varies in this soil, but it is not enough to interfere with cultivation. Finer textured material occurs at a depth of 48 to 60 inches in places, principally in Flushing and Montrose Townships.

Shortage of soil moisture is the major limitation in the use of this soil for crops. Because of the slope, erosion is a risk if this soil is cultivated, and soil blowing is also a risk in unprotected fields. Cropping systems that maintain the organic-matter content and fertility are desirable. Under good management this soil is suited to corn, small grains, and forage crops. It is also suited to vegetables and small fruit if irrigation water is available. Capability unit IIIs–4 (4a).

Pinconning Series

The Pinconning series consists of poorly drained, level or slightly depressional soils on lake plains. These soils formed in sandy deposits 18 to 42 inches thick over clayey material. They are most extensive in the northwestern part of the county. Pinconning soils in this county were mapped only in a complex with Allendale soils.

In a typical profile, the surface layer is very dark brown loamy fine sand about 9 inches thick. It is underlain by about 5 inches of brown, very friable loamy fine sand. Below this is 16 inches of light brownish-gray fine sand or very fine sand that is faintly mottled with light yellowish brown. This material is very friable. Gray silty clay is at a depth of about 30 inches. It is very firm and has a high lime content.

Because they are level or nearly level, these soils have very slow runoff. Water ponds in depressions in spring and following heavy rainfall. The gray color of the subsoil indicates that these soils are wet for long periods. A high water table hinders the growth of plant roots and often delays tillage and planting. The upper sandy layers are moderately rapidly permeable, but the underlying clayey material is slowly permeable. Where the clayey material is at a shallow depth, tile drainage does not work well. If these soils are drained, they tend to be droughty because of the sandy upper layers. Available moisture capacity and natural fertility are moderate.

Most areas have been drained and are used for crops. Drainage by surface drains and open ditches is common. Because the underlying clayey material restricts water movement, tile lines generally require backfilling. A few areas that lack suitable drainage outlets remain in woodland.

Typical profile of Pinconning loamy fine sand, 0 to 2 percent slopes, in an idle field, NE¼SE¼ sec. 8, T. 9 N., R. 6 E., Vienna Township:

Ap—0 to 9 inches, very dark brown (10YR 2/2) loamy fine sand; weak, medium, granular structure; very friable; neutral; abrupt, wavy boundary.

C1g—9 to 14 inches, grayish-brown (10YR 5/2) loamy fine sand; few, fine, distinct, light yellowish-brown (10YR 6/4) mottles; weak, fine, granular structure; very friable; neutral; clear, wavy boundary.

C2g—14 to 26 inches, light brownish-gray (10YR 6/2) fine sand; common, fine, distinct, light yellowish-brown (10YR 6/4) mottles; single grain; loose; neutral; clear, wavy boundary.

C3g—26 to 30 inches, light brownish-gray (10YR 6/2) very fine sand; common, medium, faint, light yellowish-brown (10YR 6/4) mottles; single grain; very friable; mildly alkaline; abrupt, wavy boundary.

IIC4g—30 to 42 inches, gray (10YR 5/1) silty clay; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; very firm; calcareous.

In some depressions a layer of muck as much as 10 inches thick is on the surface. The color of the A horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). The texture of the A horizon and upper three C horizons is sand, but it is loamy sand in some areas. The combined thickness of these horizons is commonly 18 to 36 inches. In places a layer of heavy loamy sand or sandy loam 3 to 5 inches thick overlies the IIC horizon. The texture of the IIC horizon is heavy silty clay loam or silty clay. The reaction of the sandy upper horizons is dominantly slightly acid or neutral but ranges to mildly alkaline.

Pinconning soils have coarser textured upper layers than Breckenridge soils. They have more fine sand in the upper layers and finer textured underlying material than Brevort soils.

Pinconning-Allendale loamy fine sands, 0 to 2 percent slopes (PnA).—This complex of soils occupies large, low areas on the sandy lake plains (fig. 6).

Figure 6.—Typical area of Pinconning soils on lake plain in northwestern part of the county. The associated Allendale soils occupy the lighter colored areas.

The soils formed in 18 to 42 inches of sandy material over clayey lake sediment under a fluctuating water table. The Pinconning soil makes up 60 percent of the complex, the Allendale soil 35 percent, and included soils 5 percent. The Pinconning soil occupies broad depressions and is poorly drained. The Allendale soil occupies small areas only a foot or so above the Pinconning soils and is somewhat poorly drained. Slopes are generally less than 2 percent but are slightly steeper in areas bordering drainage channels.

The plow layer is dominantly dark-brown or very dark grayish-brown loamy fine sand. The Allendale soil has a dark yellowish-brown to dark-brown upper subsoil layer, and in places a small amount of this material is mixed with the plow layer. Minor areas of the finer textured Lenawee soils in the shallow drainageways are included in mapping.

Except for small woodlots, most areas of this complex have been cultivated. Undrained areas are wet in spring and in fall, but the supply of moisture for crops is inadequate during dry summer weather when the water table is low. This lack of moisture is more severe in the slightly higher Allendale soils. Tile drainage is usually beneficial, as it permits earlier warming up of the soils and better root growth in advance of dry summer weather. Natural fertility is moderate to moderately low. Capability unit IIIw–9 (4/1b,4/1c).

Rifle Series

The Rifle series consists of level and slightly depressional soils on till plains and moraines. These soils formed in partly decomposed woody and fibrous vegetation. They occur at random, generally in small wooded areas.

In a typical profile, the surface layer is black muck that is about 12 inches thick and contains many fibrous roots. The second layer is dark reddish-brown, fibrous peat about 24 inches thick. The underlying layers, to a depth of 48 inches or more, are dark reddish-brown peat that contains partly decomposed woody material.

Rifle soils occupy low positions on the landscape and therefore have very little runoff. Many areas lack natural outlets and are ponded during spring and after heavy rainfall. These soils have moderately rapid permeability, however, once the water table is lowered. Their available moisture capacity is high. They are strongly acid and are low in natural fertility. Lime is needed, as well as phosphorus, potassium, and some micronutrients.

Most areas of these soils are woodland consisting of elm, ash, soft maple, and some aspen, birch, and black cherry. These soils are difficult to farm because of the high water table, low fertility, and strongly acid reaction. They are difficult to drain because of the lack of adequate outlets, and when drained they settle readily. Soil blowing and frost damage are major risks.

Typical profile of Rifle muck (0 to 1 percent slopes) in a wooded area, NW¼NE¼ sec. 29, T. 9 N., R. 8 E., Forest Township:

1—0 to 12 inches, black (5YR 2/1) muck containing many, fine, fibrous roots; moderate, medium, granular structure; friable; very strongly acid; gradual, wavy boundary.

2—12 to 36 inches, dark reddish-brown (5YR 3/3), fine, fibrous peat; thinly layered; very weak, coarse, granular structure; friable; very strongly acid.

3—36 to 48 inches, dark reddish-brown (5YR 2/2) peat containing a varying amount of partly decomposed woody material; thinly layered; fibrous; very strongly acid.

The color of the surface layer ranges from black (5YR 2/1) to very dark brown (10YR 2/2), and the material is peat in some places. The color of the lower horizons is dark brown (7.5YR 3/2) or dark reddish brown (5YR 3/2–3/3). The organic material in the lower horizons is thinly layered in most places. The reaction of all layers is strongly acid or very strongly acid. The thickness of the organic material ranges up to 10 feet or more.

Rifle soils are more acid than Carlisle and Lupton soils. They formed in thicker organic deposits and are more acid than Markey soils.

Rifle muck (0 to 1 percent slopes) (Rf).—This organic soil occupies potholes, swales, and basinlike depressions on till plains and on the more strongly sloping uplands. These areas are generally surrounded by short slopes.

The surface layer is black muck. The upper organic layers contain a varying amount of partly decomposed woody material. The organic material ranges from 4 to 10 feet or more in thickness, but it is generally thinner where this soil borders uplands.

Poor drainage and low fertility are the major limitations in the use of this soil for crops. Many areas lack adequate drainage outlets. Soil blowing is a risk in cultivated areas. Most of this soil is wooded. Some small areas are in brushy vegetation that consists of leatherleaf and huckleberry. Capability unit IIIw–15 (Mc).

Sebewa Series

The Sebewa series consists of poorly drained, level and nearly level soils in broad glacial drainage channels throughout the county. These soils formed in loamy material 24 to 42 inches thick over stratified coarse sand and gravel. They formed under a high water table.

In a typical profile, the surface layer is very dark brown loam about 10 inches thick. The upper 19 inches of the subsoil is gray, firm clay loam that has yellowish-brown mottles. The lower 6 inches is friable, light brownish-gray, light sandy clay loam that has light yellowish-brown mottles. Light brownish-gray, stratified coarse sand and gravel that has brownish-yellow mottles underlies the subsoil at a depth of about 35 inches. This material is loose and has a high lime content.

These soils receive runoff from higher soils. The upper soil layers are moderately permeable, but the more sandy underlying material is rapidly permeable. The gray color of the subsoil indicates that these soils are wet for long periods. Because of this wetness, plant growth is restricted, farm machinery bogs down, and tillage is sometimes delayed. These soils are easy to drain by tile lines and open ditches because of the sandy and gravelly underlying material. Where this material is at a shallow depth, however, these soils tend to become droughty when drained. They are high in natural fertility. Once drained, these soils are easily worked and kept in good tilth.

Wetness is the only limitation in farming these soils. They are suited to the main crops grown in the county. Most areas are drained and used for crops. Small areas that lack adequate drainage outlets are used for permanent pasture or are wooded.

Typical profile of Sebewa loam (0 to 2 percent slopes) in a cultivated field, SW¼SW¼ sec. 33, T. 9 N., R. 8 E., Forest Township:

Ap—0 to 10 inches, very dark brown (10YR 2/2) loam; moderate, medium, granular structure; friable; neutral; abrupt, wavy boundary.

B21g—10 to 18 inches, gray (10YR 5/1) clay loam; few, moderate, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, subangular blocky structure; firm; neutral; gradual, wavy boundary.

B22g—18 to 29 inches, gray (10YR 5/1) clay loam; few, fine, distinct, yellowish-brown (10YR 5/4) mottles; moderate, medium, subangular blocky structure; very firm; neutral; abrupt, wavy boundary.

IIB23g—29 to 35 inches, light brownish-gray (10YR 6/2) light sandy clay loam; common, fine, distinct, light yellowish-brown (10YR 6/4) mottles; weak, medium, subangular blocky structure; friable; mildly alkaline; abrupt, wavy boundary.

IIICg—35 to 48 inches, light brownish-gray (10YR 6/2), stratified coarse sand and gravel; few, coarse, faint, brownish-yellow (10YR 6/6) mottles; single grain; loose; calcareous.

The Ap horizon ranges from very dark brown (10YR 2/2) to black (10YR 2/1) in color, from loam to sandy loam or silt loam in texture, and from 10 to 12 inches in thickness. A thin very dark grayish-brown (10YR 3/2) A12 horizon occurs in some areas. The B22g horizon is silty clay loam in places. The B23g horizon ranges from heavy sandy loam to gravelly clay loam.

The combined thickness of the A and B horizons and the depth to calcareous sand and gravel is 30 to 40 inches. The reaction of the A and B horizons ranges from slightly acid to mildly alkaline.

Sebewa soils are coarser textured than Brookston soils and finer textured than Gilford soils. They have a grayer and coarser textured lower B horizon than nearby Conover soils.

Sebewa loam (0 to 2 percent slopes) (Se).—This soil occurs in broad glacial drainage channels, principally on the till plains. Above it are the better drained Celina and Conover soils.

The plow layer is typically very dark brown loam, but in some depressions a thin layer of muck is on the surface. Where this mapping unit borders uplands, narrow strips of Brookston soils are included in mapping.

Wetness is the major limitation to the use of this soil for crops. In many areas ditches have to be dug to provide outlets for tile drains. This soil dries out slowly in spring, and is easily damaged if it is tilled or is trampled by livestock when it is wet. Most areas are drained and planted to corn, field beans, soybeans, and other crops. Capability unit IIw-4 (2.5c).

Selfridge Series

The Selfridge series consists of somewhat poorly drained, nearly level and gently sloping soils on till plains and lake plains. These soils formed in sandy deposits 18 to 42 inches thick over silty clay loam under a fluctuating water table. They are most extensive between the till plains and outwash plains.

In a typical profile, the surface layer is very dark grayish-brown loamy sand about 7 inches thick. This is underlain by about 13 inches of very friable, grayish-brown loamy sand. The subsoil is about 14 inches thick. The upper 10 inches of the subsoil is very friable, brown loamy sand that has light brownish-gray and brownish-yellow mottles. The lower 4 inches is friable, yellowish-brown sandy loam that has grayish-brown mottles. Firm, gray silty clay loam that has yellowish-brown mottles and a high lime content underlies the subsoil at a depth of about 34 inches.

These sandy, nearly level or gently sloping soils have slow or very slow runoff and readily absorb most of the rainfall. They have a high water table, especially early in the growing season. Consequently, farm machinery bogs down and tillage and planting are sometimes delayed. The upper sandy layers have moderately rapid permeability, but the finer textured underlying material has moderately slow permeability. These soils can be drained by tile or open ditches, but if drained they tend to be droughty. Natural fertility is moderately low.

Many areas of these soils are drained and farmed with adjoining finer textured soils. Some areas are now idle or abandoned. Large areas exposed by cultivation are subject to soil blowing. If these soils are drained, they can be planted to crops earlier than adjoining soils. They are moderately droughty and are better suited to early maturing crops than to row crops.

Typical profile of Selfridge loamy sand, 0 to 2 percent slopes, in a cultivated field, NE¼SE¼ sec. 4, T. 6 N., R. 6 E., Mundy Township:

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

A2—7 to 20 inches, grayish-brown (10YR 5/2) loamy sand; weak, medium, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.

B1—20 to 30 inches, brown (10YR 5/3) loamy sand; common, medium, distinct, light brownish-gray (10YR 6/2) and brownish-yellow (10YR 6/6) mottles; weak, medium, subangular blocky structure; very friable; neutral; clear, wavy boundary.

B2t—30 to 34 inches, yellowish-brown (10YR 5/4) sandy loam; common, medium, distinct, grayish-brown (10YR 5/2) mottles; moderate, medium, subangular blocky structure; friable; neutral; abrupt, wavy boundary.

IICg—34 to 48 inches, gray (10YR 6/1) silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/8) mottles; massive; firm; calcareous.

The color of the Ap horizon is dark brown in places. The texture of this horizon and of the A2 horizon is sandy loam in some areas. The texture of the B1 horizon is sand or loamy sand. The A and B horizons contain a varying amount of fine sand, especially on the lake plain in the northwestern part of the county. The texture of the B2t horizon is heavy loamy sand or stratified loamy sand and sandy loam in some areas. The B2t horizon generally is 3 to 8 inches thick, but in a few areas it is thin or discontinuous. The combined thickness of the A and B horizons and the depth to the limy, finer textured material ranges from 30 to 42 inches. The texture of the IICg horizon is dominantly clay loam or silty clay loam, but in places the silty clay loam is stratified with silt and very fine sand. The reaction of the A and B horizons is slightly acid or neutral, but individual horizons are medium acid in some areas.

Selfridge soils are similar in texture to Metea soils, but they are more highly mottled and more poorly drained. They are coarser textured than Metamora soils. They contain less fine sand in the upper layers and have coarser textured underlying material than Allendale soils.

Selfridge loamy sand, 0 to 2 percent slopes (SdA).—This soil has the profile described as typical of the series. It occurs in broad, nearly level areas and on low, smooth ridges on till plains and lake plains. Many areas of this soil are transitional between the soils on till plains and the soils on lake plains. Most areas are 20 to 40 acres in size, but a few are as large as 80 acres or more. This soil occurs throughout the county but is most extensive in the central and northwestern parts.

Included in mapping are some areas in which there is a discontinuous, dark-brown or reddish-brown layer 3 to 5 inches thick in the upper subsoil. This layer is weakly cemented in places. It is present in 5 to 20 percent of the mapping unit, and it is exposed on the surface in scattered areas that are as much as 5 acres or more in size. The subsoil contains more coarse sand and fine gravel in areas bordering the Flint River. In some areas a layer of coarse sand and fine gravel 3 to 5 inches thick immediately overlies the finer textured, limy soil material. The underlying material consists of stratified silt loam and silty clay loam in some areas. The depth to this material is dominantly 30 to 42 inches, but it is slightly greater in places.

Also included in mapping are Brevort soils in shallow drainageways and in wet spots. These wet spots dry out slowly in spring and after rainfall.

Most areas of this soil are farmed. Corn, beans, small grains, and forage are the main crops grown. Tile drainage is necessary to permit early tillage and planting. This soil is moderately droughty, and crops sometimes lack adequate moisture for optimum growth during dry weather. Cropping systems should be chosen that maintain fertility and supply organic matter. Capability unit IIIw–9 (4/2b).

Selfridge loamy sand, 2 to 6 percent slopes (SdB).—This soil occurs on hills, knolls, and short slopes bordering intermittent upland drainageways. Many areas of this soil are in outwash and are transitional between the till plains and lake plains. Some areas are on ancient glacial-beach ridges and other sandy deposits on the till plains. The dominant slopes are 2 to 4 percent. Many areas of this soil are only 5 to 15 acres in size, but a few are as much as 40 acres or more.

Included in mapping are areas in which a layer of dark-brown or reddish-brown material 5 inches thick occurs in the upper subsoil. This layer is discontinuous and is weakly cemented in places. It is exposed on the surface at random, but not so extensively as on the less strongly sloping Selfridge soil. Also included in mapping are minor areas of the well drained to moderately well drained Metea soils on low ridges and knolls.

Most areas of this mapping unit are farmed with adjoining nearly level soils. Corn, beans, small grains, and mixtures of legumes and grasses are the main crops grown. Because of a seasonal high water table, drainage is necessary to permit early tillage and planting. This soil is moderately droughty. Cropping systems should be chosen that maintain the level of fertility and supply organic matter. Capability unit IIIw–9 (4/2b).

Sisson Series

The Sisson series consists of well-drained, gently sloping and sloping soils on lake plains and outwash plains. These soils formed in fine sand and silty material deposited by water.

In a typical profile, the surface layer is dark grayish-brown fine sandy loam about 7 inches thick. The subsurface layer is very friable, light yellowish-brown fine sandy loam about 10 inches thick. The subsoil is about 25 inches thick. The upper 6 inches of the subsoil consists of friable, yellowish-brown fine sandy loam. This is underlain by firm, dark-brown light silty clay loam that grades to friable, light yellowish-brown silt loam in the lower 4 inches. Brown, stratified silt, fine sand, and very fine sand occurs at a depth of about 42 inches. This material is friable and has a high lime content.

Runoff ranges from slow on the gentle slopes to moderate on the stronger slopes. There is a risk of erosion if these soils are intensively cultivated. Permeability is moderate, and adequate moisture is generally available for plants. Natural fertility is moderately high. These soils are easily worked and kept in good tilth.

Most areas of these soils are farmed, but a few sloping areas are wooded. The risk of erosion is the major limitation in the use of these soils for crops. Maintaining the organic-matter content is a problem in some areas. Under good management these soils are suited to most cultivated and forage crops grown in the county.

Typical profile of Sisson fine sandy loam, 2 to 6 percent slopes, in a cultivated field, SW¼NE¼ sec. 34, T. 9 N., R. 5 E., Montrose Township:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) fine sandy loam; weak, medium, granular structure; very friable; neutral; abrupt, smooth boundary.

A2—7 to 17 inches, light yellowish-brown (10YR 6/4) fine sandy loam; weak, fine, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.

B1—17 to 23 inches, yellowish-brown (10YR 5/4) fine sandy loam; moderate, fine, subangular blocky structure; friable; slightly acid; abrupt, smooth boundary.

B2t—23 to 38 inches, dark-brown (7.5YR 4/4) light silty clay loam; moderate, fine, angular blocky structure; firm; many light yellowish-brown (10YR 6/4) silt coatings; slightly acid; abrupt, smooth boundary.

B3—38 to 42 inches, light yellowish-brown (10YR 6/4) silt loam; weak, thin, platy structure; friable; mildly alkaline; clear, smooth boundary.

C—42 to 48 inches, brown (10YR 5/3) stratified silt, fine sand, and very fine sand; moderate, thick, platy structure; friable; a few lime streaks and coatings; calcareous.

In wooded areas there is a very dark grayish-brown (10YR 3/2) surface layer 1 to 3 inches thick. The texture of the Ap and A2 horizons is silt loam in some areas. The texture and thickness of the B horizon vary. The texture of the B2 horizon is heavy fine sandy loam, heavy silt loam, or light silty clay loam. The combined thickness of the A and B horizons ranges from 30 inches to about 48 inches. In places the texture of the C horizon is mostly fine sandy loam or silt loam. The reaction of the A and B horizons ranges from slightly acid to mildly alkaline.

Sisson soils are somewhat coarser textured than Miami soils. Sisson, Tuscola, and Kibbie soils formed in similar material, but Sisson soils lack the mottling in the B horizon.

Sisson fine sandy loam, 2 to 6 percent slopes (SfB).—This soil has the profile described as typical of the series. It commonly occupies side slopes of hills and smooth upper slopes that border well-defined drainage channels. Minor areas of this soil occur at random on low ridges and knolls on nearly level till plains. Most areas are 20 to 40 acres in size.

Included in mapping are areas in which the limy underlying material contains strata of medium sand, silt loam, or silty clay loam as much as 5 inches thick. Also included are less strongly sloping areas of this soil on smooth, low ridgetops. Other inclusions are the moderately well drained Tuscola soils in slight depressions and shallow drainageways and areas of Arkport loamy fine sands.

Except for scattered woodlots, all of this soil is cultivated. Because of the slope, there is a slight risk of erosion under intensive cultivation. Practices that return crop residue to the soil and control erosion are desirable. Management needs are slight, however, and this soil is well suited to all crops grown in the county. Corn, soybeans, and field beans are the main crops grown. Capability unit IIe–2 (2.5a).

Sisson fine sandy loam, 6 to 12 percent slopes (SfC).—This soil occupies the side slopes of hills and the shorter slopes bordering entrenched drainage channels. Along the Flint River it occurs on short terrace escarpments and around drainage heads. The slopes are generally 100 to 200 feet long. Shorter slopes are shown on the soil map by hachure symbols. Most areas of this soil range from 10 to 20 acres in size, and the total acreage is inextensive.

The plow layer is typically dark grayish-brown fine sandy loam. Included in mapping on upper slopes are small, eroded spots in which the plow layer is brown or yellowish brown and contains less organic matter. Also included are places in which the limy underlying material contains strata of medium sand, silt loam, or silty clay loam up to 5 inches thick. Seep spots occur in the random drainageways and on lower slopes throughout this mapping unit.

Except for small, scattered woodlots, all of this soil is used for crops. Corn, field beans, small grains, and forage crops are grown. Row crops can be grown on this soil if more years of sod crops are grown and other conservation practices are included in the management. Capability unit IIIe–5 (2.5a).

Sloan Series

In the Sloan series are level and depressional, poorly drained and very poorly drained soils on the flood plains of the Flint River and other major streams in the county. These soils formed in water-laid loamy deposits.

In a typical profile, the surface layer is very dark brown silt loam about 7 inches thick that is underlain by about 10 inches of very dark grayish-brown silt loam. The subsoil is firm, light brownish-gray heavy silt loam that is about 8 inches thick and has light yellowish-brown mottles. Grayish-brown very fine sand that has light olive-brown mottles underlies the subsoil at a depth of about 25 inches. This material is loose and has a high lime content.

These soils are moderately permeable, have high available moisture capacity, and have moderately high natural fertility. They occupy the lowest, most poorly drained positions on the river bottoms and are subject to spring flooding that frequently extends into the growing season.

Most areas are difficult to drain because of flooding and lack of drainage outlets. In places steep riverbanks hinder the movement of farm machinery to and from these bottom lands. These soils are used mainly as woodland, as wildlife habitat, and as recreation areas. The present vegetation consists of mixed hardwoods, mainly elm, beech, ash, soft maple, and swamp white oak.

Typical profile of Sloan silt loam (0 to 1 percent slopes) in a wooded area, NE¼SW¼SW¼ sec. 9, T. 8 N., R. 8 E., Richfield Township:

A11—0 to 7 inches, very dark brown (10YR 2/2) silt loam; moderate, medium, granular structure; friable; high organic-matter content; mildly alkaline; clear, wavy boundary.

A12—7 to 17 inches, very dark grayish-brown (10YR 3/2) silt loam; weak to moderate, medium, granular structure; friable; mildly alkaline; clear, wavy boundary.

Bg—17 to 25 inches, light brownish-gray (10YR 6/2) heavy silt loam; common, medium, distinct, light yellowish-brown (10YR 5/6) mottles; weak, coarse, subangular blocky structure; firm; dark-gray (10YR 3/1) organic coatings on many ped faces; mildly alkaline; abrupt, wavy boundary.

C1g—25 to 44 inches, grayish-brown (2.5Y 5/2) very fine sand containing thin (1/8 to 1/4 inch) lenses of silt loam; common, medium, faint, light olive-brown (2.5Y 5/6) mottles; single grain and loose very fine sand; massive and friable silt loam; calcareous.

In the deeper depressions these soils have a mucky surface layer up to 10 inches thick. The color of the A11 and A12 horizons ranges from very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) to black (10YR 2/1). The combined thickness of the A11 and A12 horizons ranges from 10 to 20 inches. The texture of the Bg and C1g horizons is loam, heavy silt loam, or light silty clay loam. In some places there is a coarser textured IIC2g horizon that ranges in depth from 30 to 48 inches. The texture of the IIC2g horizon grades to sand, loamy sand, or stratified sand and gravel. This horizon contains thin strata of silt loam or silty clay loam in some areas. The reaction of the A and B horizons is neutral or mildly alkaline.

Sloan soils are more poorly drained than the nearby Ceresco soils. They are finer textured than Cohoctah soils.

Sloan silt loam (0 to 1 percent slopes) (Sm).—This soil has the profile described as typical of the series. It is on flood plains, and many areas of it are on the slightly lower borders of the flood plains adjoining the riverbanks. Slightly above it are the better drained Ceresco soils.

Typically the surface layer is very dark brown or very dark grayish-brown silt loam, but some depressions that have a thin, mucky surface layer are included in mapping. Minor areas of the poorly drained Brookston soils are included in the narrow tributary channels. Small areas of deep muck occur in the broader downstream areas of the flood plain.

This soil is generally flooded early in spring and is difficult to drain because of the flooding and the lack of outlets. Steep riverbanks limit the use of farm machinery in some areas. Most of the acreage is in woodland. Capability unit IIIw–12 (L–2c).

Sloan silt loam, occasionally flooded (0 to 2 percent slopes) (Sn).—This is a poorly drained soil on narrow bottoms of upland drainage channels. The channels are entrenched 2 to 6 feet or more and have sloping or moderately steep sides. The areas of this soil are small, but they occur throughout the county.

The plow layer is typically very dark brown silt loam, but lighter colored, more recent deposits of washed-in material are included. Also included are minor areas of the Brookston soils in the shallow upstream parts of the drainage channels.

Wetness is the major limitation to the use of this soil for crops. Surface drainage is necessary to remove runoff early in spring. Open ditches and tile drains are usually required if this soil is used for cultivated crops. Some areas are too small for practical farming operations. If drained, however, this soil is suited to corn, small grains, and forage crops. It is well suited to improved pasture for midsummer or late summer grazing if minor improvements in surface drainage are made. Capability unit IIIw-12 (L-2c).

Spinks Series

The Spinks series consists of well-drained, nearly level to moderately steep sandy soils. These soils are most extensive on the nearly level to sloping sandy benches above the major stream channels and on sandy ridges on the till plains. The steeper areas are on the rolling uplands in the eastern and southeastern parts of the county.

In a typical profile, the surface layer is dark grayish-brown loamy sand about 7 inches thick. The subsurface layer is light yellowish-brown loamy sand about 6 inches thick. The subsoil extends to a depth of about 70 inches. The subsoil is loose, dark yellowish-brown and yellowish-brown sand that contains thin layers of heavy loamy sand or sandy loam that are darker brown and more friable. It is underlain by light yellowish-brown, loose sand that contains a moderate amount of lime.

Runoff ranges from slow to rapid, depending on slope. Permeability is moderately rapid. Because these soils are sandy, they supply a moderately small amount of moisture and nutrients for plant growth. The moisture is rarely adequate for optimum crop growth during dry summer weather.

If these soils are used for crops, low available moisture capacity and low natural fertility are the main limitations, and soil blowing and erosion are hazards. Crops that resist drought and mature early are better suited than row crops. Use of minimum tillage, stripcropping, and crop residue are ways of controlling erosion and supplying organic matter. If irrigation water is available, these soils are well suited to vegetables, small fruit, and other specialty crops. Most of the level or gently sloping areas have been farmed but are now being used largely for homesites, parks, cemeteries, and other nonfarm purposes. A few areas are cultivated or used for orchards. The steeper areas provide low-quality pasture or are wooded.

Typical profile of Spinks loamy sand, 2 to 6 percent slopes, in idle cropland, SW¼NW¼ sec. 33, T. 8 N., R. 7 E., Genesee Township:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loamy sand; weak, medium, granular structure; very friable; neutral; abrupt, smooth boundary.

A2—7 to 13 inches, light yellowish-brown (10YR 6/4) loamy sand; weak, medium, granular structure; very friable; slightly acid; clear, wavy boundary.

B—13 to 16 inches, dark yellowish-brown (10YR 4/4) loamy coarse sand; weak, medium, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.

A2&Bt—16 to 70 inches, yellowish-brown (10YR 5/4) sand representing the A2 and dark yellowish-brown (10YR 4/4) heavy loamy sand representing the Bt horizon; (the Bt horizon occurs as 1/2-inch to 1-inch, discontinuous layers separated by the A2 horizon; the A2 is single grain and loose; the Bt has weak, medium, subangular blocky structure and is very friable); slightly acid; clear, wavy boundary.

C—70 to 80 inches, light yellowish-brown (10YR 6/4) sand; single grain; loose; calcareous.

The color of the Ap horizon is dark brown (10YR 4/3) in places. The texture is loamy sand or loamy fine sand. The depth to the first Bt horizon ranges from 15 to 30 inches. The Bt horizons vary in number and continuity. Their texture is heavy loamy sand or sandy loam, and they are 1/4 inch to 2 inches thick. The combined thickness of the A and B horizons ranges from 42 to 72 inches or more. The reaction of these horizons is slightly acid or neutral. The C horizon is mildly alkaline, and in places it is calcareous.

Spinks soils are coarser textured than Boyer soils. They contain less fine sand and very fine sand than Arkport soils. The presence of the thin, finer textured Bt horizons is the principal difference between these soils and Oakville soils.

Spinks-Oakville loamy sands, 0 to 2 percent slopes (SvA).—These soils are on gravelly benches above rivers and streams throughout the county. They are most extensive along the Flint and Shiawassee Rivers and their tributaries. The Spinks soil makes up 70 percent of the complex, and the Oakville soil 30 percent. The Spinks soil formed in medium sand and contains thin bands of finer textured material. The Oakville soil formed in similar material but lacks the finer textured bands.

The plow layer is typically dark grayish-brown loamy sand, but these soils contain a varying amount of fine sand, especially along the Flint River. Thin layers of very coarse sand and fine gravel occur in the lower subsoil and underlying material in some areas. In places, principally in the northwestern part of the county, these soils are underlain at a depth of 40 inches or more by very fine sand and silt or silt loam.

Most areas of these soils have been used for crops, but now only a limited acreage is cultivated. Some areas are in orchards, and an increasing amount of acreage is being used for homesites. Crops are affected by the shortage of moisture during dry summer weather, and soil blowing is a slight hazard on unprotected areas. Because of the nearly level relief, erosion is a slight hazard. If these soils are used for crops, they can be improved by practices that make use of crop residue, conserve moisture, and control soil blowing. They are suited to vegetables and small fruit if irrigation water is available. Capability unit IIIs-3 (4a).

Spinks-Oakville loamy sands, 2 to 6 percent slopes (SvB).—These soils are on broad, undulating sandy benches above rivers and streams throughout the county. They are most extensive along the Flint and Shiawassee Rivers and their tributaries. The Spinks soil makes up 60 percent of the complex; the Oakville soil 30 percent; and other soils 10 percent. The Spinks soil formed in medium sand and contains thin bands of finer textured material. The Oakville soil formed in similar material but lacks the finer textured bands.

The plow layer is typically dark grayish-brown loamy

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sand, but included in mapping are some unprotected, eroded areas on the knolls and stronger slopes where the plow layer contains a small amount of the subsoil material. In these eroded areas the plow layer is pale brown or yellowish brown and contains less organic matter. Also included are places where the Spinks and Oakville soils are underlain by limy coarse sand and fine gravel at a depth of 42 inches or more. In other places, mostly in the northwestern part of the county, they are underlain by very fine sand and silt or silt loam at a depth of 40 inches or more.

Other inclusions are small areas of the Arkport soils and the more gravelly Boyer soils. The Arkport soils contain more fine sand and very fine sand and occupy random knolls and positions bordering the more loamy soils on uplands. The Boyer soils are on the lower slopes.

Only a limited acreage is used for crops. Some areas are in orchards. An increasing acreage is being used for homesites. Vegetables and small fruit can be grown if irrigation water is available. Because of the stronger slopes, these soils have more runoff and greater risk of erosion than the less strongly sloping Spinks and Oakville soils. Soil blowing also is a hazard in unprotected areas. Using crop residue and controlling erosion are ways of improving these soils if they are used for crops. Capability unit IIIs–4 (4a).

Spinks-Oakville loamy sands, 6 to 12 percent slopes (SvC).—These are rolling soils on sandy uplands (fig. 7). They are most extensive in the northeastern part of the county, especially in Thetford Township. Minor areas are on short side slopes of major drainage channels throughout the county. The Spinks soil makes up 50 percent of the complex; the Oakville soil 30 percent; and other soils 20 percent. The Spinks soil formed in medium sand and contains thin bands of finer textured material. The Oakville soil formed in similar material but lacks the finer textured bands.

Typical areas of this complex are characterized by many knobs, knolls, and detached ridges. Random wet spots occur in the deeper depressions. Included in mapping are the more gravelly Boyer soils on random knolls and hills. Also included are the Metea soils on the lower parts of the landscape. In some areas there are small gravel pits.

Most areas of this complex are in woodland. Some small areas, once farmed, are now idle or planted to pine trees. Droughtiness and the risk of erosion are

Figure 7.—**Second-growth woodland and brush in sloping areas of Spinks-Oakville soils in Thetford Township.**

the main limitations. Most of the areas that have been farmed are eroded. Using crop residue, conserving moisture, and controlling erosion are important management practices. These soils are better suited to small grains and other early maturing crops than to corn. They are suited to pasture and forage crops if they are well managed. Also, they can be reforested. Capability unit IIIe–9 (4a).

Spinks-Oakville loamy sands, 12 to 18 percent slopes (SvD).—These soils are on sandy uplands. They commonly occupy terrace escarpments and side slopes of well-entrenched drainage channels. Elsewhere, mainly in the northeastern part of the county, they are the predominant soils on narrow, sandy ridges and knolls. Most areas range from 10 to 25 acres in size. The Spinks soil makes up 45 percent of the complex; the Oakville soil 35 percent; and other soils 20 percent. The Spinks soil formed in medium sand and contains thin bands of finer textured material. The Oakville soil formed in similar material but lacks the finer textured bands.

In uneroded areas the plow layer is dark grayish-brown loamy sand. Included in mapping are eroded spots on the rim of slopes and the crest of interdrainage ridges where the plow layer contains a small amount of the subsoil. In these spots the plow layer is browner in color and has a lower organic-matter content. A small amount of gravel is on the surface in the more severely eroded spots. Also included are places where limy sand and gravel occur at a shallow depth. Random seep spots occur on foot slopes early in spring.

Areas of these soils once farmed are now idle, are in pasture, or are planted to pine trees. The rest of the acreage is second-growth woodland consisting mainly of beech, maple, birch, and aspen. Shortage of moisture and risk of erosion are the main limitations for crops. These soils are poorly suited to cultivated crops, but they are suited to forage crops if they are well managed. They are better suited to reforestation. Capability unit IVe–9 (4a).

Spinks Series, Wet Subsoil Variant

The Spinks series, wet subsoil variant, consists of nearly level, somewhat poorly drained soils that formed in sandy and gravelly material under a fluctuating water table. These soils are on outwash plains and river terraces and in scattered areas in broad, glacial drainage channels.

In a typical profile, the surface layer is very dark grayish-brown loamy sand about 9 inches thick. The subsurface layer, about 6 inches thick, is very friable, pale-brown loamy sand. The subsoil is about 33 inches thick. The upper 15 inches of the subsoil consists of very friable, brown, stratified sandy loam and loamy sand that have brownish-gray and brownish-yellow mottles. Grayish-brown stratified sand and fine gravel underlie the subsoil at a depth of about 48 inches. This material is loose and has a high lime content.

These soils are nearly level and have little runoff, but they receive runoff from higher soils. They are saturated by a high water table during spring and other wet periods. Because of their sandy texture, they dry out quickly and tend to be droughty after the water table has subsided. They have moderately rapid permeability when the water table is not high. Their available moisture capacity and natural fertility are moderately low.

Droughtiness and moderately low natural fertility limit the use of these soils for crops. Many areas have been cleared and farmed, but only a few areas are now cultivated or used for pasture. These areas are drained mainly by open ditches. Most of the acreage was once farmed but is now idle. These nearly level soils are easy to work and are easily drained by tile and open ditches. Because of their limitations, however, they are better suited to drought-resistant and early maturing crops than to row crops.

Typical profile of Spinks loamy sand, wet subsoil variant, 0 to 2 percent slopes, in an idle field, SW¼NE¼ sec. 2, T. 6 N., R. 5 E., Gaines Township:

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) loamy sand; weak, medium, granular structure; very friable; slightly acid; abrupt, wavy boundary.

A2—9 to 15 inches, pale-brown (10YR 6/3) loamy sand; weak, medium, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.

B2t—15 to 30 inches, brown (10YR 5/3) stratified sandy loam and loamy sand; common, coarse, distinct, light brownish-gray (10YR 6/2) and brownish-yellow (10YR 6/8) mottles; weak, medium, subangular blocky structure; very friable; slightly acid; abrupt, wavy boundary.

B3—30 to 48 inches, pale-brown (10YR 6/3) sand; common, coarse, faint, light brownish-gray (10YR 6/2) and brownish-yellow (10YR 6/8) mottles; single grain; loose; neutral; abrupt, wavy boundary.

IICg—48 to 60 inches, grayish-brown (10YR 5/2) stratified sand and fine gravel; common, coarse, distinct, brownish-yellow (10YR 6/6) mottles; single grain; loose; calcareous.

The color of the A horizon ranges from very dark grayish brown (10YR 3/2) to very dark gray (10YR 3/1) or dark brown (10YR 3/3). The texture of this horizon ranges from loamy sand to sandy loam in a few places. The B horizon varies in texture and thickness. In places the Bt horizon is heavy loamy sand or sandy loam 10 to 15 inches thick. In other areas this horizon consists of sand or loamy sand that contains discontinuous bands of sandy loam or coarse sandy loam 1 to 3 inches thick. The texture of the B3 horizon is sand or loamy coarse sand. The texture of the IIC horizon is coarse sand or stratified sand and fine gravel.

The combined thickness of the A and B horizons ranges from 42 to 60 inches. In some areas the A and B horizons contain a varying amount of fine gravel. The amount and intensity of mottling depend on the degree of natural drainage. The reaction of the A and B horizons ranges from slightly acid to mildly alkaline.

These soils are somewhat finer textured than Au Gres soils. They formed in material similar to that of the well-drained Spinks soils, but they have a mottled B horizon and are somewhat poorly drained.

Spinks loamy sand, wet subsoil variant, 0 to 2 percent slopes (SpA).—This soil generally occupies sandy and gravelly benches above rivers and streams. Elsewhere it is in broad, glacial drainage channels throughout the county.

The plow layer is very dark grayish-brown loamy sand. Included in mapping are small areas of the darker colored Granby and Gilford soils in shallow drainageways and wet depressions. Because these wet spots dry out more slowly than the Spinks soil, tillage and planting are delayed.

Wetness and moderately low natural fertility are the main limitations of this soil for crops. Most areas are in idle cropland or in pasture. Open ditches and tile drains help to remove the excess water. If drained, this soil is generally better suited to small grains, forage, and other early maturing or drought-resistant crops than to row crops. Capability unit IIIw–5 (4b).

Tuscola Series

The Tuscola series consists of moderately well drained, nearly level and gently sloping soils on till plains and outwash plains. They commonly occur near major stream channels throughout the county. These soils formed in water-laid fine sandy and silty material.

In a typical profile, the surface layer is dark-brown silt loam about 8 inches thick. The subsurface layer is pale-brown, friable silt loam about 7 inches thick. The subsoil is about 17 inches thick. The upper 10 inches of the subsoil consists of yellowish-brown, firm, light silty clay loam that has pale-brown and yellowish-brown mottles. The lower 7 inches consists of strong-brown, very firm silty clay loam that has light brownish-gray mottles. Stratified layers of light-gray very fine sand and silt underlie the subsoil at a depth of about 32 inches. This material has pale-brown and yellowish-brown mottles, is very friable, and has a high lime content.

Because Tuscola soils are nearly level to gently sloping, they have slow runoff. Natural fertility is moderately high. Permeability is moderate, and available moisture capacity is high. These soils generally supply enough moisture for crops. There is a slight risk of erosion in the more strongly sloping areas. These soils are generally easy to work and to keep in good tilth.

Most of the acreage has been farmed, and much of it is still in crops. A few areas once farmed are now idle. Management problems are minor, and these soils are suited to all cultivated and forage crops grown in the county.

Typical profile of Tuscola silt loam, 2 to 6 percent slopes, in idle cropland, SE¼SW¼ sec. 10, T. 7 N., R. 7 E., Burton Township:

Ap—0 to 8 inches, dark-brown (10YR 4/3) silt loam, moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2—8 to 15 inches, pale-brown (10YR 6/3) silt loam; weak, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21t—15 to 25 inches, yellowish-brown (10YR 5/4) light silty clay loam; common, medium, faint, pale-brown (10YR 6/3) and yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; firm; neutral; clear, wavy boundary.

B22t—25 to 32 inches, strong-brown (7.5YR 5/6) silty clay loam; common, medium, distinct, light brownish-gray (10YR 6/2) mottles; moderate, medium, angular blocky structure; very firm; mildly alkaline; abrupt, wavy boundary.

Cg—32 to 48 inches, light-gray (10YR 7/2), stratified very fine sand and silt; common, medium, faint, pale-brown (10YR 6/3) and brownish-yellow (10YR 6/6) mottles; weak, medium, platy structure; very friable; calcareous.

The color of the A horizon is dark brown (10YR 3/3) or very dark grayish brown (10YR 3/2) in the deeper depressions. The texture of the Ap and A2 horizons is fine sandy loam in places. The texture of the B21 and B22 horizons is heavy silt loam, light silty clay loam, or silty clay loam. Faint mottling occurs in the B21 horizon in many areas, but prominent mottles, in chromas of 2 or less, are present only in the B22 and lower horizons. The combined thickness of the A and B horizons and the depth to calcareous, stratified material is 30 to 42 inches. In some areas the C horizon contains thin strata of silt loam or silty clay loam. The reaction of the A and B horizons ranges from slightly acid to mildly alkaline.

Tuscola and Sisson soils formed in similar material, but Tuscola soils are mottled and more poorly drained. They are better drained and not so highly mottled as Kibbie soils. They are more stratified and more variable in texture than Celina and Miami soils.

Tuscola silt loam, 0 to 2 percent slopes (TsA).—Most areas of this soil are on benches bordering major drainage channels near the Flint River. Some areas are on the broad, nearly level parts of interdrainage divides. Minor areas are on scattered, low ridges on the nearly level till plains. Most areas are 20 to 40 acres in size, and the total acreage is inextensive.

The plow layer is dark-brown or dark grayish-brown silt loam, except in some included areas where this layer and the subsurface layer are fine sandy loam. Also included are places where the underlying material contains thin strata of silty clay loam. Other inclusions are minor areas of the somewhat poorly drained Kibbie soils in slight depressions and a few shallow drains. These soils dry out more slowly than the Tuscola soil.

This soil has no major management needs. If adequately fertilized, it is suited to intensive cultivation. Corn, soybeans, and field beans are the main crops grown. Random drainage of the included wet spots permits earlier planting of crops. Capability unit I–1 (2.5a).

Tuscola silt loam, 2 to 6 percent slopes (TsB).—This soil has the profile described as typical of the series. Most areas of it are around drainage heads and on upper slopes bordering well-defined drainage channels near the Flint River. Some areas are on smoothly rounded ridges on the interdrainage divides in the same general area. Minor, scattered areas are on low ridges and knolls on the nearly level till plains. Most areas are 20 to 40 acres in size.

The plow layer is generally dark-brown or dark grayish-brown silt loam, but included in mapping are some areas in which the plow layer and subsurface layer are fine sandy loam. On knolls and other sharply breaking parts of the landscape are small eroded areas that are pale brown or yellowish brown and contain less organic matter than surrounding areas. In places the limy underlying material contains thin strata of medium sand, sandy loam, or silty clay loam.

Other inclusions are some steeper areas occupied by the well-drained Sisson soils. These areas are commonly eroded and have a lighter colored plow layer than the rest of the mapping unit. In scattered drainageways there are inclusions of the somewhat poorly drained Kibbie soils. These darker colored wet spots dry out more slowly than the Tuscola soil.

Except for scattered woodlots, all areas of this soil have been cropped. Because of slope, there is a slight risk of erosion if the soil is intensively cultivated. Management needs are slight, however, and this soil is well suited to cultivated and forage crops. Random drainage of the included wet spots permits earlier planting of crops. Capability unit IIe-2 (2.5a).

Wallkill Series

The Wallkill series consists of level and nearly level, poorly drained loamy soils on uplands. These soils are 10 to 40 inches thick and overlie organic material. The loamy material is composed of recent deposits washed in from higher areas. These soils occur mostly in basinlike areas surrounded by more strongly sloping soils. They are in the eastern and southeastern parts of the county.

In a typical profile, the surface layer is very dark brown silt loam about 6 inches thick. The underlying mineral layer is dark-gray, friable silt loam about 18 inches thick. Very dark gray, friable muck underlies the mineral soil at a depth of about 24 inches. This material grades to very dark grayish-brown mucky peat at a depth of about 45 inches.

These soils receive runoff from nearby higher soils. They have moderate permeability in the mineral soil layers and moderately rapid permeability in the underlying organic material. Most areas are surrounded by sloping soils and therefore lack surface outlets. Water ponds in these areas early in the growing season and after heavy rainfall. Natural fertility is moderately high, and these soils are generally well supplied with lime.

Wetness and the lack of drainage outlets are the major limitations in the use of these soils for crops. A few areas where outlets are available have been drained and farmed with nearby soils. A small acreage is used for pasture. Many areas that are too wet for crops are idle or support an open stand of trees, brush, and wetland grasses.

Typical profile of Wallkill silt loam (0 to 1 percent slopes) in an idle field, SE¼SE¼ sec. 1, T. 7 N., R. 7 E., Burton Township:

A1—0 to 6 inches, very dark brown (10YR 2/2) silt loam; moderate, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

Cg—6 to 24 inches, dark-gray (10YR 4/1) silt loam; moderate, medium, subangular blocky structure; friable; mildly alkaline; abrupt, wavy boundary.

1b—24 to 45 inches, very dark gray (10YR 3/1) muck; weak, fine, granular structure; friable; mildly alkaline; gradual, wavy boundary.

2b—45 to 60 inches, very dark grayish-brown (10YR 3/2) mucky peat; massive; friable; neutral.

The color of the Ap horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). The texture of the Ap and Cg horizons is dominantly loam or silt loam but ranges to sandy loam. The reaction of these horizons is neutral to moderately alkaline. The recent mineral deposits are generally 12 to 30 inches thick, although they range in thickness from 10 to 40 inches. The organic material in the lower horizons is muck, peaty muck, peat, or sedimentary peat. Partly decomposed woody material and lenses of mineral soil occur to a varying extent in the organic horizons in some areas. The reaction of the organic horizons ranges from slightly acid to mildly alkaline.

Wallkill silt loam (0 to 1 percent slopes) (Wa).—This soil occupies basinlike depressions and swales, mostly in undulating to rolling uplands in the eastern and southeastern parts of the county. Most areas are surrounded by sloping or moderately steep soils and lack drainage outlets. The areas generally range from 2 to 5 acres in size, but some are as large as 10 acres.

The surface layer is generally very dark brown silt loam, but more recent deposits are lighter colored. Included in mapping are minor areas of Lupton muck in the wider or deeper depressions.

Most areas of this soil are too wet for crops. Lack of drainage outlets is the main limitation. Some areas are too small for farming. A few areas are farmed intermittently, depending on the height of the water table at planting time. If this soil is drained, it is suited to corn, small grains, and forage crops. (Capability unit IIIw-15 (Mc).

Wasepi Series

The Wasepi series consists of nearly level, loamy soils on gravelly benches and flats bordering the major streams throughout the county. These soils formed in sandy and loamy material under a fluctuating water table and are somewhat poorly drained.

In a typical profile, the surface layer is very dark grayish-brown sandy loam about 8 inches thick. The subsurface layer is brown, very friable sandy loam about 5 inches thick. The subsoil is about 17 inches thick. The upper 4 inches of the subsoil consists of yellowish-brown, very friable loamy sand that has grayish-brown mottles. This is underlain by about 7 inches of yellowish-brown, friable sandy loam that has grayish-brown and brownish-yellow mottles. The lower 6 inches of the subsoil is brown, friable light sandy clay loam that has light brownish-gray and yellowish-brown mottles. Light brownish-gray, stratified sand and fine gravel underlie the subsoil at a depth of about 30 inches. This material is loose and has a high lime content.

Because of the nearly level relief, runoff is very slow, and most of the rainfall is readily absorbed by the sandy upper layers. Permeability is moderately rapid, but these soils are saturated by a high water table early in the growing season. This saturation hinders the growth of plant roots and delays tillage and planting. If drained, these soils tend to be droughty. Crops suffer from lack of adequate moisture during long periods of dry weather. These soils have moderately low natural fertility. If they are drained, they are easy to work and keep in good tilth.

Most areas of these soils have been farmed. They are easily tilled and are moderately well suited to cultivated and forage crops in most years. Wetness is the main limitation in the use of these soils for crops. If drained, they respond readily to management.

Typical profile of Wasepi sandy loam, 0 to 2 percent slopes, in an idle field, SW¼SE¼ sec. 25, T. 6 N., R. 8 E., Atlas Township:

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

A2—8 to 13 inches, brown (10YR 5/3) sandy loam; weak medium, granular structure; very friable; slightly acid; clear, wavy boundary.

B1—13 to 17 inches, yellowish-brown (10YR 5/4) loamy sand; few, medium, distinct, grayish-brown (10YR 5/2) mottles; weak, medium, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.

B21—17 to 24 inches, yellowish-brown (10YR 5/4) sandy loam; common, medium, distinct, grayish-brown (10YR 5/2) and brownish-yellow (10YR 6/6) mottles; weak, medium, subangular blocky structure; friable; slightly acid; gradual, wavy boundary.

B22t—24 to 30 inches, brown (10YR 5/3) light sandy clay loam; common, medium, distinct, light brownish-gray (10YR 6/2) and yellowish-brown (10YR 5/6) mottles; moderate, fine, subangular blocky structure; friable; abrupt, wavy boundary.

IICg—30 to 48 inches, light brownish-gray (10YR 6/2) stratified sand and fine gravel; few coarse, faint, brownish-yellow (10YR 6/8) mottles; single grain; loose; calcareous.

The color of the A horizon ranges from very dark grayish brown (10YR 3/2) to very dark brown (10YR 2/2) in the deeper depressions. The Ap and A2 horizons range in texture from sandy loam to loamy sand, and each of these horizons ranges in thickness from 6 to 10 inches. The B21 and B22 horizons are sandy loam or light sandy clay loam, and each ranges in thickness from 8 to 15 inches. A varying amount of fine gravel occurs throughout the A and B horizons in many areas. The amount and intensity of mottling depend on the degree of natural drainage. The combined thickness of the A and B horizons and the depth to calcareous sand and gravel is 24 to 42 inches. The reaction of the A and B horizons ranges from slightly acid to mildly alkaline.

The Wasepi, Boyer, and Perrin soils formed in similar material, but Wasepi soils are more highly mottled and more poorly drained. They are better drained than nearby Gilford soils.

Wasepi sandy loam, 0 to 2 percent slopes (WeA).—This soil has the profile described as typical of the series. It occupies sandy and gravelly benches above rivers and streams and is slightly below the Boyer and Perrin soils. Slopes are dominantly less than 2 percent but are slightly steeper near drainageways.

The plow layer is very dark grayish-brown sandy loam. The depth to stratified sand and gravel is dominantly 24 to 42 inches but is slightly greater in places. This stratified material contains thin layers of silt loam or silty clay loam in some areas.

Wetness and moderately low natural fertility are the main limitations to the use of this soil for crops. Runoff is slow, and shallow drainageways are needed in some areas. Tile or open ditch drainage improves this soil for cultivated crops. Corn, small grains, and forage are the main crops grown. Capability unit IIIw-5 (4b).

Wasepi sandy loam, loamy substratum, 0 to 2 percent slopes (WpA).—This is a somewhat poorly drained soil on river terraces and gravelly outwash plains above the Flint River. In places this soil occurs in transitional areas between soils on outwash plains and till plains. The slopes are dominantly less than 2 percent but are slightly steeper near drainageways and terrace escarpments. Areas of this soil range from 10 to 40 acres in size. The total acreage is inextensive, and most of it is in Flushing and Montrose Townships.

The profile of this soil is similar to the one described as typical of the series, except that clay loam or silty clay loam underlies the sand and gravel at a depth of 42 to 66 inches. The plow layer is typically very dark grayish-brown sandy loam, but in some mapped areas the texture is loamy sand. Where this soil borders the more loamy soils on till plains, minor areas of the somewhat poorly drained Metamora soils are included. Also included are Breckenridge soils in shallow drainageways and wet depressions. These wet areas dry out slowly in spring and delay tillage and planting.

Wetness and moderately low natural fertility are the main limitations for crops. This soil can be drained by tile or open ditches. Moisture is inadequate for some crops late in summer when the water table has fallen. The presence of the loamy underlying material, however, enables this soil to store more moisture than the other Wasepi soils, especially for deep-rooted crops or trees. In drained areas corn, small grains, and forage are the major crops grown. Soybeans and field beans are important crops in some areas. Capability unit IIIw-5 (4b).

Use and Management of the Soils

The soils of Genesee County are used mainly for crops and pasture. This section explains how the soils can be managed for these purposes, as well as for wildlife, in building highways, farm ponds, and other engineering structures, and in community development.

Crops and Pasture

In this subsection the capability classification used by the Soil Conservation Service is explained, and the management of soils by capability units is discussed.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major, and generally expensive, land-forming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for forest trees or engineering.

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 groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife. (None in Genesee County.)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife. (None in Genesee County.)

Class VIII soils and landforms have limitations that preclude their use for commercial plants 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 the 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 part of the United States but not in Genesee County, shows that the chief limitation is climate that is too cold or too dry.

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

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIe-4. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraphs; and the Arabic numeral specifically identifies the capability unit within each subclass. In this survey the Arabic numerals are not consecutive, because not all the capability units used in Michigan are represented in Genesee County.

In parentheses following the symbol of each capability unit are symbols made up of Arabic numerals and small or capital letters. These symbols in parentheses identify the management group or groups, all or parts of which are represented by the soils in that capability unit. These management groups are part of a statewide system used in Michigan for making recommendations on application of fertilizer, drainage, and other practices. For an explanation of this classification, refer to "Fertilizer Recommendations for Michigan Vegetables and Field Crops" (7).

In the following pages the capability units in Genesee County are described and suggestions for the use and management of the soils are given.

Management by capability units [2]

This subsection describes the soils in each capability unit, tells of their use and suitability for crops and pasture, and discusses management practices. The soil series represented in each capability unit are named, but this does not mean that all the soils in the series are in the capability unit. To find the names of the soils in any given unit, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1 (2.5a, 2.5b)

This unit consists of soils of the Celina, Conover, and Tuscola series. The Celina and Tuscola soils are moderately well drained, and the Conover soils are somewhat poorly drained. These are nearly level soils of the uplands. The subsoil is moderately fine textured or medium textured, and the underlying material is medium textured. Permeability is moderate or moderately slow. Available moisture capacity is moderately high or high, and crops generally receive adequate moisture. The hazard of erosion is slight. These soils are fertile and are easy to cultivate and manage.

These soils are well suited to all crops commonly grown in the county. Corn, small grains, white beans, soybeans, and alfalfa are the main crops, but sugar beets are also grown. Grazing on these soils when they are wet results in severe soil compaction and loss of structure.

Proper management includes the use of crop residue, green-manure crops, and minimum tillage to improve organic-matter content and reduce soil compaction. Proper use of crop residue helps to control soil blowing, crusting, and evaporation and increases the

[2] By JAMES E. FEENSTRA, United States Department of Agriculture, Soil Conservation Service.

water-intake rate. Wet areas delay planting in spring and hamper harvesting. Surface or tile drains can be used where drainage of small wet spots is needed.

CAPABILITY UNIT IIe-1 (1.5a)

Morley silt loam, 2 to 6 percent slopes, is the only soil in this capability unit. This is a moderately well drained soil of the sloping or undulating uplands. The subsoil is moderately fine textured or fine textured, and the underlying material is fine textured. Available moisture capacity is high, and permeability is moderately slow. Moisture supply is normally adequate for plant growth. Fertility is moderately high.

This soil is suited to crops normally grown in the county. Corn, soybeans, small grains, and mixtures of grasses and legumes are the main crops. The planting of small grains and mixtures of grasses and legumes is important to the cropping system. Grazing on this soil when it is wet results in severe soil compaction and loss of structure.

Proper management includes control of runoff and erosion; maintenance of tilth and organic-matter content; use of diversion terraces and sodded waterways; growing of green-manure crops; application of lime and fertilizer; rotation of crops; and minimum tillage. Although fall plowing may permit earlier planting next spring, it may result in excessive erosion. If this soil is tilled when wet, it puddles, loses its granular structure, becomes cloddy and hard when dry, and is subject to increased runoff. The short, complex slopes limit the use of contour strips and diversion terraces.

Plowing under of crop residue and green-manure crops reduces surface crusting and evaporation of soil moisture, adds organic matter, improves tilth, and makes the surface layer absorb more water. Tilling and harvesting are delayed in drainageways and depressions because the soil dries out slowly. Tile lines or surface drains help to remove excess water in these areas if adequate outlets can be provided.

CAPABILITY UNIT IIe-2 (2.5a, 2.5b, 3/2a, 4/2a)

This unit consists of soils of the Celina, Conover, Metea, Miami, Owosso, Sisson, and Tuscola series. With the exception of the somewhat poorly drained Conover soils, these soils are moderately well drained and well drained. They are gently sloping or undulating soils of the uplands. The subsoil is mainly moderately fine textured, and the underlying material is medium textured. The Sisson and Tuscola soils, however, are medium textured in both the subsoil and underlying material. Available moisture capacity is moderately high or high, permeability is moderate or moderately slow, and runoff is slow. Fertility is medium or moderately high, and tillage is good.

Crops commonly grown in the county are suited to these soils. Corn, field beans, soybeans, small grains, and alfalfa are the main crops. These soils are suited to intensive cropping if they are properly managed.

Proper management includes control of erosion, maintenance of organic-matter content, and replacement of nutrients lost by erosion or used by crops. Erosion control measures include minimum tillage; stripcropping where there are long, uniform slopes; and use of sodded waterways (fig. 8). Contour farming and use of diversion terraces are not practical in the many areas that do not have long, uniform slopes. Mixtures of grasses and legumes, cover crops, and minimum tillage are more suitable means of erosion control in these areas.

Plowing under crop residue and green-manure crops reduces crusting of the surface and evaporation of soil moisture, adds organic matter, and makes the soils easier to work and more absorbent of water. Application of large amounts of manure improves tilth and structure, especially on the few small eroded spots.

Surface drains to remove excess water are needed in some steep areas, drainageways, and wet depressions. Catch basins with sump pumps can be used if suitable outlets are not available. Diversion terraces are used to intercept runoff and protect adjacent lowlands from ponding.

CAPABILITY UNIT IIe-3 (3a)

Fox sandy loam, 2 to 6 percent slopes, is the only soil in this capability unit. This is a well-drained soil of the uplands. Its subsoil is medium textured or moderately fine textured. The subsoil is underlain at a depth of 18 to 42 inches by coarse-textured material. Available moisture capacity and permeability are moderate. Moisture supply may not be adequate for plant growth during extreme drought. Runoff is slow. Fertility is medium or moderately high.

This soil is well suited to crops commonly grown in the county. Corn, soybeans, small grains, and alfalfa are the main crops, but field beans and some sugar beets are also grown.

Proper management includes control of erosion and soil blowing, and maintenance of organic-matter content and fertility. Growing of winter cover and green-manure crops and use of manure and crop residue help maintain organic-matter content, preserve tilth, and protect the soil from erosion. Other erosion control measures are minimum tillage, stripcropping on long, uniform slopes, and use of sodded waterways and windbreaks.

Stripcropping, contour farming, and use of diversion terraces are not practical in the many areas that do not have long, uniform slopes. In such areas the use of crop residue or green-manure crops reduces soil moisture evaporation, adds organic matter, controls soil blowing, and makes the soil easier to work and more absorbent of water. Crop residue should be worked into the soil frequently.

This soil can be tilled easily over a wide range of moisture content without clodding or crusting. It can be worked early in spring and soon after rain. This soil warms up earlier in spring than finer textured soils. Lime generally improves the growth of crops, especially of legumes.

CAPABILITY UNIT IIw-2 (1.5b, 1.5c)

The unit consists of soils of the Del Rey and Lenawee series. These are somewhat poorly drained and poorly drained, level or nearly level soils, some areas

Figure 8.—**Sodded waterway on gently sloping area of Celina-Conover loams, 2 to 6 percent slopes, in Mundy Township.**

of which are in depressions and drainageways. The subsoil is moderately fine textured or fine textured, and the underlying material is moderately fine textured. Available moisture capacity is moderately high or high, permeability is moderately slow or slow, and runoff is very slow. These soils are moderately well supplied with plant nutrients. The poorly drained soils have slightly higher organic-matter content and are darker than the somewhat poorly drained soils.

Crops commonly grown in the county are suited to these soils. Corn, small grains, soybeans, and alfalfa are the main crops, but field beans and sugar beets are also grown. Row crops generally can be grown several years in succession when a green-manure crop is seeded at the last cultivation. Small grains may drown out or lodge before harvest, and field beans may be damaged by wetness. Crops, especially corn, can be damaged by periods of hot, dry weather, because the clayey subsoil releases moisture slowly. These soils can be intensively cultivated if properly managed.

Main problems in management are excess surface and subsoil moisture, and maintenance and improvement of soil tilth. Some areas are difficult to drain because of high clay content in the subsoil. The clay restricts the movement of air and moisture and the penetration of roots. The growing of legumes and other deep-rooted crops helps improve aeration and internal drainage of these soils. Other practices that improve tilth and add organic matter are growing green-manure crops, adding lime and fertilizer, and using minimum tillage. These soils can be tilled only within a limited range of moisture content and tend to dry out and warm up slowly in spring.

Water ponds on these soils in spring and after heavy rainfall, and water remains in the subsoil after the surface dries. The resulting wetness delays tillage in spring and restricts harvesting in fall. If these soils are tilled when wet, they puddle, lose their granular structure, and become cloddy and hard when dry. Fall plowing allows earlier planting in spring and is often less destructive of soil tilth than plowing when the soil is too wet in spring. Farm machinery easily bogs down when these soils are wet.

Artificial drainage is generally needed on these soils. Drainage is by ditch or tile line, but lack of outlets makes such drainage impractical in some areas. Where adequate outlets are lacking, catch basins and sump pumps are used. Tile lines should be covered with straw or porous backfill. Open-ditch drainage is used to handle large quantities of water. Diversion terraces are used in places to intercept runoff from adjacent higher slopes.

Surface crusting after heavy rainfall makes it difficult for seedlings to break through the surface, which results in a high mortality of desirable plants. Surface crusting can be reduced by returning crop residue or green-manure crops to the soil. This also limits evaporation of soil moisture, adds organic matter, improves tilth, and makes the surface layer more absorbent of water.

Soil blowing can cause severe seedling losses or crop damage. This can be especially serious on the Lenawee soil. Practices that help prevent soil blowing damage are using special tillage practices, windbreaks, and buffer strips; leaving crop residue near the surface; and growing cover crops.

CAPABILITY UNIT IIw-3 (1.5b)

Del Rey silt loam, 2 to 6 percent slopes, is the only soil in this capability unit. This is a somewhat poorly drained, gently sloping or undulating soil of the uplands. The subsoil is fine textured or moderately fine textured, and the underlying material is moderately fine textured. Available moisture capacity is moderately high, and permeability is moderately slow. A fluctuating high water table is near the surface in spring. Runoff is slow, and water ponds in depressions. Wet depressions often delay planting and tilling of crops. Many areas are too wet in spring and after rain to support farm machinery.

Most crops commonly grown in the county are suited to this soil if it is drained. Corn, small grains, soybeans, and alfalfa are the main crops, but field beans and sugar beets are also grown.

The main problems in management are a slight hazard of erosion, excess subsoil moisture, and maintenance of tilth and fertility. Practices that help control erosion and improve fertility when this soil is intensively cultivated are minimum tillage, stripcropping, growing of green-manure crops, and use of sodded waterways. In some areas complex slopes make contour stripcropping and terracing impractical.

If this soil is tilled when wet, it puddles, loses its granular structure, and becomes cloddy and hard when dry. The surface crusts when it dries after a hard rain. This crusting makes it difficult for seedlings to break through the surface and may result in a high mortality of desirable plants. Application of barnyard manure, especially in eroded areas, is beneficial. Return of crop residue or green-manure crops to the soil reduces crusting of the surface, improves tilth, makes the soil absorb more water, and helps water move more readily to tile drains.

Design and installation of drainage systems in this soil are more difficult than in more nearly level soils. On the higher slopes, which range from 3 to 5 percent, random tile drains may be adequate for good drainage. Since the soil is stable, ditchbanks and tiled trenches need little maintenance.

CAPABILITY UNIT IIw-4 (2.5b, 2.5c, 3/2b)

This unit consists of soils of the Brookston, Conover, Metamora, and Sebewa series. These are somewhat poorly drained and poorly drained loamy soils that are nearly level to slightly depressional. The subsoil is medium textured or moderately fine textured, and the underlying material is medium textured or moderately coarse textured. Permeability is moderate or moderately slow. Available moisture capacity is moderately high or high. The water table remains near the surface especially in the poorly drained soils.

Crops commonly grown in the county are well suited to these soils if they have been drained. Corn, soybeans, and field beans are the main crops, but small grains and mixtures of alfalfa and grass are also important crops in some areas. Growing a continuous row crop, such as corn, and seeding a green-manure crop at the last cultivation improves tilth and organic-matter content.

Grazing on these soils when they are wet results in puddling and loss of soil structure. The species selected for forage production should be suited to the wetness of the soil. These soils cannot be grazed so early in the season as upland soils.

Runoff from these soils is very slow, and water ponds in the deeper depressions in spring and after heavy rainfall (fig. 9). Spring planting and harvesting are delayed or hampered when these soils are wet, because farm machinery easily bogs down. When drained, however, they are easy to work and keep in good tilth. In some years crops are damaged by frost because of the low position of the soils.

Since the soils have few natural outlets, ditches must be dug to provide outlets. Where ditches are impractical, catch basins and sump pumps are used. Tile systems are improved by backfilling with straw or other porous material. Tile laid in the Sebewa soil should be covered with straw or other porous material to keep sand and silt from flowing into the tile line.

Tile lines are more easily installed during dry periods because some of these soils are unstable when wet. Return of large amounts of crop residue and green-manure crops to the soils increases porosity, permits water to move more rapidly to tile drains, and makes the soils absorb more water.

CAPABILITY UNIT IIw-5 (2.5b, 3b, 3/2b)

This unit consists of soils of the Conover, Kibbie, and Metamora series. These are somewhat poorly drained, gently sloping or undulating soils of the uplands. The subsoil is medium textured or moderately fine textured, and the underlying material is medium textured. Available moisture capacity is moderately high or high, permeability is moderately slow or moderate, and runoff is slow. Water ponds in low areas.

Crops commonly grown in the county are well suited to these soils. Corn, soybeans, small grains, and alfalfa are the main crops, but field beans and sugar beets are also grown. These soils can be cropped intensively if drainage is adequate and fertility and organic-matter content are maintained.

The main problem in management is excess water

Figure 9.—Wet areas of the Brookston soils delay planting and tilling.

in the subsoil, but there is also a slight hazard of erosion. Practices that help control erosion under intensive cultivation are minimum tillage, use of crop residue, planting on the contour, stripcropping, and sodding local waterways. Many areas, however, do not have long, uniform slopes, and on these contour farming and stripcropping are not practical.

Many areas of these soils are wet in spring and after rain, and the soils become puddled and compacted if farm machinery is used. This delays planting and tilling of crops. Artificial drainage is required in these areas. Natural outlets are few, and ditches usually must be dug to provide outlets. In some areas, where drainage is impractical because suitable outlets are not available, catch basins and sump pumps are used. Random drainage of drainageways and depressions may be adequate in the more undulating areas.

Design and layout of drainage systems are more difficult on these soils than on nearly level soils because short laterals must be used in many areas to get the proper grade. Tile lines installed in the sandy and silty Kibbie soil must be covered with straw or other porous material to prevent sand and silt from flowing into the tile. Tile lines and open ditches are easier to install during dry periods, since these soils cave in when wet.

Soil porosity is maintained and excess water can move more rapidly to tile drains if crop residue or green-manure crops are returned to the soil. Crop residue helps to prevent soil crusting and loss of soil moisture by evaporation, and increases the water-intake rate. Residue should be worked into the soil by stubble mulching or minimum surface tillage.

CAPABILITY UNIT IIw-6 (2.5c, 3b)

This unit consists of soils of the Colwood and Kibbie series. These are level, somewhat poorly drained or poorly drained soils. The subsoil is medium textured or moderately fine textured, and the underlying material is medium textured. Available moisture capacity and natural fertility are high or moderately high, and permeability is moderate. Runoff is slow, and water ponds in depressions.

Most crops commonly grown in the county are suited to these soils if they are drained. Small grains are likely to drown out and lodge before harvest when planted on the poorly drained soils. Selection of forage crops depends on degree of drainage or wetness. If green-manure and crop residue are plowed under, organic-matter content and the chance for a good stand of plants are improved.

These soils generally supply adequate moisture for crop growth, but they are excessively wet in spring and after rain because of a fluctuating high water table. Planting, harvesting, and weed control are hampered in wet years because farm machinery easily bogs down when the soils are wet. Once these soils are drained and have dried out, however, tilth is not a problem.

Tile drains and surface drains provide drainage if outlets are available. Tile drains are difficult to install in some areas because the silty and sandy material caves into the tile trenches readily. Use of organic material or surface soil to backfill the trenches helps prevent the silty and sandy material from flowing into the tile drains.

CAPABILITY UNIT IIw-8 (3/2b, 3/2c)

This unit consists of soils of the Breckenridge, Brevort, and Metamora series. These are somewhat poorly drained or poorly drained, level to gently sloping soils, some areas of which are in depressions. The upper layer, 18 to 42 inches thick, is moderately coarse textured, and the underlying material is moderately fine textured. Available moisture capacity is moderate or moderately high. Permeability is moderately rapid in the upper layer and moderately slow in the underlying material. Runoff is slow in gently sloping or undulating areas and very slow in nearly level areas.

Crops commonly grown in the county are well suited to these soils if they are drained. Corn, soybeans, small grains, and mixtures of alfalfa and grass are the main crops, but field beans are also grown. Yields of small grains are more reliable than yields of crops that mature late in summer, such as corn, because small grains normally mature before there is a shortage of moisture.

These soils are easily tilled over a wide range of moisture content without clodding or crusting. They warm up earlier in spring than the more silty and clayey soils. Light and frequent application of fertilizer, especially nitrogen, is needed to replace losses through leaching. Crops grown on the low-lying soils can be damaged by frost, which reduces yields and results in uneven stands of crops.

The main problems in management are excess subsoil moisture and removal of surface water. There is a slight hazard of erosion in gently sloping areas. Water ponds on the nearly level areas in spring and after heavy rain. Farm machinery tends to bog down when these soils are wet, and weed control, spring planting, spraying, and harvesting are hampered or delayed.

When designing tile drainage systems, onsite investigation is important because of the variable depth to the finer textured substratum. Since natural outlets are few, it is generally necessary to dig ditches to provide outlets, and in places artificial drainage is impractical. Catch basins and sump pumps can be used in some of these areas. Diversion terraces can be used in some places to intercept runoff from adjacent higher slopes. Where tile lines are used, they should be covered with straw or other porous material to help keep the sandy material from flowing into the tile.

These soils can be cropped intensively if sufficient crop residue is returned to the soil and cover crops are used where needed. Crop residue supplies organic matter, controls soil blowing, and checks loss of soil moisture by evaporation. Results are best if residue is worked into the soil by stubble mulching and minimum tillage. Legumes need additional lime because these soils tend to be slightly acid.

CAPABILITY UNIT IIw-9 (L-2a)

Landes fine sandy loam is the only soil in this capability unit. This is a moderately coarse textured, moderately well drained or well drained, nearly level soil of the river bottoms. Available moisture capacity and permeability are moderate. Supply of soil moisture is usually adequate, although the water table is 3 feet or more below the surface. Runoff is slight. Fertility is moderate.

This soil is used mainly for pasture, woodland, and wildlife habitat. Where areas are large and uniform enough to make farming practical, corn, soybeans, small grains, and mixtures of legumes and grasses are suitable crops. In places where the hazard of flooding or frost is not too severe, this soil is excellent for garden crops. During extreme drought, however, crops may not have enough moisture for best growth. On narrow bottom lands of meandering streams, areas adjacent to other soils that are not suitable for cultivation are used for permanent hay or pasture. Crops are damaged by occasional flooding and deposits of soil, but floodwaters recede readily as the streams subside.

The main need in management for pasture is to maintain a grass cover at all times by proper seeding and regulated mowing or grazing. Once the better pasture plants are established, they maintain themselves if protected from overgrazing. Quality of the forage is improved by including legumes in the seeding mixture. Spraying may be needed to eliminate weeds and woody plants.

Crop residue supplies organic matter, reduces moisture evaporation, makes tillage easier, and allows the soil to absorb more water. Residue worked into the soil by minimum surface tillage gives the best results.

Dikes and diversions are useful in some areas to collect and divert floodwater or runoff from higher slopes. Sodded waterways are seldom used. Flooding can be controlled by conservation measures upstream and by the use of flood-control measures.

CAPABILITY UNIT IIw-10 (M/3c)

Linwood muck is the only soil in this unit. This is a very poorly drained organic soil that is underlain at a depth of 12 to 42 inches by medium-textured or moderately fine textured material. Available moisture capacity is high. Permeability is moderately rapid in the upper organic layer and moderately slow in the underlying mineral soil material. Runoff is very slow or ponded. Fertility is low.

This soil is well suited to short-season, frost-resistant truck crops such as celery, carrots, and cabbage if it is artificially drained and soil blowing is controlled. In places this soil is too limy for good production of onions, spinach, lettuce, soybeans, and blueberries. Most of this soil is in native grasses, bushes, and trees.

The main problems in management are droughtiness, a high water table, soil blowing, generally low fertility, and a frost hazard. Sprinkler irrigation aids the growth of young transplants, decreases soil blowing, and provides frost protection. Frost damage can be further reduced by selecting hardy plants, choosing sites with the most favorable air drainage, and applying large amounts of potash. This soil is ordinarily low in phosphorus, potassium, and micronutrients such as manganese, boron, copper, molybdenum, and zinc, but lime generally is not required.

Artificial drainage is needed before this soil can be cultivated intensively. Depth and spacing of tile depend on the thickness of the organic matter. In areas where suitable drainage outlets are lacking, catch basins and sump pumps are used. Tile drainage may be a problem since some organic soils do not provide a suitable foundation for tile lines.

The water table should be maintained at a height that will allow good growth of plants and yet reduce thinning of the organic layer. If the organic layer is thick enough, the water level can be controlled by the use of dams, dikes, and subirrigation through tile lines. Managing the water table level controls droughtiness, decreases subsidence, and reduces soil blowing.

Severe losses can result from wind damage on this soil. Soil blowing causes the blowing out of newly seeded crops, reduces the thickness of the organic material, results in mechanical injury to growing crops, and fills in drainage ditches. Soil blowing can be further reduced by compacting the surface, irrigating, stripcropping, and using buffer strips and windbreaks. Windbreaks also provide nesting and cover areas for wildlife.

CAPABILITY UNIT IIs-2 (3a)

This unit consists of soils of the Fox and Miami series. These are level, well-drained soils. Their subsoil is medium or moderately fine textured, and the underlying material is coarse textured. Available moisture capacity and permeability are moderate. Runoff is slow, and hazard of erosion is slight because of the nearly level relief and the rapid movement of water into the soils. Fertility is moderate or moderately high.

Crops commonly grown in the county are suited to these soils, but soil moisture may not be adequate for crop growth during extreme drought. Soils in this unit are well suited to forage crops, especially to legumes and grasses that are adapted to well-drained sites.

The main needs in management are control of soil blowing, maintenance of fertility and organic matter, and conservation of moisture. These soils are easy to till over a wide range of moisture content, can be tilled early in spring, dry out quickly after rain, and warm up earlier in spring than finer textured soils. Surface crusting is seldom a problem, especially if minimum tillage is practiced and organic matter is plowed under.

The use of stripcropping and buffer strips of small grains helps to control erosion. Minimum tillage also helps to control erosion and to keep good tilth. The use of cover and green-manure crops adds organic matter to the soil and aids in the control of soil blowing. Plowing under barnyard manure and crop residue improves tilth and makes the soils absorb more water.

CAPABILITY UNIT IIIe-4 (1.5a)

Morley silt loam, 6 to 12 percent slopes, is the only soil in this unit. This is a well drained and moderately well drained, sloping soil that occurs mainly on uplands. The subsoil is moderately fine textured or fine textured, and the underlying material is moderately fine textured. Available moisture capacity is medium, and permeability is moderately slow. Runoff is rapid, and there is a risk of erosion. Fertility is moderately high, but tilth is poor.

Crops commonly grown in the county are moderately well suited to this soil. Corn, small grains, and mixtures of grasses and legumes are the main crops. The cropping system should include close-growing crops. Row crops do not grow so well on this soil as on less sloping soils because of the increased runoff.

The main needs in management are control of runoff and erosion, maintenance and improvement of tilth and organic-matter content, and renewal of fertility lost through erosion and cropping. Proper management includes use of diversion terraces and sodded waterways, crop rotation, minimum tillage, and application of lime and fertilizer as needed. Since most slopes are short and complex, however, it is difficult to lay out and farm contour strips and to construct diversion terraces.

Surface drains to remove excess water are needed in places, and tile drains can be used to remove excess water in seep areas, drainageways, and wet depressions. This soil crusts when it dries after heavy rainfall. This crusting makes it difficult for new seedlings to break through the surface, and a high mortality of desirable plants can result. Return of crop residue and green-manure crops reduces crusting, clodding, and evaporation of soil moisture. Crop residue also supplies organic matter, improves workability, and makes the soil more absorbent of water. A large amount of crop residue is needed on the eroded areas to increase the water infiltration rate and available moisture capacity.

CAPABILITY UNIT IIIe-5 (2.5a, 4/2a)

This unit consists of soils of the Celina, Metea, Miami, and Sisson series. These are moderately well drained and well drained soils of sloping or rolling uplands. The subsoil is moderately fine textured, and the underlying material is medium textured. Available moisture capacity is moderately high, and permeability is moderate or moderately slow. Water runs off rapidly when these soils are farmed intensively. Fertility is moderately high.

Crops commonly grown in the county are moderately well suited to these soils. Corn, small grains, and alfalfa are the main crops, but field beans and soybeans are also grown.

The main problems in management are erosion control and maintenance of organic-matter content and fertility. Winter cover crops, manure, and crop residue help maintain and improve organic-matter content and fertility, assure good tilth, and provide protection from erosion. Runoff is reduced by use of minimum tillage and interseeding of cover crops.

Row crops are grown successfully on these soils if fields are contour farmed or stripcropped. They are easy to cultivate, but layout of farm contour strips, terraces, and diversions is difficult because most slopes are short and complex.

Crop residue and green-manure crops, if returned to the soil, reduce crusting of the surface and evaporation of soil moisture, add organic matter, and make the soils easier to work and more absorbent of water. Large amounts of manure are especially helpful on eroded spots.

The areas in drainageways and depressions dry out slowly, and if they are tilled when wet, the surface may become compact and puddled. Some areas need surface drains to remove excess water. Tile drains help remove excess water in seep areas, drainageways, and wet depressions.

CAPABILITY UNIT IIIe–9 (4a, 4/2a)

This unit consists of soils of the Arkport, Boyer, Metea, Oakville, and Spinks series. These are well-drained, mainly coarse-textured, sloping and rolling soils of the uplands. The Boyer soil is underlain by stratified sand and gravel, and the Metea soil is underlain by medium-textured materials. Available moisture capacity is medium or moderately low. Permeability is moderate or moderately rapid, and runoff is medium. Organic matter content is moderately low, and fertility is medium or moderately low.

Crops commonly grown in the county are moderately well suited to these soils. Corn, wheat, and alfalfa are the main crops. Since small grains normally mature before there is a shortage of water, small-grain crops are more dependable than those that mature late in summer. Trees and pasture plants that resist drought are better suited to these soils than cultivated crops. Drought-resistant, deep-rooted forage plants are better suited than other kinds of plants.

The potential productivity of these soils for pine-tree plantations is moderately high. Suitable trees to plant are red pine, white pine, and Scotch pine. Plant competition is slight to moderate, and planted and natural stands of seedlings have very good survival. White-pine weevil and blister rust present slight management problems, but there are no serious problems from insects and disease. Hazard of windthrow is slight under normal wind and exposure conditions. These soils can be used for developing habitat for open-land and woodland wildlife.

When these soils are cultivated, the main problems in management are maintenance of organic-matter content and fertility, a shortage of moisture for crops during dry periods, soil blowing, and erosion. The Spinks and Metea soils are more droughty and susceptible to soil blowing than the other soils in this unit.

These sloping and rolling soils are subject to erosion if they are cultivated, especially if row crops are grown too often. Practices that help to control erosion under intensive use are minimum tillage, leaving residue on the surface, stripcropping, and sodding waterways. Contour stripcropping is not practical in areas that do not have long, uniform slopes. In these areas field stripcropping and planting of close-growing crops reduce erosion. Sodded waterways help carry surplus water along natural drains and from areas where water collects. Tile drains help to remove excess water from drainageways, seep areas, and wet depressions.

On these soils, frequent addition of crop residue, manure, and green manure is needed to maintain or improve organic-matter levels. Plowing under green-manure crops and crop residue also reduces evaporation of soil moisture, raises fertility, and increases available moisture content. Organic matter decomposes rapidly in these soils. Fairly frequent application of fertilizer is preferred because nutrients are readily lost through leaching. Large amounts of fertilizer and organic residue are needed in some eroded areas. Crops respond well to fertilizer when the supply of moisture is adequate.

These soils are easily tilled and can be cultivated over a wide range of moisture content without clodding. They can be worked early in spring and soon after rain, and warm earlier in spring than more silty and clayey soils.

CAPABILITY UNIT IIIw–5 (4b)

This unit consists of soils of the Minoa and Wasepi series and of the Spinks series, wet subsoil variant. These are nearly level, coarse-textured, somewhat poorly drained soils. The Minoa soils are underlain by sand, and soils of the Wasepi series and the Spinks series, wet subsoil variant, are underlain by stratified sand and gravel. Available moisture capacity is moderately low, permeability is moderately rapid, and runoff is slow. Organic-matter content is moderate, and fertility is moderately low. These soils are slightly acid.

Crops commonly grown in the county are suited to these soils if they are drained. Corn, soybeans, field beans, small grains, and alfalfa are the main crops. Unless they are artifically drained, these soils are limited for most crops and pasture plants grown in the county. Wetness can hamper or delay spring planting, spraying, and harvesting and makes weed control more difficult. During long drought small grains are relatively better suited than corn because they normally mature before there is a shortage of water.

Main problems in management are excess water in the subsoil, lack of moisture in the subsoil during dry years, and maintaining organic-matter content and fertility. These soils are artificially drained in some areas. Ditches generally must be dug to provide outlets because few natural outlets are available. Lack of suitable outlets in some areas makes ditches or tile drainage impractical. In these areas catch basins and sump pumps are used.

Tile lines installed in these soils are covered with straw or other porous material to prevent the sandy or silty material from flowing into the tile. Tile drains and open ditches should be installed during dry periods because the soil is unstable and caves in when wet.

Erosion is not a problem, because the soils take in water readily and there is little runoff. Diversion terraces are used in some areas to intercept runoff from adjacent higher slopes. Where soil blowing is a problem, stubble mulching, minimum tillage, and stripcropping can be used. Stripcropping is suitable on long, uniform slopes. Crop residue or green-manure crops should be returned to the soil to reduce evaporation of soil moisture, add organic matter, and allow the soils to absorb more water.

These soils are easily tilled and generally can be cultivated over a wide range of moisture content without clodding or crusting. Light and frequent application of fertilizer is sometimes more beneficial than heavy application because nutrients are lost through leaching.

CAPABILITY UNIT IIIw–6 (4c)

This unit consists of soils of the Gilford and Lamson series. These are moderately coarse textured, poorly drained or very poorly drained soils in nearly level depressions and drainageways. The Gilford soils are underlain by stratified sand and gravel, and the Lamson soils are underlain by very fine sand. Available moisture capacity is moderately low. Permeability is moderately rapid, but these soils have a high water table unless they are artificially drained. Runoff is very slow. Fertility is moderately low.

Crops commonly grown in the county are suited to these soils if they are drained. Corn, soybeans, small grains, and mixtures of legumes and grasses are the main crops, but some acreage is used for field beans and sod for lawns. Because of the high water table, these soils furnish good forage during July and August when upland pasture is generally poor. Pastures need to be limed and fertilized, and grazing should be controlled so that desirable legumes and grasses are maintained. Crops grown on these soils are damaged by early frost because of their low position.

The main needs in management are control of water and maintenance of fertility. Excess water on the surface and in the subsoil is a problem in cultivated areas. Water ponds in depressions and on flats after heavy rain, and even after the surface dries, the water table often remains close to the surface. When these soils are wet, farm machinery bogs down and spring planting, spraying, and harvesting are hampered or delayed.

Unless these soils are drained, they are limited for most crops and pasture plants grown in the county. Care must be used in providing artificial drainage to prevent excessive drainage. Natural outlets are few, and it is generally necessary to dig ditches to provide outlets. Open ditches also remove surface water and improve internal drainage. These ditches, however, require careful maintenance because they fill with sand that blows in or caves in from the banks. If tile drains are installed, they should be covered with straw or other material to keep sand from flowing into the tile.

Other management procedures include stripcropping to lessen the hazard of soil blowing, return of crop residue to the soil, light and frequent application of fertilizer to offset losses through leaching, and use of diversion terraces in some areas to intercept runoff from adjacent higher slopes.

CAPABILITY UNIT IIIw–9 (4/2b, 4/1b, 4/1c)

This unit consists of soils of the Allendale, Pinconning, and Selfridge series. These are somewhat poorly drained and poorly drained soils of nearly level, gently sloping, or undulating uplands. These soils are sandy to a depth of 18 to 42 inches, and below this they are moderately fine textured or fine textured. Permeability is moderately rapid in the sandy portion and moderately slow to slow in the underlying finer material. Available moisture capacity is moderately low or medium; runoff is slow or very slow; and fertility is moderately low or medium.

Crops commonly grown in the county are suited to these soils if they are drained. Corn, soybeans, small grains, and mixtures of legumes and grasses are the main crops, but field beans are also grown. Small fruits and truck crops do well on these soils, but irrigation is important for such high-value crops.

Row crops, such as corn, can be grown several years in succession without damage to the soils. It might be more practical, however, to include more years of small grains in the cropping system. Legumes can also be included and used for hay or as green manure. During drought small grains are generally better suited to these soils than corn because they normally mature before there is a shortage of water.

The main problems in management are excessive moisture in the subsoil, insufficient moisture supply after drainage, and maintaining organic-matter content and fertility. Soil blowing is also a problem where large areas of these soils are exposed by tillage.

Excess water is the main problem in cultivated areas. These soils are saturated in spring and after rain because of a seasonal high water table and moderately slowly or slowly permeable underlying material. Once the water table is lowered by drainage, however, the soils dry out quickly and easily support farm machinery that otherwise would bog down.

The soils of this unit are artificially drained in some places. Natural outlets are few, however, and it is generally necessary to dig ditches to provide outlets. Tile lines should be covered with straw or other porous material to prevent sand from flowing into the tile. Tile lines and open ditches are easier to install during dry periods because these soils are unstable and cave in when they are moist. Diversion terraces can be used in some areas to intercept runoff from adjacent higher slopes.

Light but frequent application of fertilizer is helpful because of losses through leaching. Crops respond well to fertilizer in years when the supply of moisture is favorable, but heavy application of fertilizer may not be profitable in dry years, because the soils lack the moisture needed to mature crops.

CAPABILITY UNIT IIIw-10 (4/2c)

Brevort loamy sand is the only soil in this unit. This is a poorly drained soil of nearly level depressions and drainageways. It is a sandy soil to a depth of 18 to 40 inches, and below this it is moderately fine textured. Available moisture capacity is low. Permeability is rapid in the sandy upper part of the soil and moderately slow in the finer textured lower part. Runoff is very slow or ponded. Fertility is low.

Crops commonly grown in the county are suited to this soil. Corn, soybeans, small grains, and mixtures of legumes and grasses are the main crops, but field beans are also grown. Row crops such as corn can be grown several years in succession without damage to the soil. It might be more practical, however, to include more years of small grains in the cropping system. Legumes can also be included and used for hay or green manure. Because this soil is in low places, crops grown on it are subject to frost damage.

The main problems in management are excess subsoil moisture in wet periods, moderately low moisture supply during dry periods, and maintenance of fertility. Light and frequent application of fertilizer is desirable because of losses through leaching.

This soil is saturated with water because of a high water table and the moderately slow permeability of the underlying material. When this soil is wet, farm machinery bogs down, and weed control, spring planting, spraying, and harvesting are hampered or delayed.

This soil is severely limited for most crops and pasture plants grown in the county unless it is artificially drained. It is drained in places, but since there are few natural outlets, ditches must be dug. In some areas drainage is impractical because suitable outlets are lacking. Where tile lines are installed, they must be covered with straw or other porous material to prevent sand from flowing into the tile. Tile lines and open ditches are easier to install during dry periods because this soil is unstable and caves in when it is moist. Diversion terraces can be used in some areas to intercept runoff from adjacent higher slopes.

After this soil is drained, it dries out quickly but becomes droughty during dry periods. It is easily tilled and can be cultivated over a wide range of moisture content without clodding or crusting. This soil warms up earlier in spring than more silty and clayey soils, and it generally can be worked early in spring and soon after rain.

CAPABILITY UNIT IIIw-11 (5c)

Granby loamy sand is the only soil in this unit. This is a dark, sandy, poorly drained, nearly level soil. If this soil is not drained, the water table is near the surface during wet seasons. This soil is rapidly permeable. Available moisture capacity is low. Organic-matter content is moderately high, and fertility is low.

This soil is generally poorly suited to row crops and is seldom cultivated. It is best suited to forage crops, and the selection of forage crops depends on the degree of wetness. This soil is occasionally intensively managed for sod production, and some vegetables and small fruits are grown.

The main problems in management are excessive wetness, low fertility, and soil blowing. Since most of this soil is in depressions, crops are subject to frost damage.

CAPABILITY UNIT IIIw-12 (L-2c)

This unit consists of soils of the Ceresco, Cohoctah, and Sloan series. These are somewhat poorly drained to very poorly drained soils of level bottom land that is subject to flooding. These soils formed in stratified water-laid material. They are dominantly moderately coarse textured, but they range to medium textured. Available moisture capacity is moderate to high, permeability is moderate, and runoff is very slow or ponded. Fertility is moderate to high.

Crops commonly grown in the county are suited to these soils if they are drained and flooding is prevented. Corn, soybeans, small grains, and mixtures of legumes and grasses are the main crops. Row crops can be grown continuously in areas of sufficient size. Crops are grown mainly in areas that border the Flint River in Montrose and Flushing Townships. In other areas the soils are in woodland and pasture.

The main problems in management are excess subsoil moisture, periodic flooding, especially in spring; frost hazard; lack of drainage outlets; and shape and size of the soil areas.

In many areas it is difficult to provide drainage because suitable outlets are lacking. Dredging of streams can improve drainage of some areas, and pumps and dikes can be used in other areas. Diversion terraces can be used to intercept runoff from uplands. Flooding, which occurs most commonly in spring, is best controlled by levees or similar structures.

Some narrow bottom land of meandering streams adjacent to other soils that are not suitable for cultivation is used for permanent hay or pasture, and some is wooded. Where the hazard of flooding or frost is not too serious, these soils are excellent for garden crops. It is helpful, however, to use frost-resistant plants.

The main need in management for pasture is to maintain a grass cover by proper seeding, liming, and fertilizing, and by regulated mowing or grazing. Spraying is sometimes necessary to eliminate weeds and woody plants, and the quality of the forage is improved by including legumes in the seeding. Rotation of grazing between alternate pastures helps to maintain the better pasture plants.

CAPABILITY UNIT IIIw-15 (Mc, M/3c)

This unit consists of soils of the Carlisle, Linwood, Lupton, Rifle, and Wallkill series. These are level, very poorly drained organic soils that formed from woody and fibrous plant materials. The Wallkill soil has a surface accumulation of loamy material, 10 to 40 inches thick, overlying a thick deposit of organic materials. Linwood soils are underlain by loamy mineral soil material at a depth of 12 to 42 inches. Available moisture capacity is high, and permeability is moderately rapid. Runoff is very slow or ponded. Organic-matter content is high. Fertility is generally low, but fertility of the Wallkill soil is moderately high.

These soils are used mainly for the commercial production of sod for lawns. The remaining acreage is in native grasses, brush, and trees. Many short-season, frost-resistant truck crops, including celery, carrots, and cabbage, are well suited if these soils are drained. The Lupton soils are too limy for good production of onions, spinach, lettuce, and soybeans. The reaction of all the soils, except the Rifle, is too high for good production of blueberries. Small grains tend to grow rank and to lodge before harvest.

The main problems in management are a high water table, low fertility, frost hazard, and soil blowing. Serious losses can result from wind damage to these soils. Soil blowing causes the blowing out of newly seeded crops, decreases the thickness of the organic layer, injures growing crops, and fills drainage ditches with drifting material. On the Wallkill soil, soil blowing is not a problem, because the mineral surface layer is less subject to blowing.

These soils are suitable for windbreaks and for development of wetland wildlife habitat. Planting of trees, except in windbreaks, is not practiced because of excess moisture and severe plant competition. Hazard of windthrow is very severe.

These soils must be drained before they can be cultivated intensively. The water table should be maintained at a height that insures the best yields and yet minimizes the thinning of the organic layer. Crops vary in their tolerance to excess water. A higher water table is tolerated in grassland farming areas than in areas used for specialty crops.

Water should be held at a level that will allow good growth of crops but avoid thinning of the organic layer through blowing and decomposition of the organic matter. The water level can be controlled in most areas by the use of dams, dikes, subirrigation through tile lines, and open-ditch drainage. Tile drainage is difficult to install in many areas because the organic materials do not provide a suitable foundation for tile lines. Drainage is not practical in some areas because of lack of suitable outlets.

These soils are generally low in phosphorus, potassium, and micronutrients such as manganese, boron, copper, molybdenum, and zinc. The amount and kind of fertilizer to apply depend on soil reaction and the crop to be grown. Lime is generally not required for these soils, but it might be needed for the Rifle soils.

Sprinkler irrigation is commonly used on these soils to increase yields, decrease soil blowing, aid the growth of young transplants, and provide frost protection. Soil blowing can also be reduced by compacting the surface, stripcropping, and using buffer strips and windbreaks.

CAPABILITY UNIT IIIs-3 (4a, 4/2a)

This unit consists of soils of the Arkport, Boyer, Metea, Oakville, Perrin, and Spinks series. These are well drained and moderately well drained soils of nearly level areas. All but the Metea soils have a moderately coarse textured subsoil underlain by coarse textured material. The Metea soils formed in coarse-textured deposits, 18 to 42 inches thick, that are underlain by medium-textured or moderately fine textured material. Available moisture capacity is moderate or moderately low, and permeability is moderate or moderately rapid. Erosion is slight because these soils take in water readily and have little runoff. Organic-matter content is moderately low.

Crops commonly grown in the county are moderately well suited to these soils. Corn, small grains, and mixtures of grasses and legumes are the main crops, but soybeans and field beans are also grown. Trees and pasture plants that resist drought are better suited than other kinds of plants. These soils are easily tilled and can be cultivated over a wide range of moisture content without clodding or crusting.

The main problems in management are maintaining organic-matter content and fertility, lack of moisture for crops during dry seasons, and soil blowing. The Oakville and Spinks soils are more droughty and susceptible to soil blowing than other soils in this unit. Practices that help control soil blowing under intensive use are minimum tillage, stubble mulching, and use of windbreaks. Trees suited for windbreaks on these soils include red pine, white pine, Norway spruce, and white spruce.

Potential productivity of these soils for pine plantations is moderately high. Plant competition is slight to moderate, and both planted and natural stands of seedlings have good survival. Insects and disease are not serious problems in managing soils of this unit, but white pine weevil and blister rust require some attention. Windthrow is slight under normal exposure to wind. These soils can also be used for developing open-land and woodland wildlife habitat.

Specialty crops, such as small fruits and vegetables grown under irrigation, are particularly well suited to these soils because they warm early in spring. Crops such as corn are adversely affected by lack of moisture in the subsoil. During drought, production of small grains is better than corn because small grains normally mature before there is a water shortage. Additional fertilizer helps increase yields if moisture is adequate, but heavy application of fertilizer is not profitable in some dry years, because the soils lack the moisture needed to mature crops. Supplemental irrigation may be needed for high-value crops.

Frequent additions of crop residue, manure, and green manure are needed to maintain the content of organic matter, which decomposes rapidly when these soils are intensively cultivated. Crop residue also reduces evaporation and makes the soils easier to work and more absorbent of water. Legumes need additional lime.

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CAPABILITY UNIT IIIs-4 (4a, 4/2a)

This unit consists of soils of the Arkport, Boyer, Metea, Oakville, Perrin, and Spinks series. These are well drained and moderately well drained, gently sloping or undulating soils of the uplands. Metea soils formed in coarse-textured deposits, 18 to 42 inches thick, underlain by medium or moderately fine textured material. The other soils have a moderately coarse textured subsoil that overlies coarse textured material. Available moisture capacity is moderate or moderately low, and permeability is moderate or moderately rapid. Since the slopes are gentle, runoff is slow and the hazard of erosion is slight. Fertility is moderate or moderately low.

Crops commonly grown in the county are suited to these soils, but crops that resist drought and mature early in the season do best. Corn, small grains, hay, and beans are the main crops.

The main problems in management are droughtiness, soil blowing, and maintaining organic-matter content and fertility. These soils are nearly saturated at the start of the growing season, but as the season progresses rainfall is not adequate to replenish the water used by plants. Yields are reduced during extreme drought. The Metea soil remains more moist than the other soils of this unit because its finer textured material restricts downward movement of water. These soils can be cultivated over a wide range of moisture content without clodding or crusting.

Potential productivity of these soils for pine plantations is moderately high. Plant competition is slight, and planted and natural stands of seedlings have good survival. Insects and disease are not serious management problems in these soils, but white pine weevil and blister rust do need attention. Windthrow is slight where the exposure to wind and the velocity of the wind are normal. These soils can also be used for developing open-land and woodland wildlife habitat.

Use of windbreaks, stripcropping, and minimum tillage helps control soil blowing. Trees suitable for windbreaks on these soils include red pine, white pine, Norway spruce, and white spruce. The Oakville and Spinks soils are more droughty and therefore more subject to soil blowing than the other soils of this unit.

Large additions of crop residue, manure, and green manure increase fertility and organic-matter content and make the soils absorb more water. Application of fertilizer increases yields if moisture is adequate, but heavy application of fertilizer may not be profitable in dry years because the soils lack the moisture needed to mature crops.

CAPABILITY UNIT IVe-4 (2.5a, 4/2a)

This unit consists of soils of the Miami and Metea series. These are well-drained soils of sloping and moderately steep uplands. The subsoil is moderately fine textured, and the underlying material is medium textured. Available moisture capacity is moderately high or moderate, permeability is moderate, and runoff is rapid. Organic-matter content is moderate. Most soils in this unit are medium in natural fertility.

The sloping soils in this unit have lost most of their original surface layer through erosion. These soils are lower in organic-matter content and fertility than the others. Runoff is more rapid, and available moisture capacity is lower. The present surface layer is difficult to keep in good tilth and tends to crust and dry out cloddy and hard. On these eroded soils, more organic matter is needed to improve workability and increase absorption of water.

Crops best suited to soils in this unit are small grains and mixtures of legumes and grasses. The soils are also well suited to trees and development for open-land and woodland wildlife habitat.

The soils of this group are generally too steep or eroded for row crops. If they are tilled, measures for control of runoff and erosion are needed. Runoff is reduced and organic-matter content maintained by using minimum tillage, crop-residue management, and interseeding of cover crops. Crop residue or green-manure crops should be returned. This reduces crusting and evaporation of soil moisture, adds organic matter, and makes the soils easier to work and more absorbent of water. Additional benefits are obtained by applying barnyard manure, especially to eroded areas. Sodded waterways are needed in some places to carry excess water along natural drains or to move it from areas where it collects.

CAPABILITY UNIT IVe-9 (4a)

This unit consists of soils of the Boyer, Oakville, and Spinks series. These are coarse-textured, well-drained soils of the moderately steep or hilly uplands. The Boyer soil is underlain by stratified sand and gravel. Available moisture capacity of the soils in this group is moderately low. Permeability is moderately rapid, and runoff is rapid. Organic-matter content is moderately low or low, and fertility is moderately low.

Small grains, hay, and pasture plants are suited to these soils. Oats, wheat, alfalfa, and some corn are now grown, and the remaining acreage is in pine plantations or remains idle. Row crops are severely limited in these soils because of droughtiness. Drought-resistant, deep-rooted forage and pasture plants are better suited than other kinds of plants.

Potential productivity of these soils for pine plantations is moderately high. Suitable trees for planting are red pine, white pine, and Scotch pine. Conifers are planted on the contour where practicable to help control runoff and erosion. Windthrow is not a problem under normal exposure to wind and normal wind velocity. These soils can be used for developing open-land and woodland wildlife habitat.

The main problems in management are maintenance of organic-matter content and fertility, lack of moisture for crops during dry seasons, and erosion. Manure, including large amounts of green manure, and crop residue help maintain organic-matter content and protect the soil from erosion. Frequent application of fertilizer helps reduce losses through leaching.

Overgrazing increases runoff and thus increases the hazard of erosion. Runoff can also be reduced, and organic-matter content maintained, by using minimum tillage and returning crop residue. Sodded waterways are difficult to establish and maintain on these soils.

Crops do not grow well because much of the water runs off and little is stored in the soils.

CAPABILITY UNIT IVw-2 (5b)

This unit consists of two soils of the Au Gres series. These are sandy, somewhat poorly drained soils that are level to gently sloping. Au Gres loamy sand, loamy substratum, 0 to 6 percent slopes, is underlain at a depth of 42 to 66 inches by medium-textured to fine-textured material. Available moisture capacity for both soils is low, permeability is rapid, and runoff is slow or very slow. Organic-matter content is moderately low.

Except for small grains and hay, these soils are poorly suited to cultivated crops. Some corn and soybeans are grown in years of above-average rainfall, however, and blueberries grow well on the strongly acid areas in the northern part of the county.

Potential productivity of these soils is medium for pine, low for spruce, and low for mixed hardwoods. Suitable trees to plant are Austrian pine and white pine. Planting may require special techniques and a considerable amount of replanting, and plant competition may slow the initial growth rate. Windthrow is slight. These soils can be used for developing habitat for open-land and woodland wildlife.

The main problems in management are droughtiness, especially on the gently sloping soils; soil blowing; excess subsoil moisture; and maintaining organic-matter content and fertility. Organic-matter content and fertility are difficult to maintain because the soils are sandy, but they can be worked earlier in spring than more silty and clayey soils, and roots penetrate easily and deeply. These soils, however, generally do not produce satisfactorily without irrigation.

Wetness severely limits choice of crops and pasture plants grown in the county and hampers weed control, spring planting, spraying, and harvesting. These soils are therefore artificially drained in some areas. Tile lines and open ditches are used for drainage. Generally it is necessary to dig ditches to provide outlets. Open ditches normally do not hold their shape, however, and since their sides continually cave in, tile drains are difficult to install except during dry periods. Where tile drains are installed, they should be covered with straw or other porous material to prevent sand from flowing into the tile. When these soils are drained, they can easily be cultivated over a wide range of moisture content without clodding or crusting.

CAPABILITY UNIT IVw-5 (M/4c)

Markey muck is the only soil in this unit. This is a very poorly drained, nearly level soil. It formed in organic material underlain by sand at a depth of 12 to 42 inches. Available moisture capacity is high, permeability is moderately rapid, and runoff is very slow or ponded. Organic-matter content is high. The sandy material underlying the Muck is droughty and low in fertility.

Crops commonly grown in the county are suited to this soil if it is adequately drained and soil blowing is controlled. Corn and soybeans can be grown, but small grains grow rank and tend to lodge because of the high nitrogen content of the organic material. If this soil is drained, and its organic layer is thick enough, it is well suited to such short-season, frost-resistant truck crops as celery, carrots, and cabbage, especially when it is irrigated. In places this soil is too limy for good production of onions, spinach, lettuce, soybeans, and blueberries. Many areas are too small or irregular in shape for practical farming.

Planting of trees, except in windbreaks, is not practical because of excess moisture, severe plant competition, and very severe hazard of windthrow. This soil is suitable as a site for developing wetland wildlife habitat.

The main problems in management are soil blowing, low fertility, a high water table, frost hazard, and droughtiness. Control of soil blowing is important because the organic materials are shallow. Newly seeded crops are blown out, drainage ditches are filled, and yields are reduced when the sandy material is exposed. Soil blowing is reduced by compacting the surface, leaving crop residue on or near the surface, stripcropping, growing cover crops where possible, and using windbreaks and buffer strips. Windbreaks also provide nesting and cover areas for wildlife.

Unless this soil is fertilized, it is usually low in phosphorus, potassium, and micronutrients such as manganese, boron, copper, molybdenum, and zinc. Lime is generally not required. Sprinkler irrigation generally can be used to decrease soil blowing, as well as to aid the growth of young transplants and provide frost protection.

Artificial drainage is necessary on this soil if it is to be cultivated intensively. Proper tile spacing is determined by investigating the areas to be drained to determine the average depth to the sandy underlying material. Tile lines installed in the sandy materials should be covered with straw or other porous material to prevent sand from flowing into the tile. Since the sandy materials cave in when wet, open ditches should be dug during dry periods. Open ditches may need periodic cleanout because of this cave-in hazard. Tile drains can be a problem if they are laid in the organic layer, as this material is not a suitable foundation for tile lines.

A higher water table is tolerated in grassland farming areas than in areas used for specialty crops. Farm machinery easily bogs down when this soil is wet, and weed control, spraying, planting, and harvesting are hampered or delayed unless the water table is lowered. The water table can be controlled by the use of dams, dikes, subirrigation by tile line, and open-ditch drainage. It should be maintained at a height that allows good growth of plants and yet reduces subsidence of the organic matter. Drainage is not always practical, however, because of lack of suitable outlets. In such areas catch basins and sump pumps can be used.

Frost damage is reduced by selecting frost-resistant plants, providing good air drainage, and applying large amounts of potash. Other measures for reducing frost damage are the use of smudge pots and heaters and the mechanical stirring of air.

CAPABILITY UNIT IVw-6 (M/mc)

Edwards muck is the only soil in this unit. This is a level, very poorly drained organic soil. The surface is muck, and the subsoil is mucky peat or peat underlain by marl at a depth of 12 to 42 inches. Available moisture capacity is high. Permeability is variable because of differences in the marl. Fertility is moderate to moderately low, organic-matter content is high, and soil reaction is neutral to moderately alkaline. The water table is at the surface during part of the year.

The deeper organic areas of this soil are suitable for vegetables and row crops. Many short-season, frost-resistant truck crops can be grown if the soil is drained. Frost-resistant crops include celery, carrots, and cabbage. This soil is generally too limy for good production of onions, spinach, lettuce, soybeans, wheat, and blueberries. Forage crops are moderately well suited if the types of plants are carefully selected to suit the wetness of the soil. Grazing should be delayed during wet periods.

The main problems in management are a high water table; soil blowing; hazard of frost; and the undesirable physical and chemical properties of the underlying marl, which result in some nutrient deficiencies. Application of sulfur to increase acidity of the soil is not practical where free lime is abundant.

Areas where the marl is near the surface should be left in permanent pasture or trees. Planting of trees, except in windbreaks, is not practical because of excess moisture and severe plant competition. Hazard of windthrow is severe. This soil is suitable for windbreaks and development of wetland wildlife habitat.

Soil blowing can severely damage this soil by blowing out newly seeded crops and reducing the thickness of the organic material. In addition, drainage ditches are filled by drifting soil material.

CAPABILITY UNIT IVs-2 (5a, 5/2a)

This unit consists of soils of the Croswell and Oakville series. These are moderately well drained or well drained soils that are coarse textured to a depth of 42 inches or more. Available moisture capacity is low, and permeability is rapid. Little water runs off these soils because they are sandy in texture and level to moderately sloping. Fertility is low.

The main crops on these soils are small grains; mixtures of legumes and grasses; fruits, such as apples and cherries; and small fruits, such as raspberries. Fruit is grown in areas bordering the Flint River, mainly in Flushing and Montrose Townships.

The main problems in management are control of soil blowing, low available moisture in the subsoil, and low fertility. Soil moisture is rarely adequate for good crop growth, especially in dry summer months. For this reason trees, such as pine, and drought-resistant, deep-rooted forage and pasture plants are better suited to these soils than row crops unless irrigation is used. Supplemental irrigation should be provided if practicable.

Potential productivity of these soils is moderate to high for pines and low to very low for spruce. Suitable trees to plant are red pine, white pine, and Scotch pine. Forest plantations on these soils present no special problems, and losses resulting from soil influences are estimated at less than 25 percent. Plant competition is slight. Problems from forest pests and disease are slight or moderate, and sawfly damage and white pine blister rust can, in some cases, retard the normal growth of conifers. Windthrow is not a problem under normal wind and exposure conditions. These soils can be used to develop wildlife habitat.

The soils of this unit need large and frequent additions of crop residue and manure, including green manure, to maintain content of organic matter, which decomposes rapidly in these soils. Crop residue or green manure should be kept near the surface by minimum tillage or stubble mulching. This reduces evaporation of soil moisture, helps control erosion, and makes these soils easier to work and more absorbent of water.

CAPABILITY UNIT VIe-2 (2.5a)

This unit consists of soils of the Miami series. These are well-drained, moderately steep or steep soils. The subsoil is moderately fine textured, and the underlying material is medium textured. Available moisture capacity is moderately high, and permeability is moderate. Very rapid runoff has eroded some soils in this unit.

These soils are well suited to grass and trees and to the development of wildlife habitat. Their potential productivity is high for spruce and fir plantations and low for pine plantations. Some replanting is usually needed in establishing plantations, and trees should be planted on the contour as much as is practical to control erosion. Problems from pests and disease are few, and windthrow is slight. Some small grains and mixtures of legumes and grasses are also grown.

The main need in management is to maintain a protective cover at all times. Such practices as proper seeding or planting and regulated mowing and grazing are effective in regulating runoff and controlling erosion. The steep slopes limit the use of farm machinery and are subject to severe erosion when cultivated. The eroded soils are in poor tilth and crust readily when they dry. Fertility is generally moderately high, but on eroded soils it is low. Organic-matter content is moderate in the less eroded soils and low in the eroded soils.

CAPABILITY UNIT VIIIs-1 (Sa)

This unit consists of Borrow pits, Gravel pits, Made land, and Lake beaches. These are miscellaneous land types that generally are not suitable for farming. Borrow pits and Gravel pits are land from which soil material, sand, and gravel have been removed for use as fill. Some Borrow pits contain water and therefore have some potential for recreational uses or as a limited source of water.

Made land consists of areas that have been covered with fill material of variable composition or of areas in which the soil profile has been destroyed. Most areas of Made land are in commercial or residential uses and are not available for farming.

Lake beaches are severely limited for farming. They are very low in fertility, very droughty, and highly erodible. This land type is best suited to recreational and esthetic purposes.

Predicted Yields

The soils of Genesee County vary considerably in productivity. Some consistently produce high yields of cultivated crops; others are better suited to less intensive uses because of soil limitations or erosion hazard. The predicted average acre yields of the principal crops grown in the county are given in table 2 for each soil under two levels of management.

In columns A are average yields obtained under the management that was common in the county when the survey was made. Some mixtures of legumes and grasses are grown in crop rotations, but little consideration is given to the suitability of the rotation for the soil. Barnyard manure produced on the farm is returned to the soil. Lime is applied, but usually not in sufficient amounts, and some fertilizer is used. Poorly drained areas are worked while they are wet, and often only a partial crop is harvested because of excess water. Proper soil management and erosion control practices are not used to the fullest advantage.

In columns B are yields obtained under improved management. Under this management the crop rotation is adapted to the soil, and the proper proportion of row crops to legume and grass crops is maintained. The rotation is supplemented by measures to control soil blowing and erosion. Other measures used are contour tillage, stripcropping, and minimum tillage. Cover crops, crop residue, and manure are returned to improve soil structure, supply organic matter, and control erosion. The amount of lime and fertilizer applied is determined by soil tests. Improved varieties of plants and high-quality seeds are used. Weed, disease, and insect control is practiced. Suitable methods and proper timing of tillage and harvesting are used.

The crop yields listed are those that can be expected over a period of several years under the two defined levels of management. The yields under improved management are not presumed to be the maximum obtainable. Potential yields per acre are somewhat higher, especially where there is a favorable combination of soil, plant, and weather conditions.

Wildlife[3]

In table 3 the soils of the county are rated according to their suitability for elements of wildlife habitat and according to their suitability as habitat for openland, woodland, and wetland wildlife. In this table, each soil is rated *slight, moderate, severe,* or *very severe* in its limitation for each habitat element.

[3] By CHARLES M. SMITH, biologist, United States Department of Agriculture, Soil Conservation Service.

The following gives examples of plants in the plant categories in table 3 and tells something about the properties of soils suitable for water developments.

Grain and seed crops.—These include corn, wheat, oats, rye, soybeans, sorghum, buckwheat, and field beans.

Grasses and legumes.—These include planted grasses and legumes commonly used for forage. Species for wildlife are alfalfa, clover, bromegrass, and sudangrass.

Wild herbaceous upland plants.—These include annual or other herbaceous plants that commonly grow in uplands. Examples are strawberries, dandelion, goldenrod, mullein, burdock, milkweed, lambsquarters, and wild grasses.

Hardwood woody plants.—These include hardwood trees and shrubs that produce vigorous growth and heavy crops of fruit or seed and that either grow naturally or are planted. Examples are maple, birch, oak, poplar, dogwood, wild cherry (choke), thornapple, raspberry, wild grape, sumac, multiflora rose, autumn-olive, blackberry, and viburnum, including cranberry, nannyberry, arrowwood, and wild raisin.

Coniferous woody plants.—These include native or planted coniferous trees and shrubs. Examples are white, Scotch, and Austrian pine; white and Norway spruce; and eastern redcedar.

Wetland food and cover plants.—These include wetland plants that provide food and cover for waterfowl and furbearing animals. Examples are cattail, sedge, arrowhead, bulrush, burreed, and pondweed, mainly waterplantain and other microscopic forms.

Shallow water developments.—These include impoundments in which shallow water can be maintained at a desired level. Examples are level ditches and possibly shallow dugouts.

Excavated ponds.—These include ponds of the excavated or dugout type. Migrating waterfowl are especially attracted to such ponds. These must not depend on runoff from surrounding areas, although they may be benefited by such runoff if it is not excessive and does not cause too much silting in.

The following defines and gives examples of wildlife in the three wildlife classes. In table 3, the soils of the county are rated *good, fair, poor,* or *unsuited* to these three classes of wildlife.

Open-land wildlife.—Birds and mammals that normally frequent cropland, pasture, meadow, and areas supporting grasses, herbs, and shrubs. Examples are quail, pheasants, meadowlarks, field sparrows, hawks, foxes, cottontail rabbits, woodchucks, field mice, and songbirds such as robins, cardinals, blue jays, and black-capped chickadees.

Woodland wildlife.—Birds and mammals that normally frequent wooded areas of hardwood trees, coniferous trees, shrubs, or mixtures of such plants. Examples are woodpeckers, warblers, nuthatches, owls, squirrels, raccoons, and white-tailed deer.

Wetland wildlife.—Birds and mammals that normally frequent such wet areas as ponds, marshes, and swamps. Examples are ducks, geese, herons, killdeer, and bitterns.

TABLE 2.—*Predicted average acre yields for 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.[1] Absence of an entry indicates soil is not suited to the crop or that the crop ordinarily is not grown. Borrow pits (Bp), Gravel pits (Gr), Lake beaches (La), and Made land (Md) are omitted from this table]

Soil	Corn (grain)		Corn (silage)		Oats		Wheat		Alfalfa or alfalfa-brome hay		Soybeans	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*
Arkport loamy fine sand, 0 to 2 percent slopes	45	85	8	14	45	65	30	40	2.2	3.5	16	24
Arkport loamy fine sand, 2 to 6 percent slopes	45	85	8	14	45	65	30	40	2.2	3.5	16	24
Arkport loamy fine sand, 6 to 12 percent slopes	40	80	7	13	40	60	25	35	2.2	3.5	14	21
Au Gres loamy sand, 0 to 6 percent slopes	25	45	4	8	20	40	16	25	1.3	2.1	--	--
Au Gres loamy sand, loamy substratum, 0 to 6 percent slopes	25	45	4	8	20	40	16	25	1.3	2.1	--	--
Boyer loamy sand, 0 to 2 percent slopes	35	65	6	11	30	50	25	40	2.0	3.0	--	--
Boyer loamy sand, 2 to 6 percent slopes	35	65	6	11	30	50	25	40	2.0	3.0	--	--
Boyer loamy sand, 6 to 12 percent slopes	32	60	5	10	27	45	20	35	2.0	3.0	--	--
Boyer loamy sand, 12 to 18 percent slopes	30	55	5	9	24	40	18	30	2.0	3.0	--	--
Breckenridge-Brevort complex	40	75	7	13	40	60	25	40	1.5	3.1	--	--
Brevort loamy sand	25	65	4	10	25	45	15	30	1.2	2.2	--	--
Brookston loam	60	110	11	18	50	80	30	55	2.5	5.0	25	40
Carlisle muck	60	110	11	18	--	--	--	--	--	--	--	--
Carlisle and Linwood mucks	60	100	11	17	--	--	--	--	--	--	--	--
Celina loam, 6 to 9 percent slopes	50	80	9	13	45	70	32	40	2.3	3.8	18	27
Celina-Conover loams, 0 to 2 percent slopes	55	95	10	16	55	75	35	45	3.0	4.5	20	30
Celina-Conover loams, 2 to 6 percent slopes	55	95	10	16	55	75	35	45	3.0	4.5	20	30
Celina-Owosso sandy loams, 2 to 6 percent slopes	50	85	9	14	45	70	32	40	2.6	4.0	18	27
Ceresco fine sandy loam	--	--	--	--	--	--	--	--	--	--	--	--
Cohoctah silt loam	--	--	--	--	--	--	--	--	--	--	--	--
Colwood silt loam	50	110	9	18	50	80	30	55	2.5	5.0	25	40
Conover loam, 0 to 2 percent slopes	60	100	11	17	55	80	35	55	2.7	5.0	23	35
Conover loam, 2 to 6 percent slopes	60	100	11	17	55	80	35	55	2.7	5.0	23	35
Conover-Metamora sandy loams, 0 to 2 percent slopes	55	95	10	16	50	75	32	50	2.5	4.5	20	30
Conover-Metamora sandy loams, 2 to 6 percent slopes	55	95	10	16	50	75	32	50	2.5	4.5	20	30
Croswell sand, 0 to 6 percent slopes	30	55	5	9	30	50	20	30	1.2	2.3	--	--
Del Rey sandy loam, 0 to 2 percent slopes	55	90	9	14	50	80	35	45	2.5	4.2	20	35
Del Rey silt loam, 0 to 2 percent slopes	55	90	10	15	50	80	35	45	2.5	4.2	20	35
Del Rey silt loam, 2 to 6 percent slopes	55	90	10	15	50	80	35	45	2.5	4.2	20	35
Edwards muck	50	90	9	15	--	--	--	--	--	--	--	--
Fox sandy loam, 0 to 2 percent slopes	50	85	9	14	45	70	30	40	2.5	4.0	20	30
Fox sandy loam, 2 to 6 percent slopes	50	85	9	14	45	70	30	40	2.5	4.0	20	30
Gilford sandy loam	40	75	7	12	35	50	22	35	1.8	3.0	20	30
Granby loamy sand	25	65	4	11	25	45	15	30	1.2	2.2	14	22
Kibbie fine sandy loam, 0 to 2 percent slopes	55	95	10	16	55	80	35	55	2.8	5.0	23	35
Kibbie fine sandy loam, 2 to 6 percent slopes	55	95	10	16	55	80	35	55	2.8	5.0	23	35
Lamson loamy fine sand	45	95	8	16	40	70	25	45	2.3	3.5	20	30
Landes fine sandy loam	45	85	8	14	45	65	--	--	2.2	3.5	18	26
Lenawee silty clay loam	50	100	9	17	45	80	30	55	2.0	5.0	25	38
Linwood muck	60	90	11	15	--	--	--	--	--	--	--	--
Lupton muck	60	110	11	18	--	--	--	--	--	--	--	--
Markey muck	50	95	9	16	--	--	--	--	--	--	--	--
Metamora sandy loam, 0 to 2 percent slopes	50	85	9	14	45	70	30	50	2.2	4.0	20	30
Metamora sandy loam, 2 to 6 percent slopes	50	85	9	14	45	70	30	50	2.2	4.0	20	30
Metea loamy sand, 0 to 2 percent slopes	30	60	5	10	30	50	20	30	1.5	2.3	16	24
Metea loamy sand, 2 to 6 percent slopes	30	60	5	10	30	50	20	30	1.5	2.3	16	24
Metea loamy sand, 6 to 12 percent slopes	27	54	5	10	27	45	18	27	1.5	2.3	14	21
Miami loam, 2 to 6 percent slopes	55	95	10	16	55	75	35	45	3.0	4.5	18	27
Miami loam, 6 to 12 percent slopes	40	75	7	13	40	65	25	35	2.3	3.5	14	24
Miami loam, 12 to 18 percent slopes	35	70	6	12	35	60	22	33	2.3	3.5	--	--
Miami loam, 18 to 25 percent slopes	--	--	--	--	--	--	--	--	1.5	2.5	--	--
Miami clay loam, 6 to 12 percent slopes, eroded	30	50	5	9	25	50	20	30	2.0	3.0	--	--
Miami clay loam, 12 to 18 percent slopes, eroded	--	--	--	--	--	--	--	--	1.5	2.5	--	--

Miami clay loam, 18 to 25 percent slopes, eroded	--	--	--	--	--	--	--	--	--	--	--	--	--
Miami sandy loam, sandy substratum, 0 to 2 percent slopes	50	85	9	14	45	70	30	40	2.5	4.0	20	30
Miami-Metea complex, 2 to 6 percent slopes	45	75	8	13	45	65	30	40	2.2	3.4	18	26
Miami-Metea complex, 6 to 12 percent slopes	35	65	6	11	35	55	22	33	2.0	3.0	14	23
Miami-Metea complex, 12 to 18 percent slopes	30	60	5	10	30	50	20	30	2.0	3.0	--	--
Minoa loamy fine sand, 0 to 2 percent slopes	50	85	9	14	40	75	25	45	2.0	3.5	20	30
Morley silt loam, 2 to 6 percent slopes	50	75	9	13	50	70	30	45	2.2	3.5	16	25
Morley silt loam, 6 to 12 percent slopes	45	70	8	12	45	68	28	42	2.0	3.0	14	23
Oakville fine sand, 0 to 6 percent slopes	20	40	3	7	17	33	12	23	1.2	2.0	--	--
Oakville fine sand, 6 to 12 percent slopes	--	--	--	--	15	30	10	20	1.2	2.0	--	--
Oakville fine sand, loamy substratum, 0 to 6 percent slopes	25	45	4	8	20	35	15	25	1.4	2.2	--	--
Perrin loamy sand, 0 to 2 percent slopes	45	75	8	13	45	65	30	50	2.1	3.5	16	24
Perrin loamy sand, 2 to 6 percent slopes	45	75	8	13	45	65	30	50	2.1	3.5	16	24
Pinconning-Allendale loamy fine sands, 0 to 2 percent slopes	30	65	5	11	30	55	20	40	1.8	3.0	--	--
Rifle muck	--	--	--	--	--	--	--	--	--	--	--	--
Sebewa loam	55	80	10	13	45	70	25	45	2.0	3.5	25	38
Selfridge loamy sand, 0 to 2 percent slopes	40	65	7	11	35	60	25	40	2.0	3.0	18	26
Selfridge loamy sand, 2 to 6 percent slopes	40	65	7	11	35	60	25	40	2.0	3.0	18	26
Sisson fine sandy loam, 2 to 6 percent slopes	55	95	10	17	55	75	35	45	3.0	4.5	23	35
Sisson fine sandy loam, 6 to 12 percent slopes	45	85	8	14	45	70	30	40	3.0	4.0	20	32
Sloan silt loam	--	--	--	--	--	--	--	--	--	--	--	--
Sloan silt loam, occasionally flooded	60	100	10	17	50	80	30	50	3.0	5.0	25	38
Spinks loamy sand, wet subsoil variant, 0 to 2 percent slopes	25	50	7	11	25	45	20	30	1.2	2.2	--	--
Spinks-Oakville loamy sands, 0 to 2 percent slopes	25	50	4	9	25	45	18	28	1.2	2.2	--	--
Spinks-Oakville loamy sands, 2 to 6 percent slopes	25	50	4	9	25	45	18	28	1.2	2.2	--	--
Spinks-Oakville loamy sands, 6 to 12 percent slopes	20	45	3	7	20	40	15	25	1.2	2.2	--	--
Spinks-Oakville loamy sands, 12 to 18 percent slopes	20	40	3	6	15	30	13	22	1.0	2.0	--	--
Tuscola silt loam, 0 to 2 percent slopes	55	95	10	17	55	75	35	45	3.0	4.5	23	35
Tuscola silt loam, 2 to 6 percent slopes	55	95	10	17	55	75	35	45	3.0	4.5	23	35
Wallkill silt loam	70	95	13	17	--	--	--	--	--	--	--	--
Wasepi sandy loam, 0 to 2 percent slopes	50	80	9	13	45	60	25	40	2.0	3.0	18	26
Wasepi sandy loam, loamy substratum, 0 to 2 percent slopes	55	90	10	15	50	70	30	50	2.2	4.0	20	30

[1] Irrigation is not considered to be a part of improved management, since its use is limited mainly to the production of truck and fruit crops.

TABLE 3.—*Limitations of soils for elements of wildlife*

[Because Borrow pits (Bp), Gravel pits (Gr), Lake beaches (La),

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Grass and legumes	Wild herbaceous upland plants	Hardwood woody plants
Allendale Mapped only with Pinconning series.	Moderate	Moderate	Slight	Moderate
Arkport: ArA, ArB, ArC	Moderate	Slight	Slight	Slight
Au Gres: AsB, AuB	Very severe	Severe	Severe	Severe
Boyer:				
On slopes of 0 to 12 percent: BrA, BrB, BrC.	Moderate	Slight	Slight	Slight
On slopes of 12 to 18 percent: BrD	Severe	Moderate	Slight	Slight
Breckenridge: Bt For Brevort part of Bt, see Brevort series.	Severe	Moderate	Moderate	Moderate
Brevort: Bv	Severe	Moderate	Moderate	Moderate
Brookston: Bw	Severe	Moderate	Moderate	Moderate
Carlisle: Cc, Cd For Linwood part of Cd, see Linwood series.	Very severe	Severe	Severe	Severe
Celina:				
On slopes of 0 to 6 percent: ClA, ClB, CmB.	Slight	Slight	Slight	Slight
On slopes of 6 to 9 percent: CeC For Conover part of ClA, and ClB, see Conover series; and for Owosso part of CmB, see Owosso series.	Moderate	Slight	Slight	Slight
Ceresco: Cn	Moderate	Moderate	Slight	Moderate
Cohoctah: Co	Severe	Moderate	Moderate	Moderate
Colwood: Cp	Severe	Moderate	Moderate	Moderate
Conover: CvA, CvB, CwA, CwB For Metamora part of CwA and CwB, see Metamora series.	Moderate	Moderate	Slight	Moderate
Croswell: CxB	Very severe	Severe	Severe	Severe
Del Rey: DlA, DrA, DrB	Moderate	Moderate	Slight	Moderate
Edwards: Ed	Very severe	Severe	Severe	Severe
Fox: FoA, FoB	Slight	Slight	Slight	Slight
Gilford: Gd	Severe	Moderate	Moderate	Moderate
Granby: Gm	Very severe	Severe	Severe	Severe
Kibbie: KfA, KfB	Moderate	Moderate	Slight	Moderate
Lamson: Lb	Severe	Moderate	Moderate	Moderate
Landes: Ld	Moderate	Slight	Slight	Slight
Lenawee: Le	Severe	Moderate	Moderate	Moderate
Linwood: Lm	Very severe	Severe	Severe	Severe
Lupton: Lu	Very severe	Severe	Severe	Severe
Markey: Mk	Very severe	Severe	Severe	Severe
Metamora: MlA, MlB	Moderate	Moderate	Slight	Moderate
Metea: MnA, MnB, MnC	Moderate	Slight	Slight	Slight

habitat and suitability for kinds of wildlife

and Made land (Md) are variable, their limitations are not listed]

Elements of wildlife habitat—Continued				Kinds of wildlife		
Coniferous woody plants	Wetland food and cover plants	Shallow water developments	Excavated ponds	Open-land	Woodland	Wetland
Severe	Moderate	Moderate	Moderate	Good	Fair	Fair.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Slight	Severe	Moderate	Moderate	Poor	Poor	Poor.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Severe	Very severe	Very severe	Very severe	Fair	Fair	Unsuited.
Moderate	Slight	Slight	Slight	Fair	Fair	Good.
Moderate	Slight	Slight	Slight	Fair	Fair	Good.
Moderate	Slight	Slight	Slight	Fair	Fair	Good.
Slight	Slight	Slight	Slight	Poor	Poor	Good.
Severe	Severe	Severe	Severe	Good	Good	Poor.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Severe	Moderate	Moderate	Moderate	Good	Fair	Fair.
Moderate	Slight	Severe	Severe	Fair	Fair	Fair.
Moderate	Slight	Slight	Slight	Fair	Fair	Good.
Severe	Moderate	Moderate	Moderate	Good	Fair	Fair.
Slight	Very severe	Very severe	Very severe	Poor	Poor	Unsuited.
Severe	Moderate	Moderate	Moderate	Good	Fair	Fair.
Slight	Slight	Slight	Slight	Poor	Poor	Good.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Moderate	Slight	Slight	Slight	Fair	Fair	Good.
Slight	Very severe	Slight	Slight	Poor	Poor	Poor.
Severe	Moderate	Moderate	Moderate	Good	Fair	Fair.
Moderate	Slight	Slight	Slight	Fair	Fair	Good.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Moderate	Slight	Slight	Slight	Fair	Fair	Good.
Slight	Slight	Slight	Slight	Poor	Poor	Good.
Slight	Slight	Slight	Slight	Poor	Poor	Good.
Slight	Slight	Slight	Slight	Poor	Poor	Good.
Severe	Moderate	Moderate	Moderate	Good	Fair	Fair.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.

TABLE 3.—*Limitations of soils for elements of wildlife*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Grass and legumes	Wild herbaceous upland plants	Hardwood woody plants
Miami:				
On slopes of 0 to 6 percent: MoB, MsA, MtB.	Slight	Slight	Slight	Slight
On slopes of 6 to 12 percent: MoC, MpC2, MtC.	Moderate	Slight	Slight	Slight
On slopes of 12 to 25 percent: MoD, MoE, MpD2, MpE2, MtD.	Severe	Moderate	Slight	Slight
For Metea part of MtB, MtC, and MtD, see Metea series.				
Minoa: MuA	Moderate	Moderate	Slight	Moderate
Morley:				
On slopes of 2 to 6 percent: MvB	Slight	Slight	Slight	Slight
On slopes of 6 to 12 percent: MvC	Moderate	Slight	Slight	Slight
Oakville: OaB, OaC, OkB	Very severe	Severe	Severe	Severe
Owosso:	Slight	Slight	Slight	Slight
Mapped only with Celina series.				
Perrin: PeA, PeB	Moderate	Slight	Slight	Slight
Pinconning: PnA	Severe	Moderate	Moderate	Moderate
For Allendale part of PnA, see Allendale series.				
Rifle: Rf	Very severe	Severe	Severe	Severe
Sebewa: Se	Severe	Moderate	Moderate	Moderate
Selfridge: SdA, SdB	Moderate	Moderate	Slight	Moderate
Sisson:				
On slopes of 2 to 6 percent: SfB	Slight	Slight	Slight	Slight
On slopes of 6 to 12 percent: SfC	Moderate	Slight	Slight	Slight
Sloan: Sm, Sn	Severe	Moderate	Moderate	Moderate
Spinks, wet subsoil variant: SpA	Moderate	Moderate	Slight	Moderate
Spinks:				
On slopes of 0 to 12 percent: SvA, SvB, SvC.	Moderate	Slight	Slight	Slight
On slopes of 12 to 18 percent: SvD	Severe	Moderate	Slight	Slight
For Oakville part of SvA, SvB, SvC, and SvD, see Oakville series.				
Tuscola: TsA, TsB	Slight	Slight	Slight	Slight
Wallkill: Wa	Very severe	Severe	Severe	Severe
Wasepi: WeA, WpA	Moderate	Moderate	Slight	Moderate

The ratings for kinds of wildlife indicate in a general way the places where it is most feasible to manage habitats and where prospects for the success of the wildlife members of the group are most satisfactory. The ratings also indicate the intensity of habitat management necessary for producing wildlife in a given group. A rating of *poor,* for example, indicates that intensive management is required.

Present land use, existing vegetation, and degree of artificial drainage are not considered in the rating system because they are subject to change. Neither is the ability of wildlife to move from place to place considered, since the rating applies to habitat and not specifically to wildlife species. Also, the soils are rated without considering their position in relation to adjoining soils.

Engineering Uses of the Soils

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for water storage, erosion control structures, drainage systems, and sewage disposal systems. Among the properties most important to engineers are permeability, shear strength, compaction *habitat and suitability for kinds of wildlife*—Continued

Elements of wildlife habitat—Continued				Kinds of wildlife		
Coniferous woody plants	Wetland food and cover plants	Shallow water developments	Excavated ponds	Open-land	Woodland	Wetland
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Severe	Very severe	Very severe	Very severe	Fair	Fair	Unsuited.
Severe	Moderate	Moderate	Moderate	Good	Fair	Fair.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Slight	Very severe	Very severe	Very severe	Poor	Poor	Unsuited.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Moderate	Slight	Slight	Slight	Fair	Fair	Good.
Slight	Slight	Slight	Slight	Poor	Poor	Good.
Moderate	Slight	Slight	Slight	Fair	Fair	Good.
Severe	Moderate	Moderate	Moderate	Good	Fair	Fair.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Severe	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Moderate	Slight	Severe	Severe	Fair	Fair	Fair.
Severe	Moderate	Moderate	Moderate	Good	Fair	Fair.
Moderate	Very severe	Very severe	Very severe	Good	Good	Unsuited.
Moderate	Very severe	Very severe	Very severe	Fair	Good	Unsuited.
Severe	Severe	Severe	Severe	Good	Good	Poor.
Slight	Slight	Slight	Slight	Poor	Poor	Good.
Severe	Moderate	Moderate	Moderate	Good	Fair	Fair.

characteristics, drainage, shrink-well characteristics, grain size, plasticity, and reaction. Also important are depth to the water table and to bedrock, and the position of the soil on the landscape.

Information in this soil survey can be used by engineers to—

1. Make studies that will aid in selecting and developing sites for industrial, business, residential, and recreational uses.
2. Make preliminary evaluations that will aid in selecting locations for highways and airports and in planning detailed surveys of the soils at the site.
3. Develop information for the design of drainage systems, farm ponds, diversion terraces, and other structures for soil and water conservation.
4. Locate possible sources of sand and gravel.
5. Correlate performance of engineering structures with soil mapping units to develop information that can be useful in designing and maintaining such structures.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from pub-

lished maps, reports, and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.

8. Develop other preliminary estimates for construction purposes pertinent to a particular area.

Data in tables 4, 5, and 6, and the soil maps at the back of this publication 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 areas of proposed excavations, and soils of several series can occur in a small area. Also, specific engineering works may involve heavy loads and ex-

TABLE 4.—*Estimated physical and*

[Borrow pits (Bp), Gravel pits (Gr), and Made land (Md) are indicate that information is not available or does not apply]

Soil series and map symbols	Depth to seasonal high water table [1]	Depth from surface of typical profile	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Allendale Mapped only with Pinconning series.	1 to 2	0–14 14–25 25–42	Loamy fine sand Fine sand Silty clay	SM SM or SP–SM CH	A–2 A–3 A–7
Arkport: ArA, ArB, ArC	3 or more	0–28 28–48	Loamy fine sand Very fine sandy loam, fine sand, and very fine sand.	SM SM or ML	A–2 A–2 or A–4
Au Gres:					
AsB	1 to 2	0–14 14–42	Loamy sand Sand	SM SP, SP–SM	A–2 A–1
AuB	1 to 2	0–19 19–44 44–60	Loamy sand Sand Silty clay loam	SM SP, SP–SM CL	A–2 A–1 A–7
Boyer: BrA, BrB, BrC, BrD	4 or more	0–18 18–33 33–42	Loamy sand Sandy loam or sandy clay loam. Stratified sand and gravel	SM SM or SC SP or GP	A–2 A–2 or A–4 A–1
Breckenridge: Bt For Brevort part, see Brevort series.	Less than 1	0–23 23–37 37–48	Sandy loam and loamy sand Sandy clay loam Clay loam	SM SC CL	A–2 A–6 A–6
Brevort: Bv	Less than 1	0–9 9–37 37–48	Loamy sand Sand Clay loam	SM SP CL	A–2 A–3 A–6
Brookston: Bw	Less than 1	0–10 10–51 51–60	Loam Clay loam Loam	ML CL ML	A–4 A–6 A–4
Carlisle: Cc, Cd For Linwood part of Cd, see Linwood series.	At the surface	0–48	Muck over peat	Pt	------
Celina: CeC, ClA, ClB, CmB For Conover part of ClA and ClB, see Conover series; and for Owosso part of CmB, see Owosso series.	2 to 3	0–12 12–28 28–42	Loam or sandy loam Clay loam Loam	ML or SM CL ML	A–4 A–6 A–4
Ceresco: Cn	[3] 1 to 2	0–23 23–29 29–48	Fine sandy loam Stratified loamy sand and sandy loam. Stratified sand and loamy sand.	SM SM SP or SM	A–2 A–2 A–3 or A–2
Cohoctah: Co	Less than 1 [3]	0–13 13–36 36–43 43–48	Silt loam Very fine sandy loam and loamy very fine sand. Very fine sand Coarse sand	ML ML or SM SM SP or SP–SM	A–4 A–4 A–2 or A–4 A–1

cavations deeper than the depths of layers here reported. Therefore, specific laboratory data should be determined for the soil or soils at the site before any engineering work is planned in detail.

Some of the terms used in this publication have a special meaning to soil scientists and a different meaning to engineers. The Glossary at the back of this publication defines many such terms as they are used in soil science. Other information useful to engineers can be found in the "Field Manual of Soil Engineering" (*6*), published by the Michigan State Highway Department.

chemical properties of the soils

so variable that their properties were not estimated; dashed lines

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
No. 4	No. 10	No. 200					Uncoated steel	Concrete
			Inches per hour	*Inches per inch of soil*	*pH value*			
100	100	15–25	2.5–5.0	.10	6.1–6.5	Low	High	Low.
100	100	5–10	2.5–5.0	.10	6.1–6.5	Low		
100	95–100	85–95	.05–0.20	.16	7.4–7.8	High		
100	100	15–30	2.5–5.0	.08	6.6–7.3	Low	Low	Low.
100	100	20–55	0.8–5.0	.14	6.6–7.3	Low		
100	95–100	15–25	5.0–10	.06	4.5–5.0	Low	Low	Moderate.
100	100	0–10	5.0–10	.04	5.1–6.0	Low		
100	95–100	15–25	5.0–10	.06	4.5–5.0	Low	Moderate in sand; high in loamy and clayey material.	Low to moderate.
100	100	0–10	5.0–10	.04	5.1–6.0	Low		
100	95–100	80–90	0.2–0.8	.18	[2] 7.4–8.0	Moderate to high		
100	90–100	15–25	2.5–5.0	.10	6.1–6.5	Low	Low to moderate	Low.
90–85	80–85	25–40	2.5–5.0	.16	5.6–6.5	Low to moderate		
40–75	35–70	0–5	5.0–10	.02	[2] 7.4–8.0	Low		
100	95–100	25–35	2.5–5.0	.12	6.1–7.8	Low	High	Low.
100	90–100	35–50	0.8–2.5	.16	7.4–7.8	Low to moderate		
100	90–100	60–80	0.2–0.8	.16	[2] 7.4–8.0	Moderate		
100	90–100	15–25	5.0–10	.10	6.1–7.3	Low	Moderate	Low.
100	100	0–5	>10	.04	7.4–7.8	Low		
100	95–100	80–90	0.2–0.8	.18	[2] 7.4–8.0	Moderate		
100	95–100	60–70	0.8–2.5	.16	6.6–7.3	Low	High	Low.
100	95–100	70–80	0.2–0.8	.16	6.6–7.3	Moderate		
95–100	90–100	60–75	0.8–2.5	.16	[2] 7.4–8.0	Low		
------	------	-----	2.5–5.0	.25	6.1–6.5	([4])	Very high	Moderate.
100	95–100	60–70	0.8–2.5	.16	5.6–6.5	Low	Moderate	Low.
100	95–100	70–80	0.2–2.5	.16	5.6–7.3	Moderate		
95–100	90–100	60–75	0.8–2.5	.16	[2] 7.4–8.0	Low		
100	95–100	25–35	2.5–5.0	.10	7.4–7.8	Low	Moderate	Low.
100	100	20–30	0.8–2.5	.10	7.4–7.8	Low		
100	100	0–15	>10	.04	7.4–7.8	Low		
100	95–100	60–75	0.8–2.5	.16	6.6–7.3	Low	Moderate	Low.
100	90–100	40–70	0.8–2.5	.16	7.4–7.8	Low		
100	90–100	30–50	2.5–5.0	.10	7.4–7.8	Low		
100	50–70	0–10	>10	.05	[2] 7.4–8.0	Low		

TABLE 4.—*Estimated physical and*

Soil series and map symbols	Depth to seasonal high water table [1]	Depth from surface of typical profile	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Colwood: Cp	Less than 1	0–18	Silt loam or fine sandy loam.	ML or SM	A–4
		18–34	Heavy silt loam	ML–CL	A–4
		34–42	Silt loam	ML–CL	A–4
Conover: CvA, CvB, CwA, CwB. For Metamora part of CwA and CwB, see Metamora series.	1 to 2	0–11	Loam or sandy loam	ML or SM	A–4
		11–30	Clay loam	CL	A–6
		30–42	Loam	ML	A–4
Croswell: CxB	2 to 3	0–48	Sand	SP or SP–SM	A–1
Del Rey: DlA, DrA, DrB	1 to 2	0–15	Silt loam	ML	A–4
		15–32	Silty clay loam	CL	A–6
		32–42	Silty clay loam with strata of very fine sand and silt.	CL	A–6
Edwards: Ed	At the surface	0–22	Muck	Pt	------
		22–48	Marl	------	------
Fox: FoA, FoB	3 or more	0–13	Sandy loam	SM	A–2 or A–4
		13–36	Sandy clay loam and gravelly loam.	SC or CL	A–6
		36–60	Stratified sand and gravel	SP, or SP–SM, or GP	A–1
Gilford: Gd	Less than 1	0–29	Sandy loam	SM	A–2
		29–36	Loamy coarse sand	SM	A–2
		36–48	Stratified sand and gravel	SP, SP–SM, or GP	A–1
Granby: Gm	Less than 1	0–14	Loamy sand	SM	A–2
		14–48	Sand	SP or SP–SM	A–3
Kibbie: KfA, KfB	1 to 2	0–24	Fine sandy loam and loamy fine sand.	SM	A–4
		24–48	Heavy silt loam	ML	A–4
		48–58	Stratified silt, fine sand, and very fine sand.	ML or SM	A–2 or A–4
Lake beaches: La	([4])	0–60	Sand and gravel	SM–SP	A–1 or A–3
Lamson: Lb	Less than 1	0–15	Loamy fine sand	SM	A–2
		15–30	Very fine sand	SM	A–2 or A–4
		30–60	Stratified fine sand and very fine sand.	SM or SP–SM	A–2 or A–4
Landes: Ld	3 or more [3]	0–18	Fine sandy loam and loamy fine sand.	SM	A–4 or A–2
		18–30	Fine sandy loam	SM	A–2
		30–42	Loamy fine sand and sand	SM or SP–SM	A–3 or A–2
Lenawee: Le	Less than 1	0–10	Silty clay loam	CL	A–6
		10–45	Silty clay loam	SL or CH	A–6 or A–7
		45–60	Silty clay loam and strata of very fine sand and silt.	CL	A–6
Linwood: Lm	At the surface	0–32	Muck and peat	Pt	------
		32–50	Stratified silt, fine sandy loam, and very fine sand.	ML or SM	A–2 or A–4
Lupton: Lu	At the surface	0–48	Muck over peat	Pt	------
Markey: Mk	At the surface	0–24	Muck	Pt	------
		24–42	Sand	SP or SP–SM	A–1 or A–3
Metamora: MlA, MlB	1 to 2	0–16	Sandy loam	SM	A–2
		16–26	Sandy clay loam	SC	A–6
		26–42	Clay loam	CL	A–6

chemical properties of the soils—Continued

Percentage passing sieve— No. 4	No. 10	No. 200	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity: Uncoated steel	Corrosivity: Concrete
			Inches per hour	*Inches per inch of soil*	*pH value*			
100	95–100	40–85	0.8–2.5	.20	6.1–7.3	Moderate	High	Low.
100	100	70–80	0.8–2.5	.20	6.6–7.3	Moderate		
100	95–100	70–85	0.8–2.5	.20	[2] 7.4–8.0	Moderate		
100	95–100	60–70	0.8–2.5	.18	6.1–6.5	Low	High	Low.
100	95–100	70–80	0.2–0.8	.18	6.6–7.3	Moderate		
95–100	90–100	60–80	0.8–2.5	.16	[2] 7.4–8.0	Low		
100	90–100	5–15	5.0–10	.05	6.1–7.3	Low	Low	Low.
100	95–100	55–80	0.8–2.5	.20	6.1–7.3	Low	High	Low.
100	95–100	70–80	0.2–0.8	.18	6.6–7.8	Moderate		
100	95–100	80–90	0.2–0.8	.18	[2] 7.4–8.0	Moderate		
------	------	-----	5.0–10	.25	7.4–7.8	([4])	High	Low.
------	------	-----	([4])	([4])	[2] 7.4–8.0	([4])		
95–100	90–100	30–40	2.5–5.0	.12	6.1–7.3	Low	Low to moderate	Low.
70–85	65–80	35–60	0.8–2.5	.14	5.6–7.3	Low to moderate		
55–80	50–70	0–10	5.0–10	.03	[2] 7.4–8.0	Low		
100	100	25–35	2.5–5.0	.10	7.4–7.8	Low	High	Low.
95–100	90–100	15–25	5.0–10	.06	7.4–7.8	Low		
40–75	35–70	0–10	5.0–10	.02	[2] 7.4–8.0	Low		
100	95–100	15–25	5.0–10	.06	6.6–7.3	Low	High	Low.
100	100	0–10	5.0–10	.04	6.6–7.8	Low		
100	100	35–50	0.8–2.5	.18	6.6–7.3	Low	Moderate	Low.
100	100	80–95	0.8–2.5	.20	7.4–7.8	Low		
95–100	95–100	30–75	0.8–5.0	.18	[2] 7.4–8.0	Low		
10–90	10–90	0–5	>10	([4])	([4])	Low	Low	Low to moderate.
100	100	15–30	2.5–5.0	.10	6.1–6.5	Low	Low	Low.
100	100	30–50	2.5–5.0	.08	6.1–6.5	Low		
100	100	25–50	2.5–5.0	.08	6.6–7.3	Low		
100	95–100	25–50	0.8–2.5	.14	[2] 6.6–7.8	Low	Low	Low.
100	90–100	25–35	0.8–2.5	.12	6.6–7.3	Low		
100	85–100	5–25	2.5–5.0	.06	6.6–7.3	Low		
100	100	80–95	0.2–0.8	.20	6.1–6.5	Moderate	High	Low.
95–100	95–100	85–95	.05–0.8	.18	6.1–7.8	Moderate		
100	95–100	80–90	0.2–0.8	.18	[2] 7.4–8.0	Moderate		
------	------	-----	2.5–5.0	.25	6.1–7.3	([4])	High	Low.
95–100	95–100	30–75	2.5–5.0	.15	[2] 7.4–8.0	Low		
------	------	-----	2.5–5.0	.25	7.4–7.8	([4])	High	Low.
------	------	-----	2.5–5.0	.25	7.4–7.8	([4])	High	Low.
100	90–100	0–10	2.5–5.0	.05	[2] 7.4–8.0	Low		
100	90–100	20–35	2.5–5.0	.12	6.1–7.3	Low	High	Low.
100	90–100	35–50	0.8–2.5	.16	6.6–7.3	Low to moderate		
100	95–100	80–90	0.2–0.8	.20	[2] 7.4–8.0	Moderate		

TABLE 4.—*Estimated physical and*

Soil series and map symbols	Depth to seasonal high water table [1]	Depth from surface of typical profile	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Metea: MnA, MnB, MnC	3 or more	0–30 30–38 38–48	Loamy sand Loamy sand with thin layers of sandy loam. Loam	SM SM ML or ML–CL	A–2 A–2 A–4
Miami: MoB, MoC, MoD, MoE, MpC2, MpD2, MpE2,, MtB, MtC, MtD. For Metea part of MtB, MtC, and MtD, see Metea series.	3 or more	0–12 12–33 33–48	Loam or sandy loam Clay loam Loam	ML or SM CL ML	A–4 A–6 A–4
MsA	4 or more	0–17 17–42 42–60	Sandy loam Heavy loam or clay loam Stratified sand and fine gravel.	SM ML or CL SP or SP–SM	A–2 A–4 or A–6 A–1
Minoa: MuA	1 to 2	0–8 8–35 35–48	Loamy fine sand Stratified loamy very fine sand and very fine sand. Sand	SM SM or SP–SM SP–SM	A–2 A–2 or A–4 A–3
Morley: MvB, MvC	2 to 3	0–11 11–29 29–42	Silt loam Silty clay loam Silty clay loam	ML CL or CH CL	A–4 A–6 of A–7 A–6
Oakville: OaB, OaC	4 or more	0–30 30–60	Fine sand Sand	SM SP or SP–SM	A–2 A–3
OkB	2 to 3	0–15 15–44 44–60	Loamy sand Sand Clay loam or silty clay loam.	SM SP or SP–SM CL	A–2 A–3 A–6
Owosso	3 or more	0–10 10–22 22–42	Sandy loam Sandy loam Loam	SM SM ML or CL	A–2 A–2 or A–4 A–4 or A–6
Perrin: PeA, PeB	2 to 3	0–18 18–38 38–48	Loamy sand Loamy coarse sand or coarse sandy loam. Stratified sand and gravel.	SM SM SP or SP–SM	A–2 A–2 A–1
Pinconning: PnA For Allendale part of PnA, see Allendale series.	Less than 1	0–14 14–30 30–42	Loamy fine sand Fine sand and very fine sand. Silty clay	SM SM CH	A–2 A–2 or A–4 A–7
Rifle: Rf	At the surface	0–48	Muck over peat	Pt	--------
Sebewa: Se	Less than 1	0–10 10–35 35–48	Loam Clay loam and sandy clay loam. Stratified sand and gravel	ML CL or SC GP or SP–SM	A–4 A–6 A–1
Selfridge: SdA, SdB	1 to 2	0–30 30–34 34–48	Loamy sand Sandy loam Silty clay loam	SM SM CL	A–2 A–2 A–6
Sisson: SfB, SfC	3 or more	0–23 23–42 42–48	Fine sandy loam Light silty clay loam and silt loam. Stratified silt, fine sand, and very fine sand.	SM CL and ML SM or ML	A–4 or A–2 A–6 and A–4 A–4
Sloan: Sm, Sn	Less than 1 [3]	0–17 17–25 25–44	Silt loam Heavy silt loam Very fine sand with thin layers of silt loam.	ML ML or CL SM	A–4 A–4 or A–6 A–2 or A–4

chemical properties of the soils—Continued

Percentage passing sieve—			Perme-ability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
No. 4	No. 10	No. 200					Uncoated steel	Concrete
			Inches per hour	*Inches per inch of soil*	*pH value*			
100	90–100	15–25	2.5–5.0	.06	6.1–6.5	Low	Moderate	Low.
100	90–100	15–25	2.5–5.0	.08	6.1–6.5	Low		
100	90–100	55–75	0.8–2.5	.16	[2] 7.4–8.0	Low		
95–100	90–100	35–75	0.8–2.5	.20	6.1–6.5	Low	Moderate	Low.
95–100	95–100	60–80	0.8–2.5	.18	5.6–6.5	Moderate		
95–100	90–100	55–75	0.8–2.5	.15	[2] 7.4–8.0	Low		
95–100	90–100	25–35	2.5–5.0	.12	6.1–6.5	Low	Low to moderate	Low.
95–100	90–100	55–75	0.8–2.5	.15	5.6–6.5	Moderate		
55–80	50–70	0–10	5.0–10	.03	[2] 7.4–8.0	Low		
100	100	15–30	2.5–5.0	.08	6.1–6.5	Low	Low	Low.
100	100	25–25	2.5–5.0	.08	6.1–7.3	Low		
100	95–100	0–10	5.0–10	.06	[2] 7.4–8.0	Low		
100	95–100	80–90	0.8–2.5	.20	6.1–7.3	Low	Moderate	Low.
100	100	80–95	0.2–0.8	.18	5.6–6.5	Moderate to high		
95–100	90–100	80–95	0.2–0.8	.18	[2] 7.4–8.0	Moderate		
100	100	0–10	5.0–10	.06	6.1–6.5	Low	Low	Low to moderate.
100	90–100	0–10	5.0–10	.05	6.1–6.5	Low		
100	100	15–25	5.0–10	.06	6.0–0.8	Low	Low in sand; high in clay.	Low to moderate.
100	100	0–10	5.0–10	.05	6.0–7.0	Low		
100	95–100	70–90	0.2–0.8	.16	[2] 7.4–8.0	Moderate		
95–100	90–100	20–35	2.5–5.0	.12	5.6–6.5	Low	High	Low.
100	95–100	30–40	0.8–2.5	.18	6.6–7.3	Low		
100	95–100	70–80	0.8–2.5	.16	[2] 7.4–8.0	Low to moderate		
95–100	90–100	25–35	2.5–10	.12	6.6–7.3	Low	Low to moderate.	Low.
95–100	90–100	25–35	2.5–5.0	.12	6.6–7.8	Low		
50–75	35-70	0–5	5.0–10	.02	[2] 7.4–8.0	Low		
100	100	15–25	2.5–5.0	.10	6.6–7.3	Low	Moderate in sand; high in clay.	Low.
100	100	30–50	2.5–5.0	.10	6.6–7.4	Low		
100	100	85–95	.05–0.20	.16	[2] 7.4–8.0	High		
------	------	-----	2.5–5.0	.25	4.5–5.0	(4)	High	Low.
100	90–100	60–70	0.8–2.5	.16	6.6–7.3	Low	High	Low.
100	90–100	35–80	0.8–2.5	.16	6.6–7.4	Moderate		
40–75	35–70	0–10	5.0–10	.02	[2] 7.4–8.0	Low		
100	90–100	15–25	2.5–5.0	.06	6.1–7.3	Low	Moderate	Low.
100	100	25–35	2.5–5.0	.12	6.6–7.3	Low		
100	95–100	80–90	0.2–0.8	.18	[2] 7.4–8.0	Moderate		
100	100	25–50	0.8–2.5	.18	6.1–7.3	Low	Moderate	Low.
100	95–100	80–90	0.8–2.5	.20	6.1–7.8	Moderate		
95–100	90–100	35–70	0.8–2.5	.15	[2] 7.4–8.0	Low		
100	95–100	70–80	0.8–2.5	.22	7.4–7.8	Low	Moderate	Low.
100	90–100	80–90	0.8–2.5	.18	7.4–7.8	Low to moderate		
100	90–100	35–50	5.0–10	.10	[2] 7.4–8.0	Low		

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TABLE 4.—*Estimated physical and*

Soil series and map symbols	Depth to seasonal high water table [1]	Depth from surface of typical profile	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Spinks:					
SvA, SvB, SvC, SvD	4 or more	0–16	Loamy sand and loamy coarse sand.	SM	A–2
For Oakville part of SvA, ,SvB, SvC and SvD, see Oakville series.		16–70	Sand with thin layers of loamy sand.	SM or SP–SM	A–2
		70–80	Sand	SP	A–3
Spinks, wet subsoil variant:					
SpA	1 to 2	0–15	Loamy sand	SM	A–2
		15–30	Stratified sandy loam and loamy sand.	SM or SP–SM	A–2
		30–60	Sand or sand and fine gravel.	SP, SP–SM	A–3
Tuscola: TsA, TsB	2 to 3	0–15	Silt loam	ML	A–4
		15–32	Silty clay loam	CL	A–6
		32–48	Stratified very fine sand and silt.	SM or ML	A–4
Wallkill: Wa	At the surface	0–24	Silt loam	ML	A–4
		24–60	Muck over peat	Pt	------
Wasepi:					
WeA	1 to 2	0–13	Sandy loam	SM	A–2
		13–17	Loamy sand	SM	A–2
		17–30	Sandy loam or light sandy clay loam.	SM or SC	A–6 or A–2
		30–48	Stratified sand and fine gravel.	SP or SP–SM	A–1
WpA	1 to 2	0–23	Loamy sand	SM	A–2
		23–35	Heavy sandy loam	SM or SC	A–2
		35–45	Stratified sand and gravel	SP or SP–SM	A–1
		45–60	Clay loam or silty clay loam.	CL	A–6

[1] Estimated depth to seasonal high water table assumes that no artificial drainage is used.
[2] Calcareous.

TABLE 5.—*Suitability of the soils*

[Borrow pits (Bp), Gravel pits (Gr), and Made land (Md) are

Soil series and map symbol	Suitability as source of—	
	Topsoil	Sand
Allendale: Mapped only with Pinconning series.	Fair in upper 8 to 10 inches: medium content of organic matter; seasonal high water table.	Fair to poor: limited source to a depth of 18 to 42 inches; considerable fines.
Arkport: ArA, ArB, ArC	Very poor in upper 6 to 8 inches: sandy; low content of organic matter; droughty.	Good: sandy material to depth of 60 inches or more.
Au Gres:		
AsB	Very poor: sandy; droughty; moderately low content of organic matter; seasonal high water table.	Good: sandy material to depth of 60 inches or more; high water table hinders excavation during wet periods.
AuB	Very poor to poor in surface layer and subsoil: sandy; droughty; moderately low content of organic matter; seasonal high water table.	Fair: sandy material to depth of 42 to 66 inches; some fines; high water table hinders excavation during wet periods.

chemical properties of the soils—Continued

Percentage passing sieve— No. 4	No. 10	No. 200	Perme-ability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity: Uncoated steel	Corrosivity: Concrete
			Inches per hour	*Inches per inch of soil*	*pH value*			
100	95–100	10–20	5.0–10	.05	6.1–7.3	Low		
100	95–100	10–25	2.5–5.0	.08	6.1–6.6	Low	Low	Low.
100	95–100	0–5	5.0–10	.03	[2] 7.4–8.0	Low		
100	100	15–25	2.5–5	.05	6.1–6.5	Low		
100	90–100	15–25	2.5–5	.08	6.1–6.5	Low	Moderate	Low to moderate.
40–75	35–70	0.10	5.0–10	.03	[2] 6.6–8.0	Low		
100	100	60–80	0.8–2.5	.20	6.1–7.3	Low		
100	100	70–90	0.8–2.5	.20	6.6–7.3	Moderate to low	Moderate	Low.
100	95–100	35–70	0.8–2.5	.16	[2] 7.4–8.0	Low		
100	95–100	70–80	0.8–2.5	.20	7.4–7.8	Low	High	Low.
------	------	-----	2.5–5.0	.25	6.6–7.8	([4])		
100	90–100	20–35	2.5–5.0	.12	6.1–7.3	Low		
95–100	90–100	15–25	2.5–5.0	.08	6.1–6.5	Low	Moderate	Low.
90–100	80–100	30–50	2.5–5.0	.10	6.1–7.3	Low to moderate		
55–80	35–70	0–10	5.0–10	.03	[2] 7.4–8.0	Low		
100	100	15–25	5.0–10	.06	6.1–7.3	Low		
100	90–100	25–35	2.5–5.0	.10	6.1–7.3	Low	Low	Low.
55–80	35–70	0–10	5.0–10	.03	[2] 7.4–8.0	Low		
100	90–100	65–85	0.2–0.8	.18	[2] 7.4–8.0	Moderate		

[3] Subject to flooding.
[4] Variable.

as construction material

so variable that their properties were not estimated]

Suitability as source of—Continued: Gravel	Road fill	Impermeable material
Not suitable	Fair to good in upper 18 to 42 inches: low volume change; good bearing capacity. Poor for clayey material: high volume change, difficult to work and compact when wet.	Not suitable in upper 18 to 42 inches: sandy; rapid permeability. Good in clayey material: high volume change; difficult to compact and work when wet.
Not suitable	Fair to good in subsoil and substratum: low volume change; fair to good bearing capacity.	Poor to not suitable in subsoil and substratum: sandy; moderately rapid permeability; subject to piping.
Not suitable	Fair to good: low volume change; good to fair bearing capacity.	Poor to not suitable: seasonal high water table; sandy; rapid permeability.
Not suitable	Fair to good in sandy material: low volume change; good to fair bearing capacity. Fair to poor in loamy and clayey material: difficult to work and compact when wet.	Not suitable to depth of 42 to 66 inches: sandy; rapid permeability. Good in loamy and clayey material.

TABLE 5.—*Suitability of the soils as*

Soil series and map symbol	Suitability as source of—	
	Topsoil	Sand
Boyer: BrA, BrB, BrC, BrD	Poor: droughty; moderately low content of organic matter; pebbles and cobblestones on surface in some areas.	Good: poorly graded sand containing some fines in upper 24 to 40 inches.
Breckenridge: Bt. For Brevort part of Bt, see Brevort series.	Fair to good in surface layer and subsoil: high water table.	Not suitable
Brevort: Bv	Poor: sandy; subject to soil blowing; high water table.	Fair: limited sandy material to depth of 18 to 42 inches; wetness hinders excavation in many areas.
Brookston: Bw	Good in upper 9 to 12 inches: loamy; medium to high content of organic matter; high water table.	Not suitable
Carlisle: Cc, Cd. For Linwood part of Cd, see Linwood series.	Poor: soil is eroded and oxidizes readily; high water table. Fair to good if mixed with mineral material.	Not suitable
Celina: CeC, ClA, ClB, CmB. For Conover part of ClA and ClB, see Conover series; and for Owosso part of CmB, see Owosso series.	Fair: thin; pebbles and cobblestones on surface in some areas.	Not suitable
Ceresco: Cn	Fair: subject to flooding; seasonal high water table.	Not suitable
Cohoctah: Co	Fair: droughty; medium content of organic matter; subject to flooding; high water table.	Not suitable
Colwood: Cp	Good: erodible; medium to high content of organic matter; high water table.	Not suitable
Conover: CvA, CvB, CwA, CwB. For Metamora part of CwA and CwB, see Metamora series.	Good in upper 8 to 12 inches: loamy; pebbles and cobblestones on surface in some areas.	Not suitable
Croswell: CxB	Very poor in upper 6 to 8 inches: sandy; droughty; low content of organic matter; subject to soil blowing.	Good: sandy material to a depth of 60 inches or more.
Del Rey: DlA, DrA, DrB	Good: seasonal high water table; crusts slightly on drying.	Not suitable
Edwards: Ed	Poor: erodes and oxidizes readily; high water table; fair to good if mixed with mineral soil.	Not suitable
Fox: FoA, FoB	Good to fair: thin in eroded areas	Good: poorly graded sand and gravel containing some fines.
Gilford: Gd	Good in upper 10 to 14 inches: medium to high content of organic matter.	Good: stratified sand and gravel; wetness hinders excavation in many areas.
Granby: Gm	Poor: sandy; subject to soil blowing; high water table.	Good: sandy material; wetness hinders excavation in many areas.

construction material—Continued

Suitability as source of—Continued		
Gravel	Road fill	Impermeable material
Good: layers of gravel below depth of 24 to 40 inches; more than 50 percent sand containing some fines.	Fair to good in subsoil. Excellent to very good in substratum: slight frost action; fair to good workability; low volume change; good subgrade material.	Good to fair in upper 18 to 42 inches. Not suitable in sand and gravel: moderately rapid permeability; subject to piping.
Not suitable	Fair to poor in subsoil; poor in substratum, which is difficult to work and compact when wet.	Fair to good in subsoil; good in substratum.
Not suitable	Fair to good to depth of 18 to 42 inches: low volume change; good to fair bearing capacity. Fair to poor in loamy material: fair workability when wet; moderate volume change.	Not suitable to depth of 18 to 42 inches: sandy; moderately rapid permeability. Good in loamy material: fair workability when wet.
Not suitable	Fair to poor: low to moderate volume change; fair to poor bearing capacity; fair workability when wet; high water table.	Good: fair workability when wet.
Not suitable	Not suitable: unstable; highly compressible.	Not suitable: unstable; highly compressible.
Not suitable	Poor to fair: low to moderate volume change; difficult to work and compact when wet; medium to high frost action.	Good: difficult to work and compact when wet.
Not suitable	Fair to good in subsoil and substratum: low volume change; fair to good bearing capacity.	Fair: some seepage; subject to piping.
Not suitable	Fair to good: low volume change; fair to good bearing capacity; high water table.	Fair: some seepage; high water table; subject to piping.
Not suitable	Poor: moderate volume change; poor bearing capacity; flows when wet; high water table.	Fair: flows when wet; high water table.
Not suitable	Fair to poor: low to moderate volume change; difficult to work and compact when wet: seasonal high water table.	Good: difficult to work and compact when wet.
Not suitable	Fair to good: low volume change; fair to good bearing capacity.	Not suitable: sandy, rapid permeability; subject to piping.
Not suitable	Poor in subsoil and substratum: seasonal high water table; difficult to work when wet; medium to high frost action.	Good: seasonally wet.
Not suitable	Not suitable in organic layers and marl: unstable; highly compressible.	Not suitable in organic layers and marl: unstable; highly compressible.
Good: poorly graded sand and gravel containing some fines.	Fair in subsoil: low to moderate volume change; good compactibility and workability. Good in substratum: low volume change and compressibility; slight frost action.	Not suitable: pervious.
Fair: more than 51 percent sand; wetness hinders excavation in many areas.	Fair in subsoil: low volume change; fair to good bearing capacity. Good in sandy and gravelly material: low volume change; wetness hinders excavation.	Fair in subsoil: low volume change. Not suitable in sand and gravel: moderately rapid permeability; subject to piping.
Not suitable	Fair to good: low volume change; fair to good bearing capacity; high water table.	Not suitable: sandy; moderately rapid permeability; high water table; subject to piping.

TABLE 5.—*Suitability of the soils as*

Soil series and map symbol	Suitability as source of—	
	Topsoil	Sand
Kibbie: KfA, KfB	Good in upper 7 to 10 inches: loamy; moderately high content of organic matter; seasonal high water table.	Not suitable
Lake beaches: La	Very poor: sandy; low content of organic matter.	Good: some gravel
Lamson: Lb	Fair to poor in surface layer; poor to very poor in subsoil; high water table.	Fair in subsoil and substratum: poorly graded sand containing some fines.
Landes: Ld	Poor: sandy; droughty; subject to flooding; seasonal high water table.	Not suitable
Lenawee: Le	Fair in upper 8 to 10 inches: loamy; high water table.	Not suitable
Linwood: Lm	Poor: erodes and oxidizes readily; high water table; fair to good if mixed with mineral material.	Not suitable
Lupton: Lu	Poor: erodes and oxidizes readily; high water table; fair to good if mixed with mineral material.	Not suitable
Markey: Mk	Poor: erodes and oxidizes readily; fair to good if mixed with mineral material.	Fair: sandy material at depth of 12 to 42 inches; wetness hinders excavation.
Metamora: MIA, MIB	Fair in upper 8 to 12 inches: moderately high content of organic matter; seasonal high water table.	Not suitable
Metea: MnA, MnB, MnC	Very poor in upper 7 to 9 inches: moderately low content of organic matter; droughty.	Fair: limited sandy material to depth of 18 to 42 inches.
Miami:		
MoB, MoC, MoD, MoE, MpC2, MpD2, MpE2, Mtb, MtC, MtD. For Metea part of MtB, MtC, and MtD, see Metea series.	Fair in thin surface layer and poor in eroded areas: pebbles and cobblestones on surface.	Not suitable below depth of 40 inches
MsA	Fair	Good: poorly graded sand and gravel containing some fines.
Minoa: MuA	Poor to very poor in surface layer and subsoil: sandy; droughty; subject to soil blowing.	Fair in subsoil and substratum: poorly graded sand containing bands of fines.
Morley: MvB, MvC	Fair in upper 7 to 9 inches: loamy; moderately low content of organic matter; few pebbles and cobblestones on surface.	Not suitable
Oakville:		
OaB, OaC	Very poor in upper 6 to 8 inches: sandy; droughty; subject to soil blowing; low content of organic matter.	Good: sandy material to depth of 60 inches or more.
OkB	Very poor: sandy; droughty; subject to soil blowing; low content of organic matter.	Fair: sandy material containing some fines to depth of 42 to 66 inches.

construction material—Continued

Suitability as source of—Continued		
Gravel	Road fill	Impermeable material
Not suitable	Poor: low volume change; poor bearing capacity; unstable when wet.	Fair: liquefies and flows when wet.
Not suitable: high content of sand	Good: low volume change; good to fair bearing capacity.	Not suitable.
Not suitable	Fair to good in subsoil and substratum: low volume change; good bearing capacity and workability.	Fair to poor in subsoil and substratum: high water table.
Not suitable	Fair to good: low volume change; fair to good bearing capacity.	Fair: some seepage.
Not suitable	Fair to poor: moderate volume change; fair to poor bearing capacity when wet; high water table.	Good: fair to poor workability when wet.
Not suitable	Not suitable in organic layers: unstable; highly compressible. Fair to poor in loamy material: low volume change; high water table.	Not suitable in organic layers: unstable; highly compressible. Good in loamy material: fair workability when wet; high water table.
Not suitable	Not suitable: unstable; highly compressible.	Not suitable: unstable organic material; highly compressible.
Not suitable	Not suitable in organic material: unstable; highly compressible. Fair in sandy material: excavation difficult because of wetness; high water table.	Not suitable: unstable organic material; moderately rapid permeability in sand.
Not suitable	Good in upper 18 to 42 inches: good to fair bearing capacity; low to moderate volume change. Fair to poor below depth of 18 to 42 inches; poor bearing capacity; moderate volume change.	Good in upper 18 to 42 inches: good workability. Material below depth of 18 to 42 inches has poor workability when wet.
Not suitable	Fair to good to depth of 18 to 42 inches: low volume change; good to fair bearing capacity. Fair to poor for loamy material: low volume change; fair workability when wet.	Not suitable to depth of 18 to 42 inches: sandy; moderately rapid permeability. Good in loamy material; fair workability when wet.
Not suitable below depth of 40 inches.	Poor to fair: low to moderate volume change; difficult to work and compact when wet.	Good: difficult to work and compact when wet.
Good: poorly graded sand and gravel containing some fines.	Fair to good: low volume change and compressibility; slight frost action.	Fair to good in upper 40 to 66 inches, and not suitable for underlying sand and gravel: rapid permeability.
Not suitable	Fair to good in subsoil and substratum: low volume change; good bearing capacity and workability.	Fair to poor in subsoil and substratum.
Not suitable	Poor to fair: moderate to high volume change; fair to poor bearing capacity; difficult to work and compact when wet.	Good: difficult to work and compact when wet.
Not suitable	Fair to good: low volume change; fair to good bearing capacity.	Not suitable: sandy; rapidly permeable; subject to piping.
Not suitable	Fair to good for sandy material: low volume change; fair to good bearing capacity. Fair to poor for loamy or clayey material: moderate volume change; difficult to work and compact when wet.	Not suitable in sandy material: rapid permeability; subject to piping. Good for loamy or clayey material.

TABLE 5.—*Suitability of the soils as*

Soil series and map symbol	Suitability as source of—	
	Topsoil	Sand
Owosso: Mapped only with Celina series.	Fair in upper 8 to 10 inches: medium in content of organic matter.	Not suitable
Perrin: PeA, PeB	Poor: droughty; moderately low content of organic matter; pebbles and cobblestones on surface in many areas.	Good: sand containing some fines and pebbles.
Pinconning: PnA For Allendale part of PnA, see Allendale series.	Good to fair in upper 9 to 12 inches: medium to high content of organic matter; high water table.	Not suitable to very poor: variable content of fines.
Rifle: Rf	Poor: erodes and oxidizes readily; high water table; fair to good if mixed with mineral material.	Not suitable
Sebewa: Se	Good in upper 9 to 14 inches: loamy; high content of organic matter; high water table.	Good: stratified sand and gravel or sand; wetness hinders excavation.
Selfridge: SdA, SdB	Very poor: upper 7 to 9 inches has medium content of organic matter; droughty.	Fair: limited source of sandy material to depth of 18 to 42 inches.
Sisson: SfB, SfC	Fair in upper 8 to 10 inches: loamy; medium content of organic matter.	Not suitable
Sloan: Sm, Sn	Good: thick; loamy; high content of organic matter; subject to flooding; seasonal high water table.	Not suitable
Spinks:		
SvA, SvB, SvC, SvD For Oakville part of SvA, SvB, SvC, and SvD, see Oakville series.	Very poor in upper 6 to 8 inches: sandy; moderately low content of organic matter; droughty.	Good: sandy material containing thin layers that are not suitable.
Spinks, wet subsoil variant: SpA	Loamy sand and sandy loam in upper 7 to 10 inches: medium content of organic matter; seasonal high water table.	Good: poorly graded sand containing fines and some gravel.
Tuscola: TsA, TsB	Fair in upper 8 to 10 inches: loamy; medium content of organic matter.	Not suitable
Wallkill: Wa	Good: thick; loamy; high content of organic matter; subject to flooding; high water table.	Not suitable
Wasepi:		
WeA	Fair in upper 8 to 12 inches; medium content of organic matter; seasonal high water table.	Good: sandy material containing some fines and gravel.
WpA	Poor in surface layer, and fair to poor in subsoil: seasonal high water table.	Fair to poor in subsoil; substratum not suitable.

construction material—Continued

Suitability as source of—Continued		
Gravel	Road fill	Impermeable material
Not suitable	Good in upper 18 to 42 inches: good to fair bearing capacity. Fair to poor below depth of 18 to 42 inches; low to moderate volume change; poor bearing capacity.	Good to depth of 18 to 42 inches: good workability. Below depth of 18 to 42 inches, workability when wet is poor.
Fair: more than 50 percent sand with some fines.	Good: low volume change; sandy and gravelly material provide good subgrade.	Good to poor in upper 24 to 42 inches, and not suitable in sand and gravel: rapid permeability; subject to piping.
Not suitable	Fair to good to depth of 18 to 42 inches: low volume change; good to fair bearing capacity. Poor to very poor below depth of 18 to 42 inches: high volume change; difficult to compact; high water table.	Poor in upper 18 to 42 inches: unstable when wet; subject to piping. Good below depth of 18 to 42 inches: slow seepage; high water table.
Not suitable	Not suitable: unstable; highly compressible.	Not suitable: unstable; highly compressible.
Good in most places: stratified sand and gravel. Not suitable in some areas: onsite investigation needed; excess wetness hinders excavation.	Fair to poor in subsoil: moderate volume change; fair to poor bearing capacity. Good in sand and gravel: low volume change; good for subgrade; high water table.	Good in subsoil: fair workability and compactibility. Not suitable in sand and gravel: rapid permeability; subject to piping.
Not suitable	Fair to good to depth of 18 to 42 inches: low volume change; good to fair bearing capacity. Fair to poor for loamy material: moderate volume change; fair workability when wet.	Not suitable to depth of 18 to 42 inches: sandy; moderately rapid permeability. Good in loamy material; fair workability when wet.
Not suitable	Fair to poor: low to moderate volume change; fair to poor bearing capacity; difficult to work when wet.	Fair: liquefies and flows when wet.
Not suitable	Poor: low to moderate volume change; fair to poor bearing capacity; poor subgrade; high water table.	Fair to good: fair workability and compactibility when wet; high water table.
Not suitable	Fair to good: low volume change; fair to good bearing capacity.	Not suitable: sandy; moderately rapid permeability; subject to piping.
Fair to poor: sandy material containing 30 to 50 percent gravel.	Fair to good in subsoil: excellent to very good in substratum: slight frost action; fair to good workability; low volume change; wetness hinders excavation.	Fair in upper 42 to 60 inches: low volume change. Not suitable in sand and gravel: rapid permeability; subject to piping.
Not suitable	Poor: low to moderate volume change; poor bearing capacity; flows when wet.	Fair: flows when wet.
Not suitable	Poor to depth of 10 to 40 inches: low volume change; fair to poor bearing capacity. Not suitable in organic material: unstable; highly compressible; high water table.	Fair to good to depth of 10 to 40 inches: low volume change; fair workability; high water table; not suitable in organic material: unstable; highly compressible.
Fair: less than 50 percent gravel	Fair in upper 24 to 42 inches: low to moderate volume change in upper 24 to 42 inches; fair to good bearing capacity. Good in sandy and gravelly material: low volume change; wetness hinders excavation.	Fair to poor in upper 24 to 42 inches: low to moderate volume change in upper 24 to 42 inches. Not suitable in sand and gravel: rapid permeability; subject to piping.
Not suitable	Fair to good in subsoil: low volume change; good to fair bearing capacity. Not suitable in substratum.	Poor to not suitable in subsoil. Good in substratum.

TABLE 6.—*Engineering*

[Borrow pits (Bp), Gravel pits (Gr), and Made land (Md)

Soil series and map symbols	Highway location	Farm ponds		Agricultural drainage	Terraces and diversions
		Reservoir area	Embankment		
Allendale ---------- Mapped only with Pinconning series.	Seasonal high water table; plastic, clayey material at depth of 18 to 42 inches; unstable and slippery when wet; fair to poor bearing capacity.	Seepage is rapid in subsoil and slow in substratum.	Seasonal high water table; fair stability; high volume change; fair to poor compactibility; slow seepage.	Subsurface drainage needed; seasonal high water table; slow permeability at depth of 18 to 42 inches.	Seasonal high water table; slow runoff in the more sloping areas; diversion ditches helpful in adjacent sloping areas.
Arkport: ArA, ArB, ArC.	Cuts and fills needed in some areas; unstable substratum; easily excavated; good to fair bearing capacity.	Well drained; sandy; rapid seepage; too porous to hold water; seal blanket required.	Rapid seepage; fair to poor stability and compactibility; low volume change; subject to piping.	Drainage not needed.	Sandy subsoil; gentle slopes; little runoff; difficult to vegetate.
Au Gres:					
AsB --------------	Seasonal high water table; sandy material not stable when wet; fill needed.	Too porous to hold water; seal blanket required.	Seasonal high water table; fair stability and compactibility; rapid seepage; subject to piping.	Drainage needed; wet depressions; sandy; rapid permeability; tiling questionable; ditch banks unstable.	Sandy substratum; highly erodible; difficult to vegetate; seasonal high water table.
AuB --------------	Seasonal high water table; wetness hinders construction in some areas; substratum subject to frost heaving.	Somewhat poorly drained; seasonal high water table: seepage is rapid in the sandy material and slow in silty clay loam substratum.	Sandy material: fair stability; medium to rapid seepage; subject to piping. Substratum: fair to good stability and compactibility; slow seepage.	Drainage needed; somewhat poorly drained; seasonal high water table; special blanket of tile required.	Seasonal high water table; sandy subsoil; little runoff; diversion ditches helpful in adjacent sloping areas.
Boyer: BrA, BrB, BrC, BrD.	Cuts and fills needed in some areas; substratum good source of material for subbase and fill.	Well drained; sandy; seepage is medium to rapid in subsoil and very rapid in substratum; seal blanket required where porous sand and gravel is exposed.	To depth of 18 to 42 inches: fair stability and compactibility; medium seepage. Substratum: good stability; has rapid seepage; subject to piping.	Drainage not needed.	Sand and gravel at a depth of 18 to 42 inches; layout and construction difficult in slopes of more than 12 percent.
Breckenridge: Bt -- For Brevort part of Bt, see Brevort series.	High water table; wetness hinders construction in some areas; subject to frost heaving.	High water table; medium seepage; poorly drained.	High water table; fair to good stability and compactibility; slow seepage.	Drainage needed; poorly drained; high water table; moderately slow permeability in substratum; depressions are wet in some areas.	Nearly level to depressional areas; high water table; little runoff; diversion ditches helpful in adjacent sloping areas.
Brevort: Bv -------	High water table; wetness hinders construction in some areas; substratum subject to frost heaving.	High water table; seepage is rapid to depth of 18 to 42 inches and medium to slow below; seal blanket required unless sandy material is removed.	High water table; fair stability and compactibility; slow seepage below depth of 18 to 42 inches.	Drainage needed; high water table; moderately slow permeability in substratum; depressions are wet in some areas.	Nearly level to depressional areas; high water table; little runoff; diversion ditches helpful in adjacent sloping areas.

interpretations

are so variable that their properties were not estimated]

Sodded waterways	Foundations for low buildings (3 stories or less)	Winter grading	Irrigation	Limitations for septic tank disposal fields
Nearly level areas; seasonal high water table; little runoff.	Seasonal high water table; fair to poor bearing capacity; high volume change; high compressibility; low shear strength.	High moisture content often hinders operations; clayey substratum has poor stability on thawing.	Medium water-holding capacity; rapid water intake rate.	Severe: seasonal high water table; slowly permeable material at depth of 18 to 42 inches; onsite investigation needed.
Sandy; difficult to vegetate, subject to soil blowing; little runoff.	Good to fair bearing capacity; low volume change; very low compressibility; may liquefy and flow when wet.	Sandy; usually low in moisture; good stability on thawing.	Medium to moderately low water-holding capacity; rapid water intake rate; requires frequent watering; subject to soil blowing.	Slight: slopes of more than 10 percent hinder installation and operation of disposal fields; possible pollution of shallow water supplies.
Sandy subsoil; highly erodible; low natural fertility; little runoff; subject to soil blowing.	Seasonal high water table; fair to good bearing capacity; low volume change; very low compressibility; fair to good shear strength; good compactibility.	Wetness often hinders operations.	Low water-holding capacity; very rapid water intake rate; requires frequent watering.	Severe: seasonal high water table; rapid percolation of effluent; may pollute water supplies; onsite investigation needed.
Sandy subsoil; little runoff; difficult to vegetate.	Seasonal high water table; fair to poor bearing capacity; moderate to high volume change; medium compressibility and shear strength.	Seasonal high water table; wetness hinders operations in some areas; poor stability on thawing.	Low water-holding capacity in subsoil; very rapid water intake rate.	Severe: seasonal high water table; rapid permeability in subsoil, and moderately slow permeability in substratum; onsite investigation needed.
Sandy material erodible; moderately low water-holding capacity; moderately low natural fertility; difficult to vegetate.	Low volume change; very low compressibility; medium to high shear strength.	Moderately low moisture; good to fair stability on thawing; good workability and trafficability.	Moderately low water-holding capacity; very rapid water intake rate; requires frequent watering; slopes subject to runoff and erosion.	Slight: moderately rapid permeability at depth of 18 to 42 inches; slopes of more than 10 percent hinder installation and operation of disposal fields; possible contamination of shallow water supplies.
Nearly level to depressional areas; high water table; little runoff.	High water table; fair to poor bearing capacity; moderate volume change; medium to high frost heaving.	High water table; wetness hinders operations; poor stability on thawing.	Moderately high water-holding capacity; medium water intake rate; drainage needed.	Severe: high water table; moderately slow permeability in substratum.
Nearly level to depressional areas; high water table; little runoff.	High water table: fair to poor bearing capacity; moderate volume change; medium shear strength and compressibility; subject to frost heaving.	High water table; wetness hinders operations; poor stability on thawing.	Low water-holding capacity; rapid water intake rate; drainage needed.	Severe: high water table; moderately slow permeability in substratum.

TABLE 6.—*Engineering*

Soil series and map symbols	Highway location	Farm ponds: Reservoir area	Farm ponds: Embankment	Agricultural drainage	Terraces and diversions
Brookston: Bw	High water table; wetness hinders construction; subject to frost heaving; fair to poor bearing capacity.	High water table; medium to slow seepage; suited to pit-type ponds.	High water table; fair to good stability and compactibility; slow seepage.	Subsurface drainage, surface drainage, or both, needed: high water table; moderately slow permeability; depressions often wet.	Nearly level to depressional areas; diversion ditches helpful in adjacent sloping areas.
Carlisle: Cc, Cd. For Linwood part of Cd, see Linwood series.	High water table; organic material must be removed.	High water table; rapid seepage; suited to pit-type ponds; caving and flotation of organic material likely.	High water table; organic material not suitable.	Drainage needed; high water table; organic material subject to subsidence if overdrained.	Level and depressional areas: diversion ditches helpful in adjacent sloping areas.
Celina: CeC, ClA, ClB, CmB. For Conover part of ClA and ClB, see Conover series; and for Owosso part of CmB, see Owosso series.	Cuts and fills needed; subject to frost heaving.	Fair stability and compactibility; slow seepage; low volume change.	Often too wet for good compaction; poor stability on thawing.	Random tiling needed in wet depressions.	No restrictions.
Ceresco: Cn	Seasonal high water table; occasional flooding; fair to good bearing capacity.	Subject to stream overflow; rapid seepage.	Seasonal high water table; fair stability; fair to good compactibility; subject to piping; medium seepage.	Drainage needed; seasonal high water table; tile can be used if overflow is controlled.	Nearly level stream bottoms; subject to flooding; diversion ditches helpful in adjacent sloping areas.
Cohoctah: Co	High water table; occasional flooding; fair to good bearing capacity.	High water table; rapid seepage in substratum; subject to stream overflow; suited to pit-type ponds.	High water table; fair stability; fair to good compactibility; subject to piping; medium seepage.	Drainage needed; high water table; subject to stream overflow; tile can be used if overflow is controlled.	Nearly level flood plains; high water table; diversion ditches helpful in adjacent sloping areas.
Colwood: Cp	High water table; silty and sandy substratum loses stability and flows when wet; subject to frost heaving.	High water table; medium seepage; suited to pit-type ponds; sides of ponds unstable when wet.	High water table; subsoil has fair stability and slow seepage; substratum has poor stability and medium seepage.	Drainage needed; high water table; silt and very fine material in substratum may flow into tile; ditchbanks unstable.	Nearly level to depressional areas; high water table; diversion ditches helpful in adjacent sloping areas.
Conover: CvA, CvB, CwA, CwB. For Metamora part of CwA and CwB, see Metamora series.	Seasonal high water table; wetness hinders construction in some areas; fair to poor bearing capacity; subject to frost heaving.	Medium to slow seepage.	Fair to good stability and compactibility; medium to slow seepage.	Drainage usually needed; seasonal high water table; moderately slow permeability; depressions need surface drains.	Nearly level to gently sloping areas; little runoff; somewhat poorly drained.
Croswell: CxB	Loose sand easily excavated but hinders hauling at times; good bearing capacity; subject to soil blowing.	Rapid seepage; too porous to hold water unless seal blanket is used.	Fair stability and compactibility; low volume change; rapid seepage; difficult to vegetate; subject to piping.	Drainage not needed.	Sandy subsoil; highly erodible; difficult to vegetate; slow runoff.

interpretations—Continued

Sodded waterways	Foundations for low buildings (3 stories or less)	Winter grading	Irrigation	Limitations for septic tank disposal fields
Nearly level to depressional areas; high water table; little runoff.	High water table; fair to poor bearing capacity; medium compressibility; fair to good workability; subject to liquefaction.	High water table; poor stability on thawing.	High water-holding capacity; medium water intake rate; drainage needed.	Severe: high water table; moderately slow permeability; disposal fields saturated during wet periods.
Level to depressional areas; very high water table; very little runoff.	High water table; very high compressibility; unstable.	High water table; unstable.	High water-holding capacity; very rapid water intake rate; drainage needed.	Severe: high water table; unstable organic material; disposal fields saturated during wet periods.
Slopes subject to rapid runoff and erosion.	Fair to poor bearing capacity; medium compressibility and shear strength; fair to good workability; low volume change.	Often too wet for good compaction; poor stability on thawing.	Moderately high water-holding capacity; medium water intake rate; slopes subject to erosion.	Moderate to severe: moderately slow permeability.
Nearly level stream bottoms and flood plains; subject to flooding; little runoff.	Seasonal high water table; low to good bearing capacity; low volume change and compressibility; may liquefy and flow when wet.	Wetness often hinders operation of equipment; fair stability on thawing.	Medium water-holding capacity; rapid water intake rate; subject to stream overflow.	Severe: seasonal high water table; subject to overflow; onsite investigation needed.
Nearly level to depressional flood plains; high water table; little runoff.	High water table; fair to good bearing capacity; low volume change and compressibility; medium to high shear strength; subject to flooding.	High water table; wetness hinders operations; poor stability on thawing.	Medium water-holding capacity; rapid water intake rate; needs drainage and protection from stream overflow.	Severe: high water table; subject stream overflow; disposal fields saturated during wet periods.
Nearly level to depressional areas; little runoff; high water table.	High water table; poor bearing capacity when wet; low to moderate volume change and compressibility; fair shear strength; may liquefy and flow when wet.	High water table; poor stability on thawing.	High water-holding capacity; medium water intake rate; drainage needed.	Severe: high water table.
Nearly level to gently sloping areas; little runoff; periodic high water table.	Seasonal high water table; fair to poor bearing capacity; moderate volume change; moderate compressibility and shear strength.	Often too wet for good compaction; poor stability on thawing.	High water-holding capacity; medium water intake rate.	Severe: seasonal high water table; moderately slow permeability; onsite investigation needed.
Sandy subsoil; highly erodible; low water-holding capacity; difficult to vegetate; little runoff.	Good bearing capacity; very low compressibility; fair workability; low volume change; fair compactibility; may liquefy and flow when wet.	Moisture content ordinarily low; good stability on thawing.	Low water-holding capacity; rapid water intake rate; requires frequent watering; subject to soil blowing.	Moderate: possible pollution of shallow water supplies; water table within 2 to 3 feet of surface during wet periods.

TABLE 6.—*Engineering*

Soil series and map symbols	Highway location	Farm ponds: Reservoir area	Farm ponds: Embankment	Agricultural drainage	Terraces and diversions
Del Rey: DlA, DrA, DrB.	Seasonal high water table hinders construction in some areas; subject to frost heaving; fair to poor bearing capacity.	Seasonal high water table; moderate to slow seepage; somewhat poorly drained.	Seasonal high water table; fair to good stability; and compactibility; slow seepage.	Surface and subsurface drainage ordinarily needed; moderately slow permeability.	Nearly level to gently sloping areas; little runoff; clayey subsoil; difficult to vegetate.
Edwards: Ed	High water table; organic material must be removed; substratum has poor bearing capacity.	High water table; seepage is rapid to depth of 12 to 42 inches and variable below; suited to pit-type ponds; flotation of organic material possible.	High water table; unstable organic material to depth of 12 to 42 inches; marl has poor compactibility and stability.	High water table; controlled drainage needed; organic material subsides if overdrained.	Nearly level to depressional areas; low stability; high water table; diversion ditches helpful in adjacent sloping areas.
Fox: FoA, FoB	Cuts and fills often needed; substratum has good bearing capacity and is good material for subbase and fill.	Medium to slow seepage in subsoil; seal blanket required where porous sand and gravel of substratum is exposed.	Subsoil has fair stability, slow seepage, and fair compactibility; substratum has good stability and rapid seepage.	Drainage not needed.	All features favorable unless slopes are short and irregular.
Gilford: Gd	High water table; wetness hinders construction; substratum excellent as subbase or fill material.	High water table; suited to pit-type ponds; seepage is rapid in sand and gravel.	High water table; subsoil has fair to good stability and slow seepage; substratum has fair stability and rapid seepage and is subject to piping.	Drainage needed; high water table; permeability is moderately slow in subsoil and rapid in substratum; sandy substratum makes blinding necessary.	Nearly level to depressional areas; high water table; diversion ditches helpful in adjacent sloping areas.
Granby: Gm	High water table; sandy material loses stability and flows when wet; fair to good bearing capacity.	High water table; rapid seepage in subsoil; suited to pit-type ponds.	High water table; fair stability and compactibility; rapid seepage; subject to piping.	Drainage needed; high water table; very sandy substratum makes tiling questionable; ditchbanks unstable; wet depressions.	Nearly level to depressional areas; high water table; diversion ditches helpful in adjacent sloping areas.
Kibbie: KfA, KfB	Seasonal high water table; silty and sandy substratum loses stability when wet; subject to frost heaving; fair to poor bearing capacity.	Medium to slow seepage; sides of ponds unstable if wet.	Subsoil has fair stability and compactibility and slow seepage; substratum has poor stability and medium seepage; subject to piping.	Drainage needed; seasonal high water table; silt and very fine sand in substratum flow into tile; ditchbanks unstable.	Nearly level to very gently sloping; sandy surface; little runoff; diversion ditches helpful in adjacent sloping areas.
Lake beaches: La	Loose sand easily excavated but sometimes difficult to haul; subject to soil blowing.	Rapid seepage; too porous to hold water unless seal blanket is used.	Fair stability and compactibility; rapid seepage; difficult to vegetate.	Drainage not needed.	Nearly level; little runoff.
Lamson: Lb	High water table; sandy material liquefies and flows when wet.	High water table; rapid seepage; too porous to hold water.	High water table; poor stability; fair compactibility; medium to rapid seepage; low volume change; subject to piping.	Drainage needed; high water table; tiling questionable; ditchbanks unstable.	Nearly level depressional areas; high water table; diversion ditches helpful in adjacent sloping areas.

interpretations—Continued

Sodded waterways	Foundations for low buildings (3 stories or less)	Winter grading	Irrigation	Limitations for septic tank disposal fields
Seasonal high water table; little runoff; diversion ditches helpful in adjacent sloping areas.	Seasonal high water table; fair to poor bearing capacity; moderate volume change.	Often too wet for good compaction; poor stability on thawing.	Moderately high water holding capacity; medium water intake rate.	Severe: seasonal high water table; moderately slow permeability; onsite investigation needed.
Nearly level to depressional areas; high water table; unstable organic material; little runoff.	Very high water table; very high compressibility; unstable organic material.	High water table; unstable organic material.	High water-holding capacity; very rapid water intake rate; drainage needed.	Severe: filter fields saturated during wet periods; high water table; unstable organic material.
Difficult to vegetate where deep cuts expose sand and gravel; sloping areas subject to runoff and erosion.	Good bearing capacity; low volume change; very low compressibility; medium to high shear strength.	Often too wet for good compactibility; poor stability on thawing.	Medium water-holding capacity; rapid water intake rate; sloping areas subject to runoff.	Slight: rapid drainage at depth of 3 feet; slopes of more than 10 percent hinder installation and operation of disposal fields; possible contamination of shallow water supplies.
Nearly level to depressional areas; sandy material is highly erodible and has low water-holding capacity; little runoff.	High water table; fair to good bearing capacity; low volume change; very low compressibility; medium to high shear strength; may liquefy and flow when wet.	High water table; wetness often hinders operations.	Moderately low water-holding capacity; rapid water intake rate; drainage needed.	Severe: high water table; moderately rapid permeability in subsoil; disposal fields saturated during wet periods.
Nearly level to depressional areas; sandy material highly erodible and low in water-holding capacity; little runoff.	High water table; fair to good bearing capacity; low volume change; very low compressibility; good shear strength; may liquefy and flow when wet.	High water table; wetness hinders operations.	Low water-holding capacity; rapid water intake rate; drainage needed; high water table.	Severe: high water table; rapid permeability; disposal fields saturated during wet periods.
Nearly level to gently sloping areas; surface layer and subsoil are sandy and silty; little runoff.	Seasonal high water table; fair to poor bearing capacity; low volume change and compressibility; fair shear strength; subject to liquefaction.	Often too wet for good compaction; poor stability on thawing.	Moderately high water-holding capacity; medium water intake rate.	Severe: seasonal high water table; soil material, when wet, may flow into tile of disposal fields; onsite investigation needed.
Little runoff; difficult to vegetate.	Fair to good bearing capacity; low volume change; very low compressibility.	Moisture content usually low; good stability on thawing.	Very low water-holding capacity; very rapid water intake rate; requires frequent watering.	Slight: possible pollution of shallow water supplies.
Nearly level depressional areas; sandy material highly erodible and moderately low in water-holding capacity; little runoff.	High water table; poor bearing capacity when wet; low volume change; medium to high shear strength.	High water table; poor stability on thawing.	Moderately low water-holding capacity; rapid water intake rate; drainage needed; high water table.	Severe: high water table; moderately rapid permeability.

TABLE 6.—*Engineering*

Soil series and map symbols	Highway location	Farm ponds: Reservoir area	Farm ponds: Embankment	Agricultural drainage	Terraces and diversions
Landes: Ld	Fair to good bearing capacity; subject to occasional flooding.	Occasional flooding of short duration; moderately rapid seepage.	Fair stability; fair to good compactibility; medium seepage; subject to piping.	Drainage not needed; subject to stream overflow.	Nearly level stream bottoms and alluvial plains; subject to stream overflow.
Lenawee: Le	High water table; subject to frost heaving; fair to poor bearing capacity; wetness hinders operations.	High water table; slow seepage; suited to pit-type ponds.	High water table; fair to good stability and compactibility; slow seepage.	Surface and subsurface drainage needed; high water table; moderately slow permeability.	Nearly level to depressional areas; diversion ditches helpful in adjacent sloping areas.
Linwood: Lm	High water table; unstable organic material must be removed; fair bearing capacity in substratum.	High water table; seepage is rapid to depth of 12 to 42 inches and slow below; flotation of organic matter possible.	Subsoil: unstable organic material. Substratum: fair to good stability and compactibility; slow seepage.	Controlled drainage needed; high water table; organic material subsides if overdrained.	Nearly level to depressional areas; low stability; high water table; diversion ditches helpful in adjacent sloping areas.
Lupton: Lu	High water table; unstable organic material must be removed.	High water table; rapid seepage; caving and flotation of organic material possible.	High water table; unstable organic material.	Controlled drainage desirable; high water table; poorly drained; organic material subsides if overdrained.	Nearly level to depressional areas; diversion ditches helpful in adjacent sloping areas.
Markey: Mk	High water table; unstable organic material must be removed; sandy substratum.	High water table; rapid seepage· flotation of organic material possible; suited to pit-type ponds.	High water table; unstable organic material to depth of 12 to 42 inches; sand substratum has moderately rapid permeability.	Drainage needed; high water table; ditchbanks unstable; poorly drained; sandy substratum; tiling questionable.	Nearly level to depressional areas; unstable organic material; diversion ditches helpful in adjacent sloping areas.
Metamora: MIA, MIB.	Periodic high water table; wetness hinders construction in some areas; fair to poor bearing capacity.	Seasonal high water table; medium to high seepage.	Subsoil and substratum have fair to good stability and compactibility; slow seepage in substratum.	Drainage usually needed in most places; moderately slow permeability at depth of 18 to 42 inches; seasonal high water table; needs random tile or surface drains in depressions.	Nearly level to very gently sloping areas; little runoff; diversion ditches helpful in adjacent sloping areas.
Metea: MnA, MnB, MnC.	Cuts and fills often needed; fair to poor bearing capacity.	Seepage is rapid to depth of 18 to 42 inches and medium to slow below depth of 18 to 42 inches; seal blanket required unless sandy material is removed.	Fair stability and compactibility; slow seepage; low volume change.	Drainage not needed.	Sandy surface and subsoil; sloping areas erode readily; construction of diversion ditches difficult on slopes of more than 12 percent.
Miami: MoB, MoC, MoD, MoE, MpC2, MpD2, MpE2, MtB, MtC, MtD. For Metea part of MtB, MtC, and MtD, see Metea series.	Cuts and fills needed in some areas; subject to frost heaving; fair to poor bearing capacity.	Medium to slow seepage.	Fair stability and compactibility; slow seepage; low to moderate volume change.	Drainage not needed.	No restrictions on slopes of less than 12 percent.

interpretations—Continued

Sodded waterways	Foundations for low buildings (3 stories or less)	Winter grading	Irrigation	Limitations for septic tank disposal fields
Nearly level stream bottoms; subject to stream overflow; little runoff.	Occasional flooding of short duration; fair to good bearing capacity and compressibility; low volume change.	Sometimes too wet for good compaction; loss of stability on thawing.	Moderately low water-holding capacity; rapid water intake rate; subject to stream overflow.	Severe: subject to stream overflow; onsite investigation needed.
Nearly level to depressional areas; water table near surface; little runoff.	High water table; moderate volume change; fair to poor bearing capacity and shear strength; medium compressibility.	High water table; stable on thawing.	High water-holding capacity; medium water intake rate; needs internal drainage.	Severe: high water table; moderately slow permeability; onsite investigation needed; disposal fields saturated during wet periods.
Nearly level to depressional areas; high water table; unstable organic material; little runoff.	High water table; unstable organic layer to depth of 12 to 42 inches; substratum has fair to poor bearing capacity and low volume change.	Severe: high water table; unstable organic material.	Very high water-holding capacity; very rapid water intake rate; drainage required.	Severe: high water table; unstable organic material to a depth of 12 to 42 inches; slow seepage; moderately slow permeability in substratum.
Nearly level to depressional areas; very high water table; very little runoff.	High water table; very high compressibility; unstable.	High water table; unstable organic material.	High water-holding capacity; very rapid water intake rate; drainage required.	Severe: high water table; unstable organic material; disposal fields saturated during wet periods.
Nearly level to depressional areas; high water table; very little runoff.	High water table; unstable organic material to depth of 12 to 42 inches; substratum has low volume change and compressibility; may liquefy and flow when wet.	High water table; unstable organic material.	High water-holding capacity; very high water intake rate; drainage required.	Severe: high water table; unstable organic material; saturated during wet periods.
Seasonal high water table; little runoff.	Seasonal high water table; fair to poor bearing capacity; moderate volume change; subject to frost heaving and liquefaction.	Often too wet for good compaction; poor stability on thawing.	Medium water-holding capacity; rapid water intake rate; periodic high water table.	Severe: seasonal high water table; permeability varies; onsite investigation needed.
Sandy surface layers and subsoil; sloping areas difficult to vegetate; highly erodible.	Fair to poor bearing capacity; low volume change; medium shear strength and compressibility.	Substratum often too wet for good compaction; poor stability on thawing.	Moderately low water-holding capacity; rapid water intake rate; frequent watering required; sloping areas subject to erosion.	Moderate: moderately slow permeability at depth of 18 to 42 inches; slopes of more than 10 percent hinder installation and operation of disposal fields.
Sloping to steep; subject to rapid runoff and erosion.	Fair to poor bearing capacity; medium compressibility; fair to good workability; low to moderate volume change; medium shear strength.	Often too wet for good compaction; poor stability on thawing.	Moderately high water-holding capacity; medium water intake rate; sloping areas subject to erosion.	Slight to severe: moderate permeability; slopes of more than 10 percent hinder installation and operation of disposal fields.

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TABLE 6.—*Engineering*

Soil series and map symbols	Highway location	Farm ponds		Agricultural drainage	Terraces and diversions
		Reservoir area	Embankment		
MsA	Substratum has good bearing capacity and is good material for subbase and fill.	Medium to slow seepage in subsoil; seal blanket required where porous sand and gravel of substratum is exposed.	Subsoil has fair stability and moderately slow seepage; substratum has good stability and rapid seepage.	Drainage not needed.	Nearly level
Minoa: MuA	Seasonal high water table; sandy material loses stability and flows when wet.	Somewhat poorly drained sandy soil; rapid seepage; too porous to hold water.	Poor stability; fair compactibility; medium to rapid seepage; low volume change; subject to piping.	Drainage needed; seasonal high water table; somewhat poorly drained; tiling questionable; ditchbanks unstable.	Sandy subsoil; little runoff; difficult to vegetate.
Morley: MvB, MvC	Cuts and fills needed in some areas; subject to frost heave.	Slow seepage	Fair stability and compactibility; moderate volume change; slow seepage.	Drainage usually not needed; small wet areas may need random tile.	Clayey subsoil difficult to vegetate.
Oakville: OaB, OaC	Cuts and fills needed in some areas; loose sands easily excavated but sometimes hinder handling; subject to soil blowing.	Rapid seepage; too porous to hold water unless seal blanket is used.	Fair stability and compactibility; rapid seepage; low volume change; difficult to vegetate; subject to piping.	Drainage not needed.	Slow runoff; difficult to vegetate; droughty; low water-holding capacity; low natural fertility.
OkB	Cuts and fills needed in some areas; loose sand hinders hauling operations; substratum is slippery when wet and slows construction.	Seepage is rapid to depth of 42 to 66 inches, and slow below; seal blanket required unless sandy material is removed.	Sandy material: fair stability; rapid seepage; subject to piping. Substratum: fair to good stability; slow seepage.	Drainage not needed.	Sandy subsoil; highly erodible; difficult to vegetate.
Owosso. Mapped only with Celina series.	Cuts and fills needed in sloping and rolling areas; fair to poor bearing capacity; material at depth below 18 to 42 inches is subject to frost heaving.	Medium to slow seepage.	Fair to good stability and compactibility; slow seepage.	Drainage usually needed only in local wet depressions.	Medium water-holding capacity.
Perrin: PeA, PeB	Substratum: good bearing capacity; good source for subbase and fill.	Medium to rapid seepage in subsoil; seal blanket required where porous sand and gravel are exposed.	Fair stability, medium seepage, and fair to good compaction to depth of 24 to 42 inches; substratum has good stability and rapid seepage; subject to piping.	Drainage not needed.	Sandy subsoil; highly erodible; slow runoff; difficult to vegetate.
Pinconning: PnA. For Allendale part of PnA, see Allendale series.	High water table; wet depressions that pond; fill required in many areas; construction difficult during wet periods; fair to good bearing capacity; low volume change; slight frost heaving.	High water table; seepage is rapid in subsoil and slow in substratum; seal blanket required unless sandy material is removed.	Sandy material: poor stability; rapid seepage, subject to piping. Clayey material: fair to good stability; slow seepage.	Internal drainage needed; high water table; slow permeability in substratum; unstable to depth of 18 to 42 inches when wet.	Nearly level to depressional areas; sandy subsoil; little runoff; diversion ditches helpful in adjacent sloping areas.

interpretations—Continued

Sodded waterways	Foundations for low buildings (3 stories or less)	Winter grading	Irrigation	Limitations for septic tank disposal fields
Nearly level	Good bearing capacity; moderate volume change; very low compressibility.	Usually too wet for good compaction; poor stability on thawing.	High water-holding capacity, rapid water intake rate.	Slight to severe: moderate permeability to a depth of 40 to 66 inches, rapid permeability in sand and gravel of substratum.
Sandy subsoil; difficult to vegetate; subject to soil blowing; little runoff.	Seasonal high water table; poor bearing capacity when wet; low volume change; good shear strength.	Too wet in some areas for good compaction; poor stability on thawing.	Moderately low water-holding capacity; rapid water intake rate; frequent watering required.	Severe: seasonal high water table; possible pollution of water supply.
Clayey subsoil; difficult to vegetate; rapid runoff in rolling areas.	Fair to poor bearing capacity; moderate volume change; medium shear strength and compressibility.	Often too wet for good compaction; poor stability on thawing.	High water-holding capacity; medium water intake rate; sloping areas subject to runoff and erosion.	Severe: moderately slow permeability.
Droughty; highly erodible; difficult to vegetate; very little runoff.	Very low compressibility; fair workability; low volume change; good to fair bearing capacity; may liquefy and flow when wet.	Sandy; low moisture content; good stability on thawing.	Low water-holding capacity; very rapid water intake rate; subject to soil blowing; frequent watering required.	Slight: possible pollution of shallow water supplies; slopes of more than 10 percent hinder installation and operation of disposal fields.
Low water-holding capacity; difficult to vegetate; highly erodible; little runoff.	Fair to poor bearing capacity; moderate volume change; low shear strength; medium to high compressibility.	Moisture content is low in sand and high in clay and loam.	Low water-holding capacity; very rapid water intake rate; requires frequent watering; subject to soil blowing.	Severe: slight restriction where clayey material is at depth of less than 48 inches; seasonally high water table in excavated areas; onsite investigation needed.
Sloping; subject to runoff and erosion.	Fair to poor bearing capacity; moderate volume change; medium shear strength and compressibility; subject to frost heaving.	Often too wet for good compaction; poor stability on thawing.	Medium water-holding capacity; rapid water intake rate.	Moderate to severe: permeability varies; onsite investigation needed.
Sandy subsoil; highly erodible; moderately low water-holding capacity; moderate natural fertility; difficult to vegetate; little runoff.	Good bearing capacity; low volume change; very low compressibility; medium to high shear strength.	Moderately low moisture content; good to fair stability on thawing; good workability and trafficability.	Moderately low water-holding capacity; moderately low fertility; rapid water intake rate; requires frequent watering.	Moderate: water table at depth of 2 to 3 feet during wet periods; possible pollution of shallow water supplies by effluent.
Nearly level to depressional areas; sandy subsoil; little runoff.	High water table; fair to poor bearing capacity; high volume change and compressibility; low shear strength.	High moisture content; poor stability on thawing.	Medium water-holding capacity; very rapid water intake rate; subject to soil blowing.	Severe: high water table; slow permeability in substratum; onsite investigation needed; disposal fields saturated during wet periods.

TABLE 6.—*Engineering*

Soil series and map symbols	Highway location	Farm ponds		Agricultural drainage	Terraces and diversions
		Reservoir area	Embankment		
Rifle: Rf	High water table; unstable organic soil must be removed.	High water table; rapid seepage; suited to pit-type ponds; caving in and flotation of organic material possible.	High water table; unstable organic material.	Controlled drainage needed; high water table; organic material subsides if overdrained.	Nearly level to depressional areas; diversion ditches helpful in adjacent sloping areas.
Sebewa: Se	High water table; wetness hinders construction; substratum is good subbase and fill material.	High water table; suited to pit-type ponds; rapid seepage in sand and gravel.	High water table; fair to good stability and slow seepage to depth of 24 to 42 inches; fair to poor stability and rapid seepage in substratum.	Drainage needed: high water table; rapid permeability in subsoil; tile requires blinding in sand and gravel of substratum; wet depressions.	Nearly level to depressional areas; little runoff; diversion ditches helpful in adjacent areas.
Selfridge: SdA, SdB.	Seasonal high water table; wetness hinders construction in some areas; fair to poor bearing capacity; substratum subject to frost heaving.	Seasonal high water table; rapid seepage to depth of 18 to 42 inches and medium to slow below; seal blanket required unless sandy material is removed.	Seasonal high water table; fair stability and compactibility and slow seepage at depth below 18 to 42 inches.	Random tile or surface drainage needed; seasonal high water table; moderately slow permeability at depth of 18 to 42 inches; wet depressions.	Nearly level or gently sloping areas; little runoff; sandy subsoil; highly erodible.
Sisson: SfB, SfC	Unstable silty and sandy substratum; subject to frost heaving.	Medium seepage; seal blanket required where unstable substratum is exposed.	Fair to good stability, slow seepage, and fair compactibility to a depth of 24 to 42 inches; substratum has fair to poor stability and is subject to piping.	Drainage not needed.	Construction of diversion ditches difficult on slopes of more than 10 percent.
Sloan: Sm, Sn	High water table; subject to stream overflow; fair to poor bearing capacity; subject to frost heaving.	High water table; seepage is slow in subsoil and rapid in substratum; subject to stream overflow.	High water table; subsoil has fair to good stability and compactibility and slow seepage.	Drainage needed; high water table; subject to stream overflow.	Nearly level to depressional areas; little runoff; diversion ditches on adjacent sloping areas help reduce runoff.
Spinks: SvA, SvB, SvC, SvD For Oakville part of SvA, SvB, SvC, and SvD, see **Oakville series.**	Cuts and fills needed in some areas; easily excavated but sometimes loose sand hinders hauling; good bearing capacity; subject to soil blowing.	Rapid seepage; too porous to hold water unless seal blanket is used.	Rapid to medium seepage; fair stability and compactibility; low volume change; subject to piping.	Drainage not needed.	Sandy soil; little runoff; difficult to vegetate.
Spinks, wet subsoil variant: SpA.	Seasonal high water table; wetness may hinder construction; substratum has fair to good bearing capacity.	Medium seepage to depth of 42 inches; seal blanket required where sand and gravel are exposed.	Fair stability, medium seepage, and fair to good compactibility to depth of 42 to 60 inches; fair stability and compactibility and rapid seepage in substratum.	Drainage usually required; seasonal high water table; sand and gravel substratum makes blinding of tile necessary.	Shallow to sand and gravel; highly erodible; difficult to vegetate; little runoff.

interpretations—Continued

Sodded waterways	Foundations for low buildings (3 stories or less)	Winter grading	Irrigation	Limitations for septic tank disposal fields
Nearly level to depressional areas; high water table; unstable organic material; very little runoff.	High water table; very high compressibility; unstable.	High water table; unstable organic material.	High water-holding capacity; very rapid water intake rate; drainage required.	Severe: high water table; unstable organic material; disposal fields saturated during wet periods.
Nearly level to depressional areas; high water table; little runoff.	High water table; substratum has good bearing capacity, low volume change, very low compressibility, and good shear strength.	High water table; wetness often hinders operations.	High water-holding capacity; medium water intake rate; drainage required.	Severe: high water table; rapid permeability in sand and gravel at depth of 24 to 42 inches; disposal fields saturated during wet periods.
Sandy subsoil highly erodible; moderately low water-holding capacity; little runoff.	Seasonal high water table; fair to poor bearing capacity; moderate volume change; medium shear strength and compressibility.	Seasonal high water table; often too wet for good compaction; poor stability on thawing.	Moderately low water-holding capacity; rapid water intake rate; seasonal high water table.	Severe: seasonal high water table; moderately slow permeability at depth of 18 to 42 inches.
Sloping areas erode readily and are difficult to vegetate; little runoff in nearly level areas.	Fair to poor bearing capacity; subject to frost heaving; reduction of bearing capacity on thawing; may liquefy and flow when wet; low volume change.	Often too wet for good compactibility; poor stability on thawing.	High water-holding capacity; medium water intake rate.	Slight: unstable substratum, when wet, may flow into tile of disposal fields.
Nearly level to depressional areas; subject to stream overflow; little runoff.	High water table; subject to stream overflow; subsoil has fair to poor bearing capacity and medium compressibility and shear strength.	High water table; wetness hinders operation of equipment; poor stability on thawing.	High water-holding capacity; medium water intake rate; subject to stream overflow; drainage required.	Severe: high water table; subject to stream overflow of short duration; onsite investigation needed.
Difficult to vegetate; subject to soil blowing; little runoff.	Good bearing capacity; low volume change; very low compressibility; may liquefy and flow when wet.	Sandy; usually moderately low water-holding capacity; good stability on thawing.	Moderately low water-holding capacity; rapid water intake rate; requires frequent watering; subject to soil blowing.	Slight: possible pollution of shallow water supplies; slopes of more than 10 percent hinder installation and operation of disposal fields.
Sandy material erodible; moderately low water-holding capacity; moderately low natural fertility; difficult to vegetate; little runoff.	Seasonal high water table; fair to good bearing capacity; low volume change; very low compressibility; medium to high shear strength; may liquefy and flow when wet.	Moderately low water-holding capacity; fair stability on thawing; good workability and trafficability.	Moderately low water-holding capacity; rapid water intake rate; requires frequent watering; sand and gravel at depth of 42 to 60 inches.	Severe: seasonal high water table; rapid permeability in sand and gravel at depth of 42 to 60 inches; possible pollution of shallow water supplies; onsite investigation needed.

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TABLE 6.—*Engineering*

Soil series and map symbols	Highway location	Farm ponds: Reservoir area	Farm ponds: Embankment	Agricultural drainage	Terraces and diversions
Tuscola: TsA, TsB.	Unstable silty and sandy substratum; subject to frost heaving.	Medium seepage; seal blanket required where unstable silty and sandy material is exposed.	Fair to good stability, slow seepage, and fair compactibility to depth of 36 to 42 inches; substratum has fair to poor stability and is subject to seeping.	Random tile needed in some areas to drain wet depressions; ditchbanks unstable.	Difficult to construct on short and irregular slopes; silty material highly erodible on rolling areas.
Wallkill: Wa	High water table; unstable organic material must be removed; subject to stream overflow.	High water table; seepage is slow to depth of 10 to 40 inches and rapid below; subject to stream overflow; suited to pit-type ponds.	High water table; organic material unsuitable; substratum is unstable for embankment.	Drainage needed; high water table; subject to flooding; organic material at depth of 10 to 40 inches unstable and subsides when drained.	Nearly level to depressional; high water table; diversion ditches helpful in adjacent sloping areas.
Wasepi: WeA	Seasonal high water table; wetness may hinder construction; substratum has fair to good bearing capacity.	Seepage is medium to depth of 24 to 42 inches; seal blanket required where porous sand and gravel are exposed.	Fair stability, medium seepage, and fair to good compactibility to depth of 24 to 42 inches; fair stability and compactibility in substratum.	Drainage usually needed; seasonal high water table; sand and gravel substratum makes blinding of tile necessary.	Nearly level to depressional; little runoff; diversion ditches helpful in adjacent sloping ditches.
WpA	Seasonal high water table; subsoil is good subbase or fill material; substratum slippery when wet and hinders construction.	Seasonal high water table; seepage medium to rapid in subsoil and slow in substratum.	Fair to good stability and compactibility and medium seepage in subsoil; fair to good stability and compactibility and moderately slow seepage in substratum.	Internal drainage needed; seasonal high water table; permeability is moderate in subsoil and slow in substratum.	Nearly level to gently sloping areas; sandy subsoil; little runoff; diversion ditches helpful on adjacent sloping areas.

Engineering classification systems

The U.S. Department of Agriculture system (*11*) 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 classifying 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). Engineers of the Soil Conservation Service prefer to use the Unified soil classification system. Both classification systems are used in this publication (see table 4) 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 material (*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 that have low strength when wet.

Unified classification.—In the Unified soil classification system (*12*), 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 properties of soils

Table 4 contains estimates of physical and chemical properties of the soils that are based on observations made in the field in parts of this county and similar soils in other counties.

The depth to bedrock is not shown, because soils in the survey area are deep enough over bedrock that bedrock generally does not affect their use.

In estimating depth to the water table, it is assumed that no artificial drainage is used. During prolonged wet or extremely dry periods, depth to the water table is commonly outside the range shown in table 4.

interpretations—Continued

Sodded waterways	Foundations for low buildings (3 stories or less)	Winter grading	Irrigation	Limitations for septic tank disposal fields
Silty and sandy surface layers; little runoff.	Fair to poor bearing capacity; subject to frost heaving and reduction of bearing capacity on thawing; may flow when wet.	Moisture content too high for good compaction; poor stability on thawing.	High water-holding capacity; medium water intake rate.	Slight to moderate: stratified sandy material, when wet, may flow into tile of disposal fields.
Nearly level to depressional areas; high water table; subject to flooding; little runoff.	High water table; unstable organic material below depth of 10 to 40 inches; very high compressibility.	High water table; substratum of unstable organic material; wetness hinders operations.	High water-holding capacity; medium water intake rate; drainage and protection from stream overflow required in some areas.	Severe: high water table; subject to stream overflow; unstable organic material at depth of 10 to 40 inches.
Nearly level to depressional areas; surface layer and subsoil sandy; little runoff.	Seasonal high water table; fair to good bearing capacity; low volume change; very low compressibility; fair to good shear strength; may liquefy and flow when wet.	May be too wet for operation of equipment.	Moderately low water-holding capacity; rapid water intake rate; moderate depth to sand and gravel.	Moderate to severe: seasonal high water table; rapid permeability in sand and gravel at depth of 24 to 42 inches; possible pollution of shallow water supplies; onsite investigation needed.
Nearly level to gently sloping areas; sandy surface layer and subsoil; little runoff.	Subsoil has medium compressibility, fair workability, low volume change, fair to good compactibility, and good shear strength.	Seasonal high water table; subsoil has good to fair stability on thawing; good workability and trafficability.	Moderately low water-holding capacity; medium to rapid water intake rate; seasonal high water table.	Moderate to severe: seasonal high water table; rapid seepage in subsoil, slow seepage in substratum; permeability is moderately rapid in subsoil and moderately slow in substratum.

Generally, the data in table 4 apply to the soil material to a depth of 60 inches or less. Horizons other than the major horizon are indicated only if their engineering properties differ significantly from those of the adjacent horizons. The depths shown are considered to be typical for the series, but in most areas actual depth and thickness of layers may vary 12 inches or less. The organic soils are classified on the basis of the upper 42 inches. Below this depth there is considerable variation in texture and thickness.

The figures in the columns showing the percentages of material passing through sieves No. 4, No. 10, and No. 200 are rounded off to the nearest 5 percent. The percentage of material passing the No. 200 sieve approximates the combined amount of silt and clay in a soil.

Soil permeability is the rate at which water moves downward through undisturbed soil material. These estimates are based mainly on texture, structure, and consistence of the soil.

Available water capacity, expressed in inches per inch of soil depth, refers to the approximate amount of capillary water in the soil when it is wet to field capacity. This amount of water will wet air-dry soil to a depth of 1 inch without deeper penetration. Available water capacity is influenced by soil texture and organic-matter content.

Soil reaction indicates the acidity or alkalinity of a soil. A pH value of 7 indicates a neutral soil. A number lower than 7 indicates acidity, and a number higher than 7 indicates alkalinity. Reaction as shown in table 4 is the estimated range in pH values as determined in the field for each major soil horizon.

Shrink-swell potential refers to the change in the volume of the soil that results from a change in moisture content. The estimates in table 4 are based mainly on the amount and kind of clay in a soil.

Corrosivity, as used in table 4, shows the potential danger to uncoated steel or concrete structures through chemical action that weakens or dissolves the structural material. Structural materials may corrode when buried in soil, and a given material may corrode in one kind of soil more rapidly than in another. Extensive installations that intersect soil boundaries or soil horizons are more likely to be damaged by corrosion than are installations entirely in one kind of soil or in one soil horizon.

Engineering interpretations

Table 5 gives the suitability ratings of the soils as sources of topsoil, sand, gravel, road fill, and impermeable material. Table 6 lists soil properties that are desirable for specific engineering structures, as well as those that present hazards and limit use of the soil under certain conditions. The data in these tables apply to the representative profile of the soil series, which is described in the section "Descriptions of the Soils."

In table 5 the suitability of the soils as a source of topsoil refers specifically to the use of material, preferably rich in organic matter, as a topdressing for backslopes, embankments, lawns, gardens, and so on. The ratings are based mainly on the texture of the soil and its organic-matter content. Unless otherwise indicated, only the surface layer of a mineral soil is considered suitable as a source of topsoil.

The suitability of the soils as a source of sand or gravel refers to materials that are no more than 60 inches from the surface. In some soils the depth to sand or gravel ranges from less than 60 inches in some places to more than 60 inches in other places. Although some soils are rated unsuitable as sources of sand and gravel, these soils in places contain sand and gravel at a depth of more than 60 inches. Individual test pits are needed in such areas to determine the availability of sand and gravel.

The suitability of a soil as a source of subgrade material for road fill depends partly on the texture of the soil material. If the subsoil and substratum have contrasting characteristics, both are stated. In general, sandy material containing adequate binder is the most desirable material for subgrade, and plastic clay is the least desirable.

The suitability of a soil as a source of impermeable material applies to its use as a reservoir sealant, a dike or levee core, a farm pond embankment, or in any other engineering structure where the rate of internal water movement must be slowed. The suitability of a soil depends on such soil properties as workability, compactibility, permeability, and hazard of piping. Highly stable sandy clay soils are among the most suitable, and loose sands or coarse materials with a rapid water intake rate are the least suitable.

The entire soil profile was considered to determine the suitability of the soils as locations for highways. The features shown in table 6 are for undisturbed soils that are not artificially drained. Additional information can be obtained from the "Field Manual of Soil Engineering" (*6*), in which the major soil series in Michigan are rated as to their suitability for highway construction.

In determining the suitability of the soils for farm ponds (table 6), the entire soil profile is considered for both the reservoir area and for embankment material unless otherwise specified. The features shown for reservoir areas are those of undisturbed soils, and the features shown for embankments are those of disturbed soils. Features that affect the suitability of the soils for reservoirs and embankments include organic-matter content, permeability, shrink-swell potential, ground-water level, shear strength, compaction characteristics, and stability.

Features that affect the suitability of the soils for agricultural drainage include soil texture, rate of water movement into and through the soil, depth to an impervious layer, depth to the water table, and the position of the soil.

Features that affect the suitability of the soils for terraces and diversions are landform, texture of the soil, and depth to soil material that is unsuited to crops.

Permeability, fertility, and erosion hazard are some of the main features affecting the suitability of the soils for sodded waterways. Features that affect the layout and construction of waterways, the establishment and growth of vegetation in waterways, and the maintenance of waterways are also considered in table 6.

The suitability of undisturbed soils for foundations for low buildings depends mainly on the characteristics of the substratum, which generally provides the base for foundations. The features shown in table 6, therefore, are those of the substratum. An important factor to consider in determining the suitability of the soils for such foundations is shrink-swell potential, which is given in table 6. The ratings for bearing capacity in table 6, as for example, GOOD bearing capacity, are estimates, and specific values, as pounds per square inch, should not be assigned.

Winter grading is affected mainly by soil features that affect the crossing of areas of soil and the handling of soil material with ordinary construction equipment when the temperature is below freezing.

In determining the limitation of the soils for septic tank disposal fields, the factors considered were depth to the water table, permeability or percolation rate, hazard of flooding, and steepness of slope (fig. 10).

The suitability of the soils for irrigation is determined mainly by water-holding capacity, water intake rate, depth to the water table, depth to layers that restrict growth of roots, and topography.

Use of Soils in Community Development

Community development, accompanied by the extension of public utilities and the establishment of business and recreational facilities, creates a need for information on soils. This information differs somewhat from that needed by farmers. Land appraisers, real estate brokers, city planners, builders, and others need facts that will help them determine what sites are suitable for homes and other buildings and what areas are best reserved for other uses. Homeowners need information on how to landscape their property and protect it against the erosion hazards of built-up communities.

Factors that must be considered when selecting a site for residential development include soil drainage, permeability, stability of the soil material, frequency of flooding, slope, and hazard of erosion.

Figure 10.—**Seasonal high water table in Conover soils restricts operation of septic tank disposal fields.**

Soils of the Breckenridge, Brookston, Lenawee, and Pinconning series are poorly drained and have a high water table. The high water table, even where it is seasonal, hinders the operation of septic tank disposal fields. In addition, it is difficult to keep basements dry in these soils. Information on drainage and other features of the soils is given in the section "Descriptions of the Soils."

The suitability of a soil for septic tank disposal fields depends on the rate at which water moves down through the soil. Soils of the Morley series, for example, have moderately slow permeability and are severely limited for septic tank disposal fields. Rapidly permeable sandy soils, such as those of the Oakville and Spinks series, may allow unfiltered effluent to enter and contaminate shallow water supplies. Information on this aspect of soils is given in the columns "Permeability" in table 4 and "Limitations for septic tank disposal fields" in table 6.

Some soils provide better foundations for houses than others. Soils of the Boyer, Fox, and Oakville series, for example, provide good foundations. Soils of the Carlisle, Edwards, and Wallkill series, on the other hand, are severely limited for foundations because of the presence of unstable organic material and marl. Information in the columns "Shrink-swell potential" in table 4 and "Foundations for low buildings" in table 6 can help in selecting soils with the fewest limitations for foundations.

Bottom-land soils, such as those of the Ceresco, Cohoctah, Landes, and Sloan series, are severely limited for houses because of flooding.

The hazard of erosion and the problem of land slippage increase as slope becomes steeper. This also increases the difficulty of laying out and constructing streets and installing utilities.

Streets, driveways, and sidewalks: The suitability of soils for streets, driveways, sidewalks, and patios is of special interest to homeowners and developers. Soils with a high silt content, such as those of the Tuscola, Kibbie, and Colwood series, are subject to frost heaving. Concrete cracks readily if it is placed on these soils without the surface first being covered with sandy and gravelly material. Soils that have a high water table or a high clay content also cause pavements and sidewalks to crack and shift excessively.

The poorly drained Carlisle, Edwards, Linwood, Rifle, and Wallkill soils settle readily, especially after being drained. This settling causes cracking of pavement and an uneven surface. The columns "Shrink-swell potential" in table 4, "Road fill" in table 5, and "Highway location" in table 6 provide information on the use of soils for streets, driveways, and sidewalks.

Underground utility lines: Water mains, gas pipelines, communication lines, and sewer lines that are buried in the soil may corrode and break unless they are protected against certain electrochemical reactions. These reactions result from the inherent properties of the soil and differ according to the kind of soil.

All metals corrode to some degree when buried in the soil, and they corrode more rapidly in some soils than in others. The corrosivity depends on factors such as oxygen content, concentration of anaerobic bacteria, and moisture content. Design and construction also have an influence. The likelihood of corrosion is increased by connecting dissimilar metals, by burying metal structures at varying depths, and by extending pipelines through different kinds of soils.

In soils that have a high shrink-swell potential, stresses produced by changes in volume can break cast-iron pipe. To prevent breakage, it may be necessary to cushion the pipes with sandy material. The column "Shrink-swell potential" in table 4 furnishes estimates of the volume changes of the soils upon wetting and drying. The column "'Corrosivity" in table 4 gives a general rating for the corrosion potential of the soils.

Control of runoff and erosion: Erosion and the resulting accumulation of sediment is a serious problem in construction areas that are on sloping soils. The compaction of the soil during construction and the increased surface covered by pavement may make runoff from built-up areas two to ten times as much as from land in farms or forest. The runoff concentrates in streets and gutters, instead of flowing into natural waterways, which results in flooding and deposition of sediment in the lower areas. Sloping to steep areas of Miami and Morley soils are especially subject to rapid runoff and severe erosion.

Some measures that help protect small residential tracts are—

1. Locating driveways, walks, and fences on the contour if possible, or straight across the slope.
2. Grading to make the surface level or gently sloping. The topsoil can be removed prior to grading and later used for topsoil.
3. Building diversion terraces that intercept runoff and keep it from flowing over erodible areas.

4. Constructing or improving waterways to prevent the formation of gullies.
5. Draining seep areas and waterlogged areas with tile drains or other facilities.

Information on features that affect use of the soils for diversions, sodded waterways, and agricultural drainage is given in table 6.

Gardening and landscaping: Homeowners and landscape architects need to know what kind of soils are present in an area to be able to select flowers, shrubs, and trees for landscaping.

The ideal soils for yard and garden plants are those that have a deep root zone, a loamy texture, a balanced supply of plant nutrients, an adequate amount of organic matter, adequate available moisture capacity, good drainage, and a structure that allows free movement of water. The Miami, Morley, Tuscola, Celina, and Fox soils closely approach this ideal soil if their slope is not too steep.

Some soils, such as the Boyer, Croswell, Oakville, and Spinks, are sandy and droughty. Lawns and shrubs dry up quickly in these soils during dry periods unless they are watered frequently. The poorly drained soils, such as the Brookston and Lenawee, are difficult to work when wet, and the surface dries out hard and cloddy. Seeding of lawns is difficult on these soils once they are disturbed during construction.

The subsection "Management by capability units" gives information that can be useful in landscaping.

Public health: Information on soils has many applications in the area of public health, including use in solving problems of sewage disposal, maintenance of a pure water supply, prevention of disease, and provision of safe and adequate shelter.

Sewage lagoons, septic tank systems, and sewer lines need to be located and constructed so that seepage or drainage from them cannot pollute water supplies. Leakage from sewage lagoons built of unsuitable soil material is one cause of pollution. The sandy Oakville and Spinks soils have rapid permeability and may allow pollution. Wells, streams, and lakes can become contaminated by runoff from clogged disposal fields, and rapid percolation of septic tank effluent can result in pollution of shallow underground water supplies. Table 6 gives information on each soil for embankments and septic tank disposal fields. The soil maps show the major drainageways of the county and can be used as a general guide in locating disposal fields.

In selecting sites for sanitary land fills, it is important to consider the topography and drainage of an area and the characteristics of the soils, including texture, permeability, reaction, and the nature of the underlying material. The soil map helps to locate sites and identify the soils. Table 6 gives estimates of pertinent properties of the soils.

The stability of the soils is of major importance in the location of sewer lines. If the gradeline is interrupted, the sewerage system breaks down, and a public health hazard results.

Mosquitos and other disease-carrying insects breed in stagnant water. By use of the soil map and the soil descriptions, it is possible to identify areas subject to flooding and areas likely to be ponded from time to time because of nearly level relief or poor internal drainage. Once these possible trouble spots are located, the health hazard can be controlled by spraying to eliminate insects and installing drainage systems to remove the standing water that attracts insects.

Recreation: Soil features such as natural drainage, texture, slope, flooding hazard, and presence of stones and cobbles have an important effect on the suitability of a site for recreation.

Soils such as those of the Breckenridge, Brookston, Lenawee, and Pinconning series are severely limited for most recreational uses. Campsites, picnic areas, and intensive play areas have severe limitations on these soils because of poor natural drainage and a high water table. The Carlisle, Edwards, Linwood, Rifle, and Wallkill soils in particular are severely limited for recreation because of very poor drainage and the unstable condition of the organic material.

Sloping to steep areas of Miami, Spinks, and Oakville soils have severe limitations for recreation except for paths and trails. Slopes hinder layout of campsites and placement of picnic tables, tents, trailers, and buildings. Level to gently sloping areas of the sandy, well-drained soils, such as the Boyer, Croswell, Oakville, and Spinks, provide fair to good campsites, picnic areas, intensive play areas, and building sites. These soils dry out quickly after rain and therefore provide firm surfaces for foot and vehicular traffic.

The Ceresco, Cohoctah, Landes, and Sloan soils are limited for recreation by a flooding hazard.

Poorly drained Brookston, Conover, Lenawee, Linwood, Pinconning, and Granby soils are suited for pit-type ponds because of their high water table (fig. 11).

Formation and Classification of the Soils

This section discusses (a) the major factors of soil formation as they relate to the soils of Genesee County, (b) the processes of soil horizon differentiation, and (c) the system of classifying soils into categories broader than the series.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic forces. The characteristics of a soil are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are the active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and action of glaciers and slowly change it into a natural body

***Figure 11.*—Farm pond on Conover and Brookston soils in Richfield Township. This pond also provides opportunities for fishing, swimming, and boating.**

with genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed to change the parent material into a soil profile. Usually, a long time is required for the development of distinct horizons.

Parent material: Parent material is the unconsolidated mass from which a soil is formed. It determines the limits of the chemical and mineralogical composition of the soil. The parent material in Genesee County was deposited by glaciers on outwash plains, valley drainageways, till plains, moraines, and flood plains. It consists of gravel, sand, loam, and clay.

Climate: The climate of Genesee County is cool and humid. Climate is so uniform throughout the county that differences in Genesee County soils cannot be attributed to climate, although its effect is modified locally by runoff.

Plant and animal life: Plants, animals, insects, bacteria, and fungi are important in the formation of soils. Gains in organic matter and nitrogen in the soil, gains or losses in plant nutrients, and changes in structure and porosity are among the changes caused by living organisms. Vegetation, dominantly hardwood and coniferous trees, has affected soil formation in Genesee County more than have other living organisms.

Relief: Relief affects soil formation through its influence on drainage, erosion, plant cover, and soil temperature. Genesee County has an extremely variable relief. The range is from depressions to steep hills. In areas of steep hills, local differences in elevation are as much as 150 to 200 feet. In other parts of the county, large level plains have slopes of less than 2 percent. Many small level areas receive runoff from the sloping areas. In depressions and in some level areas, the water table is at or near the surface and the soils are somewhat poorly drained or poorly drained. The Brookston and Lenawee soils occur in such areas.

Time: Time, usually a long time, is required for the formation of distinct horizons in soils. Differences in the time that parent materials have been in place are therefore commonly reflected in the degree of development of the soil profile.

The soils in Genesee County range from young to old. The Oakville series is an example of young soils. Young soils have little profile development except for a darkening of their surface layer, and they retain most of the characteristics of their parent material. The Miami series is an example of older soils, which have well-expressed soil horizons.

Processes of Soil Horizon Differentiation

The four main processes involved in the formation of soil horizons are (1) accumulation of organic matter; (2) leaching of calcium carbonates and bases; (3) reduction and transfer of iron; and (4) formation and translocation of silicate clay minerals. In most soils more than one of these processes has been active in the development of soil horizons.

Accumulation of organic matter in the upper part of the profile is important in the formation of an A1 horizon. The soils of Genesee County range from high to very low in organic-matter content.

Leaching of carbonates and bases has occurred in nearly all of the soils in this county. Leaching of bases in soils is generally believed to precede translocation of silicate clay minerals. Most of the soils of the county are moderately to strongly leached.

Reduction and transfer of iron, a process called gleying, is evident in the poorly drained and very poorly drained soils. The gray color in the subsoil horizons indicates the reduction and loss of iron. Some horizons contain reddish-brown mottles and concretions, which indicates segregation of iron.

In some soils the translocation of clay minerals has contributed to horizon development. Eluviated A2 horizons that overlie B horizons have a weak structure, are lower in clay content, and usually are lighter in color. The B horizons usually have an accumulation of clay (clay films) in pores and on ped surfaces. These soils were probably leached of carbonates and soluble salts to a considerable extent before translocation of silicate clay took place. Leaching of bases and translocation of silicate clays are among the more important processes in horizon differentiation in the soils. The Miami series is an example of soils that have translocated silicate clays that accumulated in the B horizon in the form of clay films.

In some soils of Genesee County, iron and humus have moved from the surface to the B horizon, and the color of the B horizon ranges from dark reddish brown to yellowish brown. The Au Gres and Croswell series are examples of soils that have translocated iron and humus.

Classification of the Soils

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and later revised (*9*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965 and supplemented in March 1967 and in September 1968 (*10*). This system is under continual study, and readers interested in the development of the system should refer to the latest literature available (*8, 10*).

In table 7, the soil series of Genesee County are placed in some categories of the current system. Placement of some soil series in the current system of classification may change as more precise information becomes available.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. The classes that make up the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, Entisols and Histosols, occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Enti-*sol.*)

The soil orders represented in Genesee County are Entisols, Inceptisols, Alfisols, Mollisols, Spodosols, and Histosols. Entisols are recent soils that lack genetic horizons or have only the beginnings of such horizons.

Inceptisols most often occur on young but not recent land surfaces. Alfisols are soils that have a clay-enriched B horizon that is high in base saturation. Mollisols are soils that have a dark-colored surface. Spodosols are soils that have a B horizon enriched with iron and humus. Histosols are soils that formed in organic material.

SUBORDER: Each order is subdivided into suborders, primarily on the basis of those soil characteristics that seem to produce classes having the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of waterlogging or the soil differences resulting from the climate or vegetation.

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations into great groups are those in which clay, iron, or humus has accumulated or those that have pans that interfere with the growth of roots or movement of water. Among the characteristics considered are the self-mulching properties of clay, soil temperature, and major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium). The great group is not shown separately in table 7 because it is the last word in the name of the subgroup.

SUBGROUP: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of one great group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order.

FAMILY: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

SERIES: The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile. Each soil series that occurs in Genesee County is discussed in the section "Descriptions of the Soils."

TABLE 7.—*Classification of soil series according to the current system*

Series	Current system [1]		
	Family	Subgroup	Order
Allendale [2]	Sandy over clayey, mixed, frigid	Aqualfic Haplorthods	Spodosols.
Arkport	Coarse-loamy, mixed, mesic	Psammentic Hapludalfs	Alfisols.
Au Gres [2]	Sandy, mixed, frigid	Entic Haplaquods	Spodosols.
Boyer [3]	Coarse-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Breckenridge [2]	Coarse-loamy, mixed, nonacid, frigid.	Mollic Haplaquepts	Inceptisols.
Brevort [2]	Sandy over loamy, mixed, nonacid, frigid.	Mollic Haplaquents	Entisols.
Brookston	Fine-loamy, mixed, noncalcareous, mesic.	Typic Argiaquolls	Mollisols.
Carlisle	Evic, mesic	Typic Medisaprists	Histosols.
Celina [4]	Fine, mixed, mesic	Aquic Hapludalfs	Alfisols.
Ceresco	Coarse-loamy, mixed, mesic	Aquic Fluventic Hapludolls	Mollisols.
Cohoctah	Coarse-loamy, mixed, noncalcareous, mesic.	Fluventic Haplaquolls	Mollisols.
Colwood	Fine-loamy, mixed, noncalcareous, mesic.	Typic Haplaquolls	Mollisols.
Conover	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Croswell [2]	Sandy, mixed, frigid	Entic Haplorthods	Spodosols.
Del Rey	Fine, illitic, mesic	Aeric Ochraqualfs	Alfisols.
Edwards	Marly, evic, mesic	Limnic Medisaprists	Histosols.
Fox	Fine-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Hapludalfs	Alfisols.
Gilford	Coarse-loamy, mixed, noncalcareous, mesic.	Typic Haplaquolls	Mollisols.
Granby	Sandy, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Kibbie	Fine-loamy, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Lamson	Coarse-loamy, mixed, nonacid, mesic	Aeric Haplaquepts	Inceptisols.
Landes	Coarse-loamy, mixed, mesic	Fluventic Hapludolls	Mollisols.
Lenawee	Fine, mixed, nonacid, mesic	Mollic Haplaquepts	Inceptisols.
Linwood	Loamy, evic, mesic	Terric Medisaprists	Histosols.
Lupton	Evic	Typic Borosaprists	Histosols.
Markey	Sandy, evic	Terric Borosaprists	Histosols.
Metamora [5]	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Metea	Coarse-loamy, mixed, mesic	Arenic Hapludalfs	Alfisols.
Miami	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Minoa	Coarse-loamy, mixed, mesic	Aquic Eutrochrepts	Inceptisols.
Morley	Fine, illitic, mesic	Typic Hapludalfs	Alfisols.
Oakville	Sandy, mixed, mesic	Typic Udipsamments	Entisols.
Owosso	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Perrin [3]	Coarse-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Pinconning [2]	Sandy over clayey, mixed, nonacid, frigid.	Mollic Haplaquents	Inceptisols.
Rifle	Evic	Typic Borohemists	Histosols.
Sebewa	Fine-loamy over sandy or sandy-skeletal, noncalcareous, mesic.	Typic Argiaquolls	Mollisols.
Selfridge [6]	Coarse-loamy, mixed, mesic	Aquic Arenic Hapludalfs	Alfisols.
Sisson	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Sloan	Fine-loamy, mixed, noncalcareous, mesic.	Fluventic Haplaquolls	Mollisols.
Spinks	Sandy, mixed, mesic	Psammentic Hapludalfs	Alfisols.

TABLE 7.—*Classification of soil series according to the current system*—Continued

Series	Current system [1]		
	Family	Subgroup	Orders
Spinks, wet subsoil variant	Sandy, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Tuscola	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Wallkill	Fine-loamy, mixed, nonacid, mesic	Thapto-Histic Haplaquepts	Inceptisols.
Wasepi	Coarse-loamy, mixed, mesic	Aquollic Hapludalfs	Alfisols.

[1] Placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.
[2] This series typically has a mean annual soil temperature of less than 47° F.
[3] This soil has a darker colored surface layer than is typical for the series.
[4] This soil classifies as a Typic Hapludalf instead of an Aquic Hapludalf, but it responds as a moderately well drained soil.
[5] This soil lacks the gray colors typical of an Ochraqualf but responds as such.
[6] This soil strongly resembles those of the Selfridge series because its argillic horizon is in the Selfridge coarse-loamy rather than the fine-loamy family, but it does not strictly fit into the series. Recognition of a separate series, however, would serve no useful purpose.

General Nature of the County

This section discusses the settlement and development, climate, geology and physiography, vegetation, water supply, and farming in Genesee County. The statistics are from reports published by the U.S. Bureau of the Census and the U.S. Weather Bureau.

Settlement and Development

The first settlers arrived in Genesee County about 1830 and settled near Flint, which was a fur-trading center and later a lumbering center. Flint became an important industrial center through the development of the lumber industry (*3*).

The rapid industrial growth of Flint provided a ready market for farm produce. Because of this demand, the acreage in farmland was increased steadily until it reached nearly 400,000 acres in the 1920's. Acreage in farmland has since decreased, and today only about 50 percent of the county remains in farms. The rest consists mainly of abandoned farmland, urban and industrial areas, and woodland.

Climate [4]

Genesee County is located in southeastern Michigan, where the lake effect is not so great as it is in most other sections of the state The main lake effect noticed in Genesee County is increased cloudiness late in fall and early in winter, when the prevailing wind moves cold air across the warmer lake water. About 5 to 10 percent more sunshine falls on Genesee County than on a similar area in western Michigan.

Available weather data for Flint (tables 8 and 9), located in the center of the county, show that the highest temperature ever recorded was 108° F. on July 13, 1936, and the lowest was −28° on February 14, 1916. Temperature is zero or lower an average of 6 days in winter. Temperature is 100° or higher only about 1 summer in 10, and it is 90° or higher an average of 14 days in summer.

[4] By NORTON D. STROMMEN, State climatologist, U.S. Weather Bureau.

Precipitation is heaviest during the growing season, and it averages about 64 percent of the annual total during the 6-month period from April through September. During the period 1937–66, the greatest average monthly precipitation was 3.48 inches and occurred in September. The smallest average monthly precipitation was 1.70 inches and occurred in January. As much as 1.2 inches of precipitation in 1 hour, 1.5 inches in 2 hours, and 2.4 inches in 24 hours occurs about once in 2 years. Precipitation of 3.6 inches and 4.4 inches in a 24-hour period occurs about once in 10 years and once in 50 years, respectively.

Evaporation data from the Dearborn station, located about 40 miles southeast of Genesee County, show a 13-year (1953–66) average evaporation from April to October of 40.73 inches. This is about twice the normal rainfall for this same period. The supply of water in the soil therefore must be replenished in winter and early in spring. The capacity of the soil to hold this supplementary water is important to farming in this area.

Snowfall averages 40.5 inches per year but varies considerably from year to year. During a 25-year period (1941–66), total snowfall was as much as 75.3 inches and as little as 17.6 inches based on records of the Weather Bureau Airport Station at Flint.

Cloudiness is greatest late in fall and early in winter and least late in spring and in summer. Records at Flint show that December has an average of 22 cloudy days, 7 partly cloudy days, and 2 clear days. July has an average of 10 cloudy days, 13 partly cloudy days, and 8 clear days.

Geology and Physiography

Several ice sheets advanced over Genesee County and retreated during the glacial period. The most recent ice sheet or glacier was during the Late Wisconsin glacial period, some 9,000 or more years ago (*5*). Several distinctive geological features were formed in Genesee County during this last period of glaciation.

Soon after the southernmost part of Genesee County emerged from the retreating Saginaw ice lobe, the lobe halted and built the Fowler Moraine. This moraine starts in Lapeer County, continues southwesterly

TABLE 8.—*Temperature and precipitation at Flint, Michigan* [1]

Month	Temperature: Average daily maximum	Temperature: Average daily minimum	Two years in 10 will have at least 4 days with— Maximum temperature equal to or higher than—	Two years in 10 will have at least 4 days with— Minimum temperature equal to or lower than—	Precipitation: Average total	One year in 10 will have— Less than—	One year in 10 will have— More than—	Days with snow cover	Average depth of snow on days with snow cover
	°F.	°F.	°F.	°F.	Inches	Inches	Inches	Number	Inches
January	31.9	17.1	46	−1	1.63	0.57	3.02	11	5.3
February	32.8	16.7	46	0	1.76	.66	2.97	11	6.0
March	41.3	24.1	61	8	2.20	1.03	3.58	6	4.1
April	55.9	34.7	77	23	2.85	1.38	4.51	1	1.6
May	68.0	44.7	84	33	3.16	1.21	6.42	--	--
June	78.5	54.7	90	44	3.32	1.68	5.36	--	--
July	83.5	58.9	94	49	2.86	.98	5.01	--	--
August	81.6	57.6	93	47	3.43	1.37	5.64	--	--
September	73.4	50.5	87	37	2.53	.98	4.51	--	--
October	62.1	40.6	79	29	2.09	.50	3.96	--	--
November	46.3	30.1	64	17	2.05	.78	3.60	2	3.8
December	34.6	20.6	52	2	1.70	.60	3.12	8	4.5
Year	57.5	37.5	[2] 95	[3] −8	29.58	20.70	39.60	39	5.0

[1] Based on period 1937–66.
[2] Average annual highest maximum.
[3] Average annual lowest minimum.

TABLE 9.—*Probabilities of last freezing temperatures in spring and first in fall at Flint, Michigan* [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 4	April 9	April 23	May 8	May 23
2 years in 10 later than	March 30	April 4	April 18	May 3	May 18
5 years in 10 later than	March 20	March 25	April 8	April 23	May 8
Fall:					
1 year in 10 earlier than	November 13	November 6	October 24	October 12	September 23
2 years in 10 earlier than	November 18	November 11	October 29	October 17	September 28
5 years in 10 earlier than	November 29	November 22	November 9	October 28	October 9

[1] Based on period 1937–64.

across Genesee County until it reaches the western part of Grand Blanc Township, and then turns west. Melt waters from the ice lobe were dammed up by the Portland Moraine, and following the path of least resistance, they flowed westward to form the Shiawassee River. The lakes of this region were also formed from melt water.

As the climate changed, the glaciers melted, receded northward, and left masses of material known as glacial till. Later the climate changed again, and the Saginaw lobe halted and built the Flint Moraine. This moraine is marked by a line running through Forest, Thetford, Genesee, and Flint Townships and through the corner of Clayton and perhaps Gaines Townships. The Flint Moraine dammed up the water draining from the northeast and formed a large glacial lake that covered most of Burton, Mundy, Grand Blanc, Davison, and Richfield Townships.

As the glaciers retreated, they left openings for lake waters to move northward. As a result, most drainage of the southern half of Genesee County, except for the Shiawassee River, comes to one point where the Flint River cuts through the Flint Moraine in the western part of the city of Flint. North of this barrier, the streams resume their course, except where they are deflected by the small moraine ridges and beaches of a second glacial lake, Lake Saginaw (*13*).

Several gravelly eskers were formed by glaciers in Genesee County (*5*). They are the Oregon Esker, in section 13 of Richfield Township; the Thread River Esker, on the west side of the Thread River; the Thetford Esker, in sections 5, 8, and 17 of Thetford Township; and an esker in section 13 of Clayton Township.

Another important geological feature of Genesee County was the Imlay outlet, which drained Lake Maumee, a glacial lake near Lake Erie. The Imlay outlet entered Genesee County and followed the Flint River to the glacial lake formed by the Flint Moraine.

This lake was located east and south of the city of Flint. It reached Swartz Creek, and left the county in section 7 of Gaines Township.

Water erosion of these glacial formations produced the present landscape. Such erosion is referred to as geologic erosion. Geologic erosion formed the uplands, terraces, and bottom lands. The present terraces, which consist mostly of glacial outwash, were once bottom lands that formed when streams were flowing at higher levels than at present. Some old terraces, such as those northwest of the town of Flushing along Seymour Road, are now considered to be uplands. The present bottom lands include only those areas subject to overflow, where alluvium is either deposited or removed by floodwaters.

Relief of Genesee County ranges from nearly level to steep. About a third of the county is nearly level and slightly undulating, and steep banks cut this landscape along the Flint River and its tributaries. The level or nearly level land is mostly in the western and central parts of the county. The extreme southwestern part is somewhat hilly or rolling, and the northeastern, southeastern, and extreme eastern parts have a generally rolling landscape that rises to low hills in places. Steep banks border local depressions and streams.

Elevations within the county range from 580 feet in the northwestern corner of Montrose Township to about 1,000 feet in the southern and southeastern parts of the county.

Vegetation

When Genesee County was first settled, all except small areas of marshland and lakes was covered by forests consisting of four major groups of trees: (1) oak, beech, sugar maple, hickory, and ash; (2) elm, ash, and sugar maple; (3) tamarack, elm, swamp oak, red maple, and aspen; and (4) oak, white pine, red pine, red maple, and birch.

Stands of oak, beech, sugar maple, hickory, and ash grew mainly in areas of undulating to rolling loamy soil located chiefly in the southeastern and southern parts of the county. Random depressions in these areas had a woodland cover of swamp oak, tamarack, elm, red maple, and aspen.

Dense stands of elm, ash, and sugar maple grew in areas of less sloping, more poorly drained loamy soils. This was the most extensive type of forest in the county. It occupied a large area in the center of the county and extended from the eastern to the western border.

Tamarack, elm, swamp oak, red maple, and aspen forests grew in the poorly drained soils, mucks, and bottom lands bordering rivers and streams. Such stands grew throughout the county, but mainly in the northwestern and southeastern parts.

Oak, white pine, red pine, red maple, and birch were the dominant species on the sandy and gravelly benches lying above the main stream channels.

Few native woodlots remain in the county, except along the Flint River and other major streams, but in some areas small second-growth woodlots produce a little timber. Most of the woodlots are used for woodlot pasture, which is sometimes damaged by grazing and becomes overstocked with undesirable plants. Under proper management the woodland stands could provide income and help control erosion of bottom land, streambanks, and steeply sloping areas. In recent years the planting of Austrian pine, jack pine, red pine, Scotch pine, and white pine on the sandy upland soils has increased throughout the county.

Lakes and Streams

Most of Genesee County drains to the Flint River. The southern halves of Argentine and Fenton Townships drain to the Shiawassee River, and a small part of northeastern Thetford Township and northwestern Forest Township drains to the Cass River.

The main tributaries of the Flint River are Swartz Creek, Thread River, Kearsley Creek, Butternut Creek, Brent Run, Pine Run, and Armstrong Creek. Swartz Creek and its tributaries, together with the Misteguay drainage system, drain the southwestern part of Genesee County; the Thread River and Kearsley Creek and their tributaries drain the southeastern part; Butternut Creek and Lefler Scothan Drain provide drainage for the northeastern corner; and Armstrong Creek, Brent Creek, Brent Run, and Pine Run drain the western part.

The major lakes in the county, located in Argentine and Fenton Townships, are Lake Fenton, 1,050 acres; Lobdell Lake, 535 acres; Silver Lake, 345 acres; and Lake Ponemah, 500 acres. In the southeastern part of the county are Shinanguag Lake, 230 acres, Hasler Lake, 95 acres; and Potter Lake, 120 acres. A few small lakes are scattered throughout the northeastern part of the county.

Artificial lakes and small ponds exist in many parts of the county. They are used for recreation and for storing water for livestock and irrigation.

Water Supply

About 19 percent of the water (*4*) used in Genesee County in 1958 was furnished by wells. Most of these wells are in glacial drift that ranges in texture from sand to clay and contains varying amounts of gravel, cobbles, and boulders. Thickness of the drift ranges from 50 feet in Montrose Township to about 250 feet near the town of Fenton in the southeastern part of the county.

The hardness of the water obtained from the drift ranges from 150 to 700 ppm., but average hardness is between 200 and 500 ppm. In places the water is too hard for domestic use.

The bedrock under the drift is Saginaw Sandstone of Pennsylvanian age in the central, western, and northern parts of the county. The Michigan Formation and Marshall Sandstone of Mississippian age underlie the eastern and southern parts of the county.

Fresh water may be obtained in places in the Saginaw Formation. Generally, however, the water is salty, and it is very salty at a depth of 200 to 300 feet. Some bedrock channels that are filled with sand and gravel are a good source of fresh water.

Water obtained from the Michigan Formation is usually salty. Water obtained from Saginaw Sandstone is of the same quality as that from Marshall Sandstone.

Industry uses 50 percent of the water used in Genesee County, but 97 percent of the industrial supply comes from streams. Additional water for both domestic and industrial uses will be supplied through a pipeline from Lake Huron.

Farming

The 1964 Census of Agriculture reported 1,794 farms in Genesee County. Of the land in farms in 1964, 119,587 acres was in harvested crops and 14,553 acres was in pasture. Corn was the main row crop grown, and that year 27,204 acres of corn was harvested for grain and 7,168 acres was cut for silage. Small grains are also important in the county. In 1964 wheat was grown on 20,391 acres, oats on 12,716 acres, barley on 536 acres, and rye on 530 acres. Soybeans were harvested from 14,316 acres. Of the hay crops harvested, 21,653 acres was alfalfa and alfalfa mixtures, and 4,246 acres was clover or timothy.

Of tree fruits harvested for sale, there were 6,106,402 pounds of apples, 211,251 pounds of peaches, 207,533 pounds of pears, 107,289 pounds of plums and prunes, 110,909 pounds of cherries, and 14,440 pounds of grapes. Of berries harvested for sale, there were 109,251 pounds of strawberries; 35,476 pounds of raspberries; and 126,972 pounds of blueberries.

Forest and nursery products provided additional income to farms in Genesee County.

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Glossary

Acidity. See Reaction, soil.

Alkalinity. See Reaction, soil.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

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.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

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; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour 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.

Diversion, or diversion terrace. 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.

Drainage. See Natural soil drainage.

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.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity*, or *capillary capacity*.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Fragipan. A loamy, brittle, subsurface horizon that is very low in organic matter and clay but is rich in silt or very fine sand. The layer is seemingly cemented. When dry, it 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.

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.

Gleization. The reduction, translocation, and segregation of soil compounds, notably of iron, usually in the lower horizons, as a result of waterlogging with poor aeration and drainage; expressed in the soil by mottled colors dominated by gray. The soil-forming processes leading to the development of a gley soil.

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. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residue.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Miscellaneous land type. A mapping unit for areas of land that have little or no natural soil; or that are too nearly inaccessible for orderly examination; or that occur where, for other reasons, it is not feasible to classify the soil.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

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 three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Natural soil drainage. Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Imperfectly or somewhat poorly drained soils are wet for significant periods but not all the time, and in Podzolic soils commonly have mottlings below 6 to 16 inches, in the lower A horizon and in the B and C horizons.

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.

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.

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.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value alkalinity; and a lower value, acidity.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Relief. The elevations or inequalities of a land surface, considered collectively.

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 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

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. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (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 the solum below plow depth.

Substratum. Technically the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

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 into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay 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 which are essential to plant growth. Some of the trace elements are zinc, cobalt, manganese, copper, and iron.

Type, soil. A subdivision of the soil series that is made on the basis of differences in the texture of the surface layer.

Variant, soil. A soil having properties sufficiently different from those of other known soils to suggest establishing a new soil series, but a soil of such limited known area 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.

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