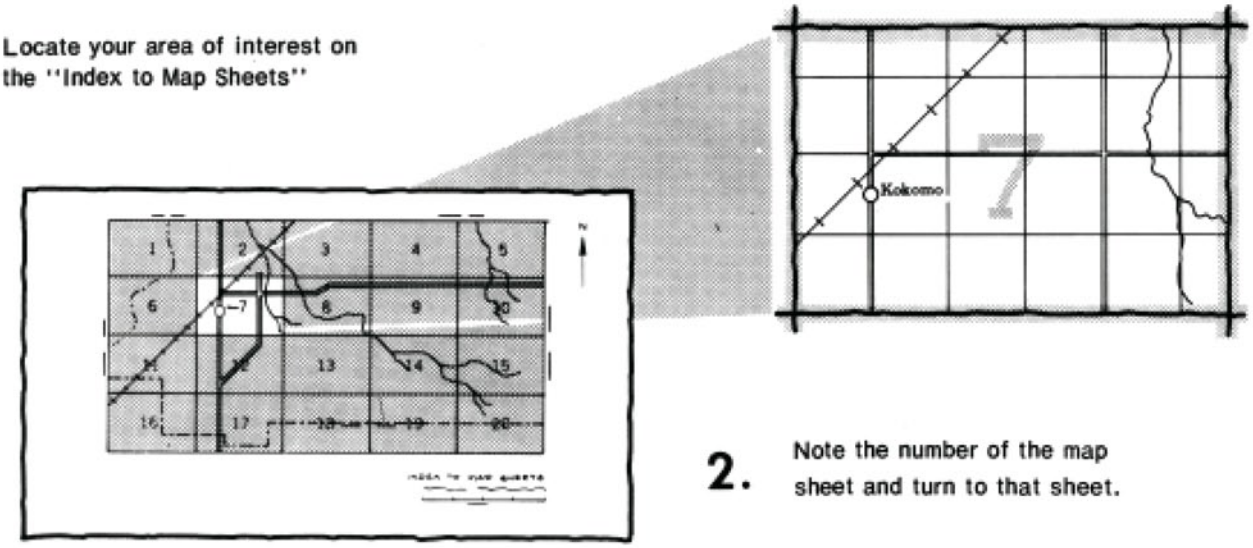
SOIL SURVEY OF

Clare County, Michigan

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Michigan Agricultural Experiment Station

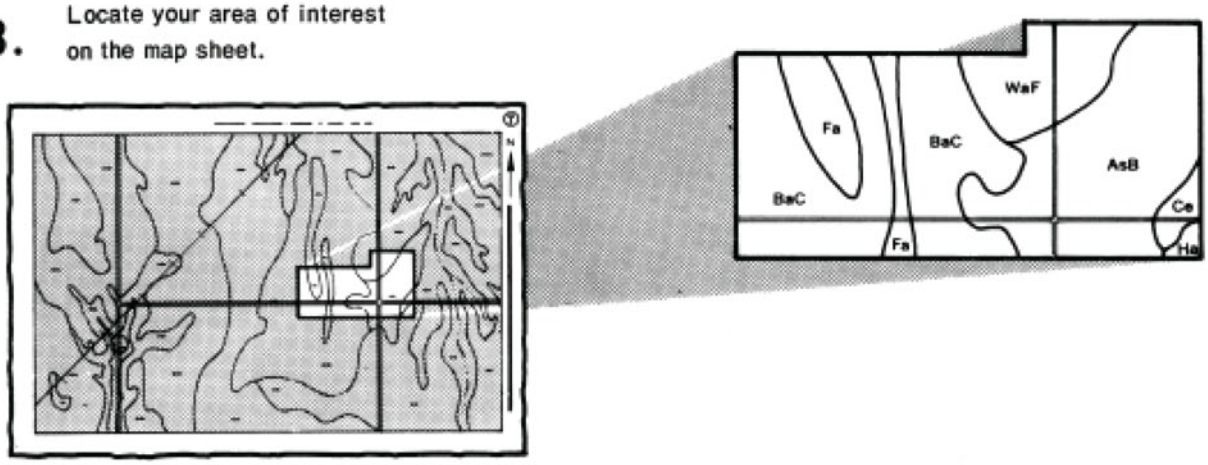
HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets"

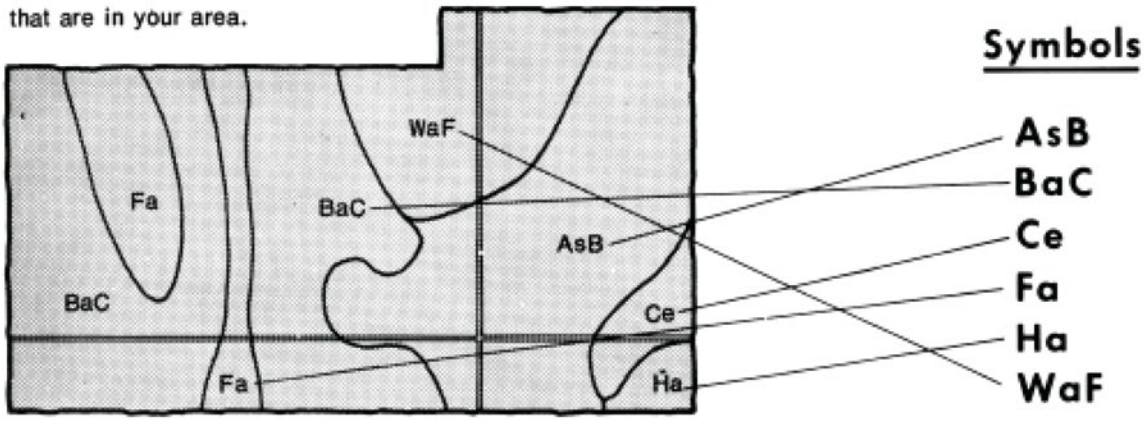


2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.

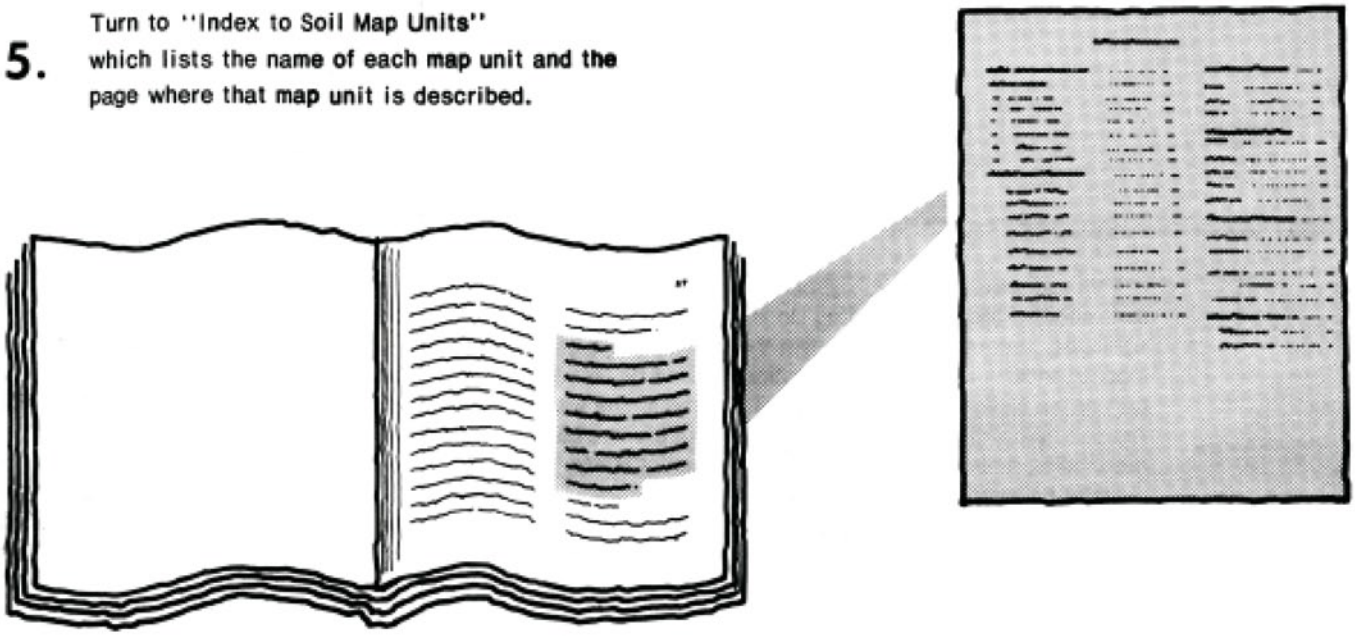


4. List the map unit symbols that are in your area.

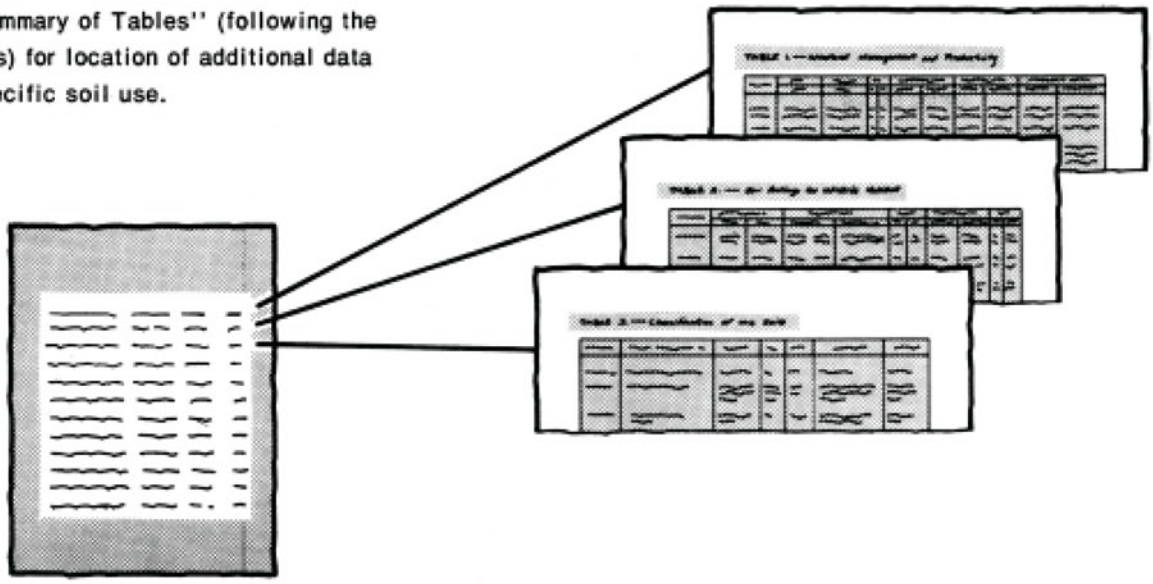


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1967 to 1976. Soil names and descriptions were approved in July 1976. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1976. 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 Clare County Soil Conservation District. Preparation of this soil survey was partly financed by the Clare County Board of Commissioners under provisions of an agreement with the Soil Conservation Service.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

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Issued June 1979

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Summary of Tables

Foreword

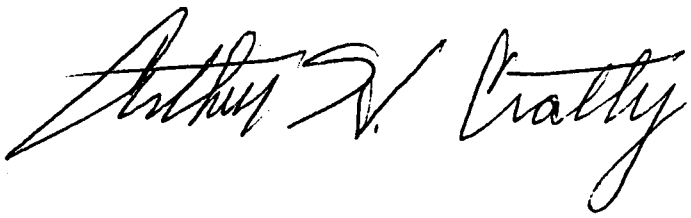
The Soil Survey of Clare County, Michigan, contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

This soil survey has been prepared for many different users. Farmers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

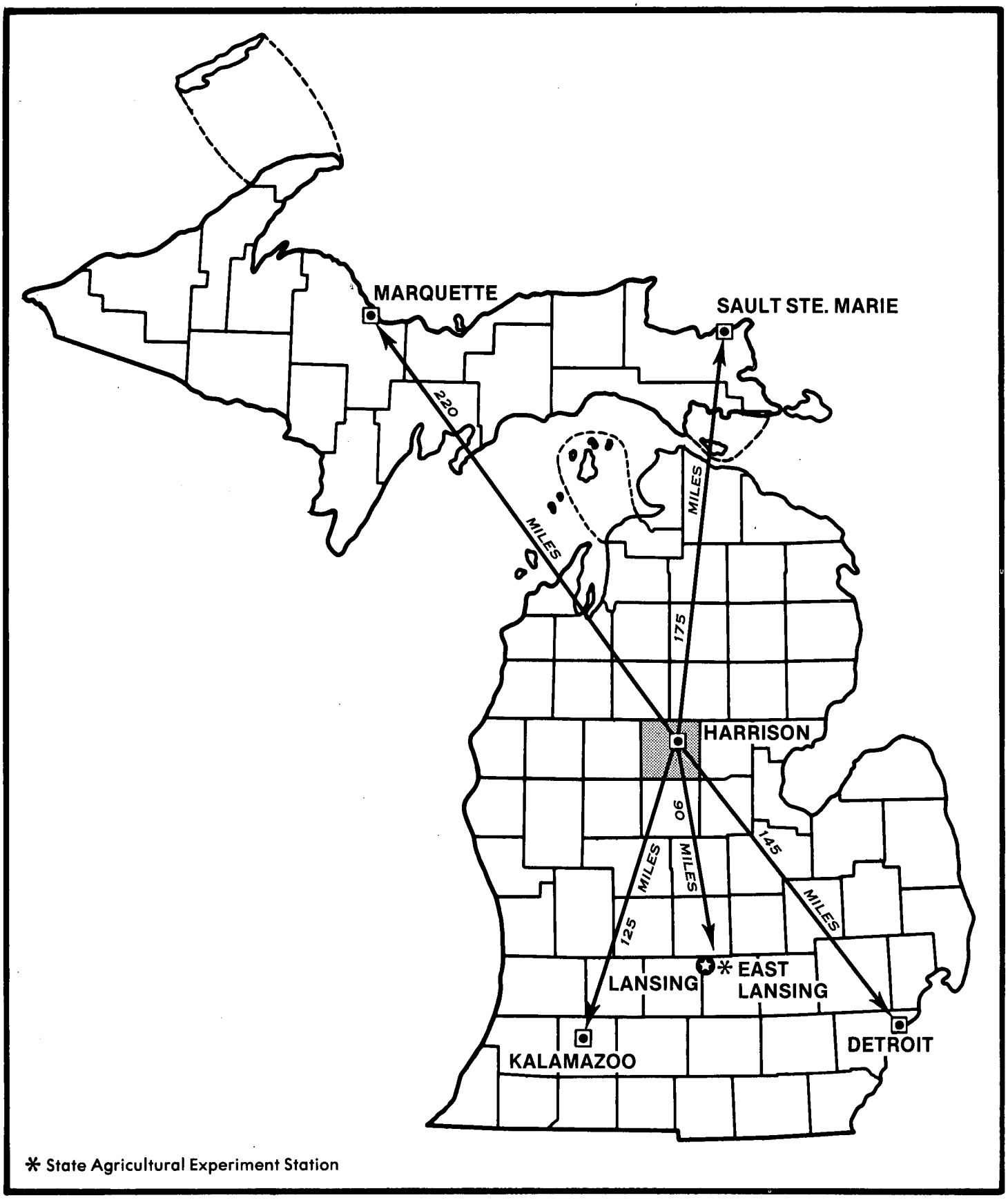
Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.



Arthur H. Cratty
State Conservationist
Soil Conservation Service



Location of Clare County in Michigan.

SOIL SURVEY OF CLARE COUNTY, MICHIGAN

By Paul G. Corder, Soil Conservation Service

Fieldwork by Paul G. Corder, Adam Hyde, William L. Bowman,
Neil W. Stroesenreuther, Sheldon G. Holcomb, and Joseph R. Dumont,
Soil Conservation Service, and Tom Nalepa, Johnnie Collins, Chwan Co Wang,
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United States Department of Agriculture, Soil Conservation Service,
in cooperation with Michigan Agricultural Experiment Station

CLARE COUNTY is situated near the center of Michigan (see facing page). The county is bordered on the north by Missaukee and Roscommon Counties, on the east by Gladwin County, on the south by Isabella County, and on the west by Osceola County. It has a land area of about 576 square miles, or 366,080 acres. Harrison, the county seat, has a population of almost 1,500.

A natural watershed divide occurs as a hilly moraine running diagonally northeast and southwest across the county. Drainage is generally good throughout the county. The Muskegon River and its tributaries drain the sandy Jack-Pine plains in the northeastern part of the county. The waters of the Muskegon flow westward to Lake Michigan. The southern and eastern parts of Clare County are drained by a network of small streams, two branches of the Cedar River, and three of the Tobacco River. These waters flow eastward into Lake Huron.

General nature of the county

John Barclay, district conservationist, Soil Conservation Service, helped prepare this section.

This section gives general information concerning the county. It describes climate, settlement and development, natural resources, and farming.

Climate

Prepared by Fred V. Nurnberger, meteorologist, Michigan Department of Agriculture, Michigan Weather Service.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Gladwin for the period 1947 to 1976. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 22.1 degrees F, and the average daily minimum temperature is 13.4 degrees. The lowest temperature on record, which occurred at Houghton Lake on February 1, 1918, is minus 48 degrees. In summer the average temperature is 67.0 degrees, and the average daily maximum temperature is 80.0 degrees. The highest recorded temperature, which occurred on July 13, 1936, is 107 degrees.

Growing degree days, shown in table 1, are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 19.4 inches, or 60 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 16.1 inches. The heaviest 1-day rainfall during the period of record was 5.18 inches at Houghton Lake on July 8, 1957. Thunderstorms occur on about 33 days each year, and most occur in June, July, and August.

Average seasonal snowfall is 51.3 inches. The greatest snow depth at any one time during the period of record was 35 inches. On the average, 95 days have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year and from the northwestern to the southeastern parts of the county.

The average relative humidity in midafternoon is about 64 percent. Humidity is higher at night, and the average at dawn is about 85 percent. The percentage of possible sunshine is 68 in summer and 32 in winter. The prevailing wind is from the southwest. Average windspeed is highest, 10.2 miles per hour, in January.

Settlement and development

Before 1870 or 1871, the only settled areas in the county were temporary lumbering camps. Small towns were established in the early 1870's, their location determined by the Flint & Pere Marquette railroad system.

Farwell, Harrison, and Clare were among the earliest towns. Harrison was the site of a productive sawmill with a capacity of 45,000 feet per day in 1881. Today, it is a recreational center as well as the headquarters for county government. Farwell was the first county seat.

Natural resources

Probably the most important natural resource in Clare County is the soil. Almost a quarter of the county, mostly the southeastern part, is farmed. About 65 percent of the county is forested with hardwoods and softwoods.

Many lakes and streams and thousands of acres of State-owned land provide many forms of outdoor recreation. The better drained sandy areas, primarily in the northern part, are forested recreation areas and wildlife habitat. Also, motorcycle and snowmobile trails are being developed on lands once used exclusively for hunting and timber.

Natural gas and oil production is an important economic factor in Clare County. In the years prior to and including 1973, more than 36,000,000 barrels of oil and more than 57,000,000 MCF (thousand cubic feet) of natural gas were produced in the county. In addition, large reserves of natural gas are stored deep in the ground in some areas.

Farming

Farming was slow to develop in the survey area, mostly because of the dense forest cover. The first crops were probably vegetable gardens. Later, larger areas were cleared, and corn, small grain, and hay were grown.

Feed grains, such as corn, wheat, oats, and hay, are still the principal crops grown in Clare County. About 50 percent of the farm income comes from dairy products; another 40 percent comes from other livestock products.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; 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, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

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

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land-use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land-use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for

planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Map unit descriptions

1. Mancelona-Gladwin-Wheatley

Nearly level to gently rolling, somewhat excessively drained and somewhat poorly drained to very poorly drained soils that have a sandy and loamy subsoil or a sandy and gravelly substratum

These nearly level to gently rolling soils are mostly on outwash plains and old glacial lakebeds, generally close to streams, rivers, and lakes. Most areas are nearly flat, but some have slight rises or low knolls.

This map unit occupies about 5 percent of the county. It is about 50 percent Mancelona soils, 15 percent Gladwin soils, 10 percent Wheatley soils, and 25 percent soils of minor extent (fig. 1).

Mancelona soils generally are slightly higher on the landscape than Gladwin and Wheatley soils. They are in flat areas and on some slight rises and low knolls. Gladwin and Wheatley soils are in flat areas and drainageways. Mancelona soils are somewhat excessively drained, Gladwin soils somewhat poorly drained, and Wheatley soils poorly drained and very poorly drained. Gladwin and Wheatley soils have a seasonal high water table. Available water capacity is low in all three soils, and permeability is moderately rapid or rapid.

Mancelona soils are nearly level to gently rolling. Typically, the surface layer is black loamy sand about 3 inches thick. The subsurface layer is grayish brown gravelly loamy sand about 2 inches thick. Below this is a very friable subsoil about 22 inches thick. The upper part is dark brown to brown, gravelly loamy sand; the next part is dark brown gravelly sandy loam; and the lower part is dark yellowish brown gravelly loamy sand. The substratum to a depth of about 60 inches is light yellowish brown, calcareous sand and gravel.

Gladwin soils are nearly level. Typically, the surface layer is very dark brown loamy sand about 8 inches thick. The subsurface layer is grayish brown sand about 3 inches thick. Below this is a dark brown, mottled subsoil about 18 inches thick. The upper part is very friable sand, and the lower part is friable gravelly sandy loam. The substratum to a depth of about 60 inches is very pale brown, calcareous, stratified gravel and coarse sand.

Wheatley soils are nearly level. Typically, the surface layer is very dark brown loamy sand about 8 inches thick. The upper part of the substratum is grayish brown, mottled sand and gravelly sand; the lower part to a depth of about 60 inches is grayish brown, calcareous sand and gravel.

The minor soils in this map unit include the excessively drained Grayling soils, the somewhat excessively drained Graycalm soils, the somewhat poorly drained Colonville soils, and the very poorly drained Markey soils. Grayling and Graycalm soils are in the same landscape position as Mancelona soils. Colonville soils are on flood plains next to streams. Markey soils are in wet mucky areas.

Most areas are used for woodland or pasture, but some are cropped. Susceptibility to soil blowing and droughtiness are the major problems for most uses. Drainage generally is needed before cultivated crops can be grown on the Gladwin and Wheatley soils. Most areas are undrained, however, because drainage outlets are difficult to locate. If drained, the soils become more droughty during the summer. The Mancelona soils are subject to erosion if cleared. As a result of the moderately rapid permeability, the effluent from septic tank absorption fields can pollute ground water. Cutbanks in excavations can cave in.

This map unit has good potential for pasture. It is a good to fair source of sand and gravel. It has fair potential for cultivated crops and upland wildlife habitat, good to fair potential for woodland, poor potential for most recreation uses, and a variable potential for engineering uses. The potential of Mancelona soils for building site development is good in the flatter areas and fair in the steeper areas. The Gladwin and Wheatley soils have poor potential for building site development because they have a seasonal high water table.

2. Montcalm-Menominee-Nester

Nearly level to rolling, well drained and moderately well drained soils that have a sandy and loamy subsoil

These nearly level to rolling soils are mostly on till plains and moraines but also are on outwash plains. Most areas are rolling, but a few are nearly flat. A few streams, rivers, and lakes are evident.

This map unit occupies about 15 percent of the county. It is about 40 percent Montcalm soils, 10 percent Menominee soils, 10 percent Nester soils, and 40 percent soils of minor extent (fig. 2).

Montcalm soils generally are slightly higher on the landscape than Menominee and Nester soils. All three soils are on knolls, in nearly flat areas, or on slight rises. Montcalm soils are well drained and Menominee and Nester soils well drained and moderately well drained.

Montcalm soils are nearly level to rolling. Typically, the surface layer is very dark grayish brown loamy sand about 2 inches thick. The subsurface layer is light brownish gray loamy sand about 2 inches thick. The subsoil is about 56 inches thick. The upper 28 inches is dark yellowish brown and yellowish brown, very friable loamy sand, and the lower part is light yellowish brown, very friable loamy sand having bands of dark brown sandy loam.

Menominee soils are nearly level to gently rolling. Typically, the surface layer is very dark brown loamy sand about 4 inches thick. The subsurface layer is pinkish gray

sand about 7 inches thick. The subsoil is about 35 inches thick. The upper part is reddish brown and yellowish brown, friable loamy sand; the next part is a mixture of strong brown and pale brown, friable sandy loam and brown and reddish brown, firm clay loam; and the lower part is dark brown, mottled, firm clay loam. The substratum to a depth of about 64 inches is light brown, mottled, calcareous clay loam.

Nester soils are gently undulating to rolling. Typically, the surface layer is dark grayish brown loam about 6 inches thick. The subsoil is about 18 inches thick. The upper part is yellowish brown, friable loam that has grayish brown coatings on the faces of peds, and the lower part is brown, firm silty clay loam. The substratum to a depth of about 60 inches is brown, calcareous silty clay loam.

The minor soils in this map unit include the somewhat excessively drained Graycalm soils, the moderately well drained McBride soils, and the somewhat poorly drained Iosco and Kawkawlin soils. Graycalm and McBride soils are in the same landscape position as the major soils in the unit. Graycalm soils tend to be slightly higher on the landscape than Montcalm soils. McBride soils are slightly lower on the landscape than Menominee soils. Iosco and Kawkawlin soils are in the nearly flat drainageways and on very gentle knolls.

This map unit is used for pasture, woodland, and cultivated crops. The susceptibility to erosion of the Nester soils and the sandy texture of the other soils are the major problems. Montcalm and Menominee soils are susceptible to soil blowing, and the Montcalm soils tend to be droughty. The Nester soils puddle and crust if worked when too wet. As a result of a high content of clay, the shrink-swell potential is moderate in the substratum of the Menominee and Nester soils. Drainage is needed in some of the scattered wet depressions throughout the unit.

This map unit has good potential for pasture and woodland and fair to good potential for cultivated crops and upland wildlife habitat. It has variable potential for recreation and engineering uses. The potential for building site development is good in the flatter areas of Montcalm soils and fair to poor in the other areas of this unit. The potential for recreation uses is good to fair in the flatter areas of Nester soils and fair on Montcalm and Menominee soils.

3. Menominee-Iosco-Kawkawlin

Nearly level to gently rolling, well drained to somewhat poorly drained soils that have a sandy and loamy subsoil

These nearly level to gently rolling soils are mostly on till plains and moraines but are also on outwash plains. Most areas are nearly flat but some have slight rises and some have a few hills. A few lakes, streams, and rivers are evident.

This map unit occupies about 11 percent of the county. It is about 30 percent Menominee soils, 25 percent Iosco and Kawkawlin soils, and 45 percent soils of minor extent (fig. 3).

Menominee soils generally are higher on the landscape than Iosco and Kawkawlin soils. They are on slight rises and knolls. Iosco soils are on very gentle knolls, and Kawkawlin soils are in nearly flat areas. Menominee soils are well drained and moderately well drained. Iosco and Kawkawlin soils are somewhat poorly drained and have a seasonal high water table.

Menominee soils are nearly level to gently rolling. Typically, the surface layer is very dark brown loamy sand about 4 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is about 35 inches thick. The upper part is reddish brown and yellowish brown, friable loamy sand; the next part is a mixture of strong brown and pale brown, friable sandy loam and brown and reddish brown, firm clay loam; and the lower part is dark brown, mottled, firm clay loam. The substratum to a depth of about 64 inches is light brown, mottled, calcareous clay loam.

Iosco soils are nearly level and gently undulating. Typically, the surface layer is very dark grayish brown loamy sand about 6 inches thick. The subsurface layer is grayish brown, mottled sand about 3 inches thick. Below this is a mottled subsoil about 51 inches thick. The upper part is dark brown, friable loamy sand; the next part is brown, loose sand; and the lower part is brown, firm silty clay loam.

Kawkawlin soils are nearly level. Typically, the surface layer is very dark gray loam about 6 inches thick. The subsoil is about 18 inches thick. The upper part is light brownish gray, friable loam and brown, firm silty clay loam, and the lower part is dark brown, mottled, firm silty clay loam. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous silty clay loam.

The minor soils in this map unit include the somewhat excessively drained Graycalm and Melita soils, the well drained Montcalm soils, the well drained and moderately well drained Ubly soils, and the poorly drained and very poorly drained Brevort soils. The Graycalm, Montcalm, Melita, and Ubly soils tend to be slightly higher on the landscape than Menominee soils. Brevort soils are in wet flat areas and drainageways.

This map unit is used mainly for pasture or woodland, but some areas are cultivated. Excessive wetness, susceptibility to soil blowing, and a high content of clay are the major problems for most uses. As a result of the high content of clay in the substratum, the shrink-swell potential is moderate and permeability is moderately slow. Iosco and Kawkawlin soils are excessively wet, and drainage outlets are difficult to locate. Unless drained, these soils are too wet for timely planting of crops. In the areas of Menominee soils in scattered wet depressions, drainage is needed. Frost usually damages some crops every year.

This map unit has good potential for pasture and good to fair potential for woodland and upland wildlife habitat. It has fair potential for cultivated crops if the Iosco and

Kawkawlin soils can be drained. The potential for recreation and engineering uses is fair to poor.

4. Nester-Kawkawlin-Sims

Nearly level to rolling, well drained to very poorly drained soils that have a loamy subsoil

These nearly level to rolling soils are mostly on till plains and moraines. Most areas are fairly flat, but some have slight rises and some have several hills.

This map unit occupies about 14 percent of the county. It is about 55 percent Nester soils, 20 percent Kawkawlin soils, 10 percent Sims soils, and 15 percent soils of minor extent (fig. 4).

Nester soils generally are higher on the landscape than Kawkawlin and Sims soils. They are on slight rises and knolls. Kawkawlin soils are in flat areas and on slight rises. Sims soils are in low-lying wet areas and depressions. Nester soils are well drained and moderately well drained, Kawkawlin soils somewhat poorly drained, and Sims soils poorly drained and very poorly drained. Kawkawlin and Sims soils have a seasonal high water table. Flooding is frequent on the Sims soils. Permeability is moderately slow in the Nester and Kawkawlin soils and slow in the Sims soils. Available water capacity is high in all three soils.

Nester soils are gently undulating to rolling. Typically, the surface layer is dark grayish brown loam about 10 inches thick. The subsoil is about 28 inches thick. The upper part is strong brown, firm clay loam and light brownish gray, friable loam. The next part is strong brown, very firm clay loam and pale brown loam. The lower part and the substratum to a depth of 60 inches are multicolored, very firm clay loam.

Kawkawlin soils are nearly level and gently undulating. Typically, the surface layer is very dark gray loam about 6 inches thick. The subsoil is about 18 inches thick. The upper part is light brownish gray, friable loam and brown, firm silty clay loam, and the lower part is dark brown, mottled, firm silty clay loam. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous silty clay loam.

Sims soils are nearly level. Typically, the surface layer is black clay loam about 9 inches thick. The subsoil is gray, mottled, firm silty clay loam about 19 inches thick. The substratum to a depth of about 60 inches is gray, calcareous silty clay loam.

The minor soils in this map unit include the well drained and moderately well drained Menominee soils, the somewhat poorly drained Iosco soils, and the very poorly drained Markey soils. Menominee soils are in sandy flat areas and on some slight rises and low knolls. Iosco soils are in the same landscape position as Kawkawlin soils. Markey soils are in wet mucky areas.

This map unit is used mainly as cropland and pasture. Cash crops, dairy herds, and beef herds are the main farm enterprises. Excessive wetness, susceptibility to erosion, and a high content of clay are the major problems for most uses. As a result of the high content of clay, the shrink-swell potential is moderate and the soils tend to warm up slowly in spring. All of the soils puddle and crust if plowed when too wet. Frost usually damages some crops every year. The Nester soils are the most susceptible to erosion. In the areas of Nester soils in scattered wet depressions, drainage is needed. It also is needed on the Kawkawlin and Sims soils, which are excessively wet. Sims soils are often flooded. Most areas of Sims soils are undrained because outlets are difficult to locate.

This map unit has good potential for woodland and certain types of wildlife habitat. It has fair to poor potential for most recreation uses and engineering uses because of excessive wetness, susceptibility to erosion, and the high content of clay. It generally has good to fair potential for cultivated crops and pasture, but the undrained areas of Sims soils have poor potential for cultivated crops.

5. Graycalm-Montcalm

Nearly level to steep, somewhat excessively drained and well drained soils that have a sandy and loamy subsoil

These nearly level to steep soils are mostly on till plains, moraines, and outwash plains. The number of streams and rivers is few, but several lakes are evident.

This map unit occupies about 29 percent of the county. It is about 45 percent Graycalm soils, 25 percent Montcalm soils, and 30 percent soils of minor extent (fig. 5).

Graycalm and Montcalm soils are at about the same level on the landscape, but Graycalm soils are slightly higher in most places. Both soils are on broad flat plains and on slight rises and hilly and steep uplands. Graycalm soils are somewhat excessively drained and Montcalm soils well drained. Permeability is rapid, and available water capacity is low.

Graycalm soils are nearly level to steep. Typically, the surface layer is very dark grayish brown sand about 3 inches thick. The subsoil to a depth of about 60 inches is multicolored, very friable or loose sand that has a few thin bands of loamy sand.

Montcalm soils are nearly level to steep. Typically, the surface layer is dark grayish brown loamy sand about 7 inches thick. The subsoil is about 53 inches thick. The upper 25 inches is dark yellowish brown to yellowish brown, very friable loamy sand, and the lower part is light yellowish brown, very friable loamy sand having bands of dark brown sandy loam.

The minor soils in this map unit include the excessively drained Grayling soils, the well drained and moderately well drained Menominee soils, the moderately well drained McBride soils, and the very poorly drained Markey soils. Grayling soils are in the same type of landscape position as the Graycalm and Montcalm soils, but they generally are slightly higher on the landscape. Menominee and McBride soils are in flat areas and on slight rises and low

knolls, generally below Montcalm soils. Markey soils are in wet mucky areas.

This map unit is used mainly for woodland, but a few areas are cultivated or pastured. Susceptibility to soil blowing and erosion and droughtiness are the major problems for most uses. As a result of rapid permeability, the effluent from septic tank absorption fields can pollute ground water. Cutbanks in excavations can cave in.

This map unit has good potential for woodland. It has fair to poor potential for cultivated crops, wildlife habitat, and recreation uses because the soils are droughty and susceptible to erosion and soil blowing. Graycalm soils are a fair source of sand. The potential for pasture and engineering uses is good in the flatter areas and fair to poor in the hilly to steep areas.

6. Grayling

Nearly level to steep, excessively drained soils that have a sandy subsoil

These nearly level to steep soils are mostly on outwash plains. Most areas are nearly flat, but some have steep hills and low knolls.

This map unit occupies about 8 percent of the county. It is about 80 percent Grayling soils and 20 percent soils of minor extent (fig. 6).

Grayling soils are on broad plains and on slight rises and steep hills. They are extremely droughty because permeability is very rapid and available water capacity is very low.

Typically, Grayling soils have a surface layer of black sand about 3 inches thick. The subsoil is about 16 inches of yellowish brown, very friable sand. The substratum to a depth of about 60 inches is light yellowish brown, loose sand.

The minor soils in this map unit include the moderately well drained Croswell soils, the somewhat excessively drained Graycalm soils, and the well drained Montcalm soils. Croswell soils are in the lower flat areas and on slight rises. Graycalm and Montcalm soils are in the same type of landscape position as Grayling soils.

This map unit is used mainly for woodland. The extreme droughtiness is the major problem. Also, soil blowing and erosion are hazards in cleared areas. Because of the very rapid permeability, the effluent from septic tank absorption fields can pollute ground water. Cutbanks in excavations can cave in.

This map unit has poor potential for cultivated crops, pasture, woodland, wildlife habitat, and recreation uses because of the extreme droughtiness. Woodland is generally the best use of this unit because of the deep rooting capacity of the trees. The potential for building site development is good in the flatter areas and fair to poor in the hilly to steep areas. This unit is a good source of sand.

7. Rubicon-Croswell-Au Gres

Nearly level to rolling, excessively drained, moderately well drained, and somewhat poorly drained soils that have a sandy subsoil

This nearly level to rolling map unit is mostly on outwash plains and till plains. It occupies about 9 percent of the county. It is about 30 percent Rubicon soils, 20 percent Croswell soils, 20 percent Au Gres soils, and 30 percent soils of minor extent (fig. 7).

Rubicon soils generally are higher on the landscape than Croswell and Au Gres soils. They are on knolls and on the higher broad plains that have slight rises. Croswell soils are in the lower flat areas that have slight rises. Au Gres soils are in the lowest flat areas. Rubicon soils are excessively drained, Croswell soils moderately well drained, and Au Gres soils somewhat poorly drained. Permeability is rapid in all three soils, and available water capacity is low. Au Gres and Croswell soils have a seasonal high water table.

Rubicon soils are nearly level to rolling. Typically, the surface layer is black sand about 3 inches thick. The subsurface layer is light brownish gray sand about 5 inches thick. The subsoil is about 32 inches thick. The upper part is dark brown or dark yellowish brown, very friable sand, and the lower part is yellowish brown, loose sand. The substratum to a depth of about 60 inches is light yellowish brown sand.

Croswell soils are nearly level and gently undulating. Typically, the surface layer is very dark brown sand about 3 inches thick. The subsurface layer is light brownish gray sand about 4 inches thick. The subsoil is about 22 inches thick. The upper part is brown to dark brown, very friable sand. The lower part and the substratum to a depth of about 60 inches are multicolored, loose sand.

Au Gres soils are nearly level. Typically, the surface layer is black loamy sand about 4 inches thick. The subsurface layer is light brownish gray, mottled sand about 9 inches thick. The subsoil is dark brown, mottled, very friable sand about 8 inches thick. The substratum to a depth of about 60 inches is multicolored sand.

The minor soils in this map unit include the excessively drained Grayling soils, the somewhat excessively drained Graycalm and Melita soils, the somewhat poorly drained Iosco and Kawkawlin soils, the very poorly drained Markey soils, and the poorly drained and very poorly drained Roscommon soils. Grayling, Graycalm, and Melita soils are in the same type of landscape position as Rubicon soils. Iosco and Kawkawlin soils are in the same type of landscape position as Au Gres soils. The Roscommon soils are in flat wet areas and drainageways, and Markey soils are in wet mucky areas.

This map unit is used mainly for woodland, but some areas are pastured. Susceptibility to soil blowing and droughtiness are the major problems for most uses. Other problems are a seasonal high water table in the Croswell and Au Gres soils, the slope of the Rubicon soils, and

erosion on the Rubicon soils. Most areas are undrained because drainage outlets are difficult to locate. If drained, Croswell and Au Gres soils become more droughty in midsummer. Unless drained, Au Gres soils remain wet late in spring. The wet depressions hinder machinery and delay planting. Frost damages some crops in most years. Many areas could be irrigated and if properly managed could be productive.

This map unit has good to fair potential for woodland. The potential for cultivated crops and recreation uses is fair to poor because the soils are wet and droughty. The potential for engineering uses and pasture varies. Rubicon soils have good potential for building site development in the flatter areas and fair potential in the steeper areas. Croswell and Au Gres soils have only fair to poor potential for building site development because they are wet. All three of the soils have poor potential for wildlife habitat. They are a good source of sand.

8. Lupton-Markey

Nearly level, very poorly drained soils that have a mucky subsoil

These nearly level soils are mostly in bogs on till plains, outwash plains, and moraines, generally next to streams, rivers, and lakes. Differences in elevation range from 0 to 3 feet.

This map unit occupies about 9 percent of the county. It is about 35 percent Lupton soils, 35 percent Markey soils, and 30 percent soils of minor extent (fig. 8).

Lupton and Markey soils are at about the same level on the landscape, in wet mucky areas. They have a seasonal high water table that is frequently at the surface. Permeability is moderately slow to moderately rapid, and available water capacity is high.

Typically, the upper tiers of the Lupton soils are black, well decomposed muck about 50 inches thick. The bottom tier to a depth of about 60 inches is very dark brown, well decomposed muck.

Typically, the organic tiers of the Markey soils are very dark brown and very dark grayish brown, well decomposed muck about 32 inches thick. The substratum to a depth of about 60 inches is gray sand.

The minor soils in this map unit include the moderately well drained Croswell soils, the somewhat poorly drained Winterfield soils, the poorly drained and very poorly drained Evart soils, and the very poorly drained Loxley and Greenwood soils. The Croswell soils are in flat areas and on slight rises next to rivers. The Winterfield and Evart soils are on flood plains next to rivers. The Loxley and Greenwood soils are in wet mucky leatherleaf bogs.

This map unit is used mainly for woodland, but some areas are in marsh grass or are covered with brush. Excessive wetness and instability are the major problems for most uses. Also, the soils are commonly flooded for long periods. Most areas are undrained because drainage outlets are very difficult to locate.

This map unit has good potential for wetland wildlife habitat. The excessive wetness and instability are such severe limitations and are so difficult to overcome that the potential for cultivated crops, pasture, woodland, and recreation and engineering uses is poor.

Broad land-use considerations

Deciding proper land use is an important issue in the survey area. As more people move into the county each year, more decisions regarding building sites and other land uses are made. The general soil map in this survey can be very helpful in planning future land-use patterns. This map is most helpful in planning the general location of future residential developments. It should not be used, however, to select specific sites for homes.

About a third of the county has good potential for building site development. The potential for building site development is good in the flat areas of the major soils in map units 5 and 6 and fair to poor in the hilly to steep areas of these soils. It is good in the nearly level and gently undulating areas of the excessively drained to well drained sandy soils in map units 1, 2, and 7, but it is only fair to poor on the other soils in these map units because of wetness, slope, or shrinking and swelling.

About two-thirds of the county has fair to poor potential for building site development. The major soils in map units 3 and 4 have moderate to severe limitations because of wetness, slope, or the shrink-swell potential. Those in map units 1 and 8 have severe limitations, mainly because of wetness. Residential development in these areas would be costly and would probably cause more problems.

About a fourth of the county has good to fair potential for cultivated crops. Some areas having good or fair potential for crops are wooded. The potential for cultivated crops is good to fair on the major soils in map units 2 and 4 and fair on those in map units 1 and 3. Tile drainage is needed in the somewhat poorly drained soils in map units 1, 3, and 4 before cultivated crops can be grown successfully. Drainage outlets, however, are difficult to locate. Drainage is needed in the areas of the well drained and moderately well drained soils in map units 1, 2, 3, and 4 that are in scattered wet depressions. The potential of map units 1, 2, 3, and 4 for cultivated crops should be seriously considered when land-use decisions are made. The major soils in map units 5, 6, 7, and 8 have fair to poor potential for crops because they are too sandy or too wet.

About half of the county has good to fair potential for open pasture and wooded pasture. The potential is good on the major soils in map units 1, 2, and 3 and good to fair on those in map units 4 and 7. The nearly level to hilly areas of the major soils in map unit 5 also have good to fair potential, but the steep areas have poor potential. These map units have few limitations unless the pasture is overgrazed. The major soils in map units 6 and 8 have

poor potential for pasture because they are either too sandy or too wet for pasture grasses.

About three-fourths of the county has good to fair potential for woodland. The major soils in map units 2, 4, and 5 have good potential and those in map units 1, 3, and 7 have good to fair potential. These potentials should be considered when land-use decisions are made. The major soils in map units 6 and 8 have fair to poor potential for woodland because they are excessively wet or too droughty.

About half of the county has good to fair potential for certain types of wildlife habitat. The major soils in map unit 8 have good potential for wetland wildlife habitat, and those in map units 1, 2, 3, and 4 have good to fair potential for openland and woodland wildlife habitat. All of these map units provide habitat for many species of wildlife. The major soils in map units 5, 6, and 7 have fair to poor potential for wildlife habitat because they do not support a good plant cover.

About half of the county has good potential for most recreation uses. The major soils in map units 1 through 7 have good potential in the nearly level and gently undulating areas. The potential of the other areas and of the major soils in map unit 8 is fair to poor.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils.

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have profiles that are almost alike make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Evart series, for example, was named for the town of Evart in Osceola County.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Nester loam, 2 to 6 percent slopes, is one of several phases within the Nester series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes and undifferentiated groups.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportions are somewhat similar in all areas. Iosco-Kawkawlin complex, 0 to 3 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because there is little value in separating them. The pattern and proportion of the soils are not uniform. An area shown on the map has at least one of the dominant (named) soils or may have all of them. Loxley and Greenwood mucky peats is an undifferentiated group in this survey area.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Pits is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

AuA—Au Gres loamy sand, 0 to 2 percent slopes. This somewhat poorly drained, nearly level soil is in flat areas. Individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is black loamy sand about 4 inches thick. The subsurface layer is light brownish gray, mottled sand about 9 inches thick. The subsoil is dark brown, mottled, very friable sand about 8 inches thick. The substratum to a depth of about 60 inches is multico-

lored sand. In a few places the upper part of the subsoil is not mottled.

Included with this soil in mapping are small areas of the excessively drained Rubicon soil on the higher knolls and ridges, the poorly drained and very poorly drained Roscommon soil in depressions, and the somewhat poorly drained Iosco soil intermixed throughout the unit. The Rubicon soil makes up about 5 percent of the unit, the Iosco soil less than 5 percent, and the Roscommon soil 5 percent. The Iosco soil has a clay loam subsoil about 20 to 40 inches from the surface.

Permeability is rapid in the Au Gres soil, runoff is slow, and available water capacity is low. In undrained areas, a seasonal high water table is within 1/2 to 1 foot of the surface during the period November through May.

Most areas are wooded, but a few are cultivated or pastured. This soil has good potential for pasture. It has fair potential for cultivated crops and woodland and poor potential for most kinds of wildlife habitat, recreation uses, and most engineering uses.

Before cultivated crops can be grown, drainage is generally needed. Undrained areas remain wet late in spring, and wet depressions hinder machinery and delay planting. Locating drainage outlets is difficult in most areas. In undrained areas the soil is droughty, and in drained areas it becomes more droughty in midsummer. Soil blowing is a hazard if the soil is cultivated. Plowing under cover crops, green manure crops, crop residue, and manure conserves soil moisture. Cover crops, stripcropping, minimum tillage, and windbreaks are effective in controlling soil blowing. Blinding material helps to prevent accumulation of sediment in drainage tile.

Many undrained areas are pastured. Pasture grasses grow well early in the season, but the pasture tends to dry up when the soil moisture is depleted during the dry summer months. Overgrazing causes pasture depletion and susceptibility to soil blowing. Rotation grazing and strip grazing are effective in controlling soil blowing.

Many areas of this soil are used as woodland. The trees grow at only a moderate rate because the available water capacity is low. The seasonal high water table also limits tree growth to some extent. The trees are generally cut for pulpwood. After harvest, they usually regenerate without replanting. The re-growth is slow because the seedling mortality rate is severe. Planting seedlings is usually difficult because the soil is too wet.

The seasonal high water table and the droughtiness of the sand surface layer limit most recreation uses. Locating drainage outlets is difficult in most areas. Snowmobile trails are easily established and maintained. Deep and shallow ponds can be constructed, but they fill up slowly. Many types of wildlife use areas of this soil for food, cover, or water.

Building site development is severely limited by the seasonal high water table, the caving of cutbanks, and the droughtiness in midsummer. Lowering the water table is very difficult. Construction of buildings with basements should be avoided because of the water table. Shoring walls and pumping excess water help to keep cutbanks from caving. Frequent watering of lawns is needed unless loam topsoil is added. Frost action is a limitation if local roads and streets are built on this soil. It can be reduced by replacing or covering the upper layer of the soil with suitable base material. The included Rubicon soil is suitable as a site for single dwellings.

If available, commercial sewers should be used for waste disposal. The water table is too high and permeability too rapid for other methods of waste disposal. Also, the effluent from septic tank absorption fields can pollute ground water.

Capability subclass IVw; Michigan management group 5b.

Br—Brevort loamy sand. This poorly drained and very poorly drained, nearly level soil is in flat areas and drainageways. It is subject to frequent flooding for brief periods. Individual areas are irregular in shape and range from 3 to 25 acres in size.

Typically, the surface layer is very dark brown loamy sand about 8 inches thick. The substratum is grayish brown and mottled. The upper 23 inches is loamy sand or sand. The lower part to a depth of about 60 inches is calcareous silt loam. In places the upper part of the substratum has bands of sandy loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Iosco soil on slight rises and the poorly drained and very poorly drained Roscommon and Sims soils throughout the unit. The Iosco soil makes up about 5 percent of the unit and the Roscommon and Sims soils 5 to 10 percent. The Roscommon soil is deep and sandy and the Sims soil deep and loamy.

Permeability is rapid in the upper part of the Brevort soil and moderately slow in the lower part. Runoff is very slow or ponded, and available water capacity is moderate. The shrink-swell potential is moderate in the lower part of the substratum. In undrained areas the seasonal high water table can be at the surface during the period November through May.

Most areas are in woodland or pasture. This soil has fair potential for wetland wildlife habitat. It has poor potential for cultivated crops, pasture, woodland, recreation uses, and most engineering uses.

Cultivated crops are seldom grown because of the seasonal high water table, frost damage to crops, and the flood hazard. Most areas remain undrained because locating drainage outlets is difficult.

This soil is suitable for pasture. Pasture grasses grow fairly well. The soil is frequently flooded for brief periods in March and April. Grazing when the soil is too wet causes surface compaction. Timely deferment of grazing and restricted use during wet periods and during floods keep the pasture and the soil in good condition.

This soil is suitable for woodland. The trees grow slowly because of the seasonal high water table. Also, they are subject to windthrow because the soil is wet. The trees

should be thinned and the most productive ones saved. They should be harvested during the winter. Equipment tends to bog down in this wet soil during the rest of the year. The trees are usually cut for pulpwood. After harvest, they regenerate without replanting. The regrowth is slow at first because plant competition and seedling mortality are severe. Planting seedlings is usually difficult because the soil is too wet.

The seasonal high water table limits most recreation uses. Locating drainage outlets is difficult in most areas. Snowmobile trails can be built if some fill material is used. Wetland wildlife habitat can be improved by digging shallow ponds. Deep ponds for fish can be constructed.

Building site development is severely limited by the seasonal high water table and the flood hazard. Construction of buildings with basements should be avoided because of the water table.

The water table and the moderately slow permeability limit the use of this soil as a site for waste disposal systems. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities. Seepage is a limitation in sewage lagoons.

Capability subclass Vw; Michigan management group 4/2c.

Co—Colonville fine sandy loam. This somewhat poorly drained, nearly level soil is on flood plains next to rivers and streams. It is commonly flooded for brief periods (fig. 9). Individual areas are long and range from 3 to 400 acres in size.

Typically, the surface layer is very dark grayish brown, calcareous fine sandy loam about 17 inches thick. The substratum to a depth of about 60 inches is multicolored fine sandy loam and sand. In places the lower part of the substratum is sand and gravel.

Included with this soil in mapping are small areas of the somewhat poorly drained Winterfield soil throughout the unit and the very poorly drained Markey and poorly drained and very poorly drained Evart soils in the lower depressions. The Winterfield soil makes up about 5 percent of the unit and the Markey and Evart soils 10 percent. The Winterfield soil is deep and sandy.

Permeability is moderately rapid in the Colonville soil, runoff is slow or ponded, and available water capacity is low. The surface layer is moderately alkaline. A seasonal high water table is within 1 foot to 2 feet of the surface during the period September through May.

Most areas are wooded, commonly with sugar maple, red maple, quaking aspen, and northern white-cedar. This soil has good potential as woodland and as habitat for upland wildlife. It has poor potential for cultivated crops, pasture, and building site development and fair to poor potential for recreation uses.

Cultivated crops and pasture grasses are seldom grown because of the flood hazard and the seasonal high water table. Also, the soil is too alkaline for most crops. Pasture grasses grow well, but the pasture tends to dry up during the summer.

This soil is used for woodland. The trees grow rapidly, but their growth is limited to some extent by the seasonal high water table. The trees are usually cut for pulpwood. After harvest, they usually regenerate without much help. Plant competition is moderate, and thinning is a suitable practice if it is necessary.

This soil is suitable for summer recreation uses. During the rest of the year, flooding is likely. Some land shaping is needed to fill in some of the low wet spots. Snowmobile trails are easily established and maintained. Deep and shallow ponds can be constructed, but protection from floodwater is needed. Wooded and open areas provide excellent habitat for wildlife.

Building site development is not practical on this soil. Measures that overcome the flood hazard are very costly, and lowering the seasonal high water table is very difficult.

Capability subclass Vw; Michigan management group L-2b.

CrB—Croswell sand, 0 to 4 percent slopes. This moderately well drained, nearly level and gently undulating soil is in flat areas and on slight rises. Individual areas are irregular in shape and range from 3 to 160 acres in size.

Typically, the surface layer is very dark brown sand about 3 inches thick. The subsurface layer is light brownish gray sand about 4 inches thick. The subsoil is about 22 inches thick. The upper part is brown to dark brown, very friable sand. The lower part and the substratum to a depth of about 60 inches are multicolored, loose sand.

Included with this soil in mapping are small areas of the somewhat poorly drained Au Gres soil in wet depressions and the excessively drained Rubicon soil on the higher rises. The Au Gres soil makes up about 5 to 10 percent of the unit and the Rubicon soil 5 percent.

Permeability is rapid in the Croswell soil, runoff is very slow, and available water capacity is low. In undrained areas the seasonal high water table is within 2 to 3 feet of the surface during the period November through April.

Most areas are in woodland. This soil has good potential for woodland, fair potential for pasture, fair to poor potential for recreation uses and for most engineering uses, and poor potential for cultivated crops and wildlife habitat.

Cultivated crops are seldom grown because the soil is droughty. Also, soil blowing is a hazard if the soil is cultivated. Plowing under cover crops, green manure crops, crop residue, and manure conserves soil moisture. Cover crops, stripcropping, and windbreaks are effective in controlling soil blowing.

Some of the open areas are pastured. Pasture grasses grow well early in spring, but the pasture tends to dry up during the summer. Overgrazing, especially in the summer, causes pasture depletion and soil loss through blowing. Rotation grazing or strip grazing is needed.

This soil is suitable for woodland, but tree growth is limited by the low available water capacity. Pine and hardwoods are common. The trees are usually cut for pulpwood. After harvest, pine seedlings should be planted to

keep the soil in production. Seedling mortality is severe in most years because of droughtiness and plant competition. Planting more trees than are necessary can compensate for seedling mortality, but thinning may be needed later. Planting trees in plow furrows reduces plant competition.

This soil is suitable for recreation uses, but the seasonal high water table is a limitation and the grass cover is usually not dense enough to withstand the heavy foot traffic. Wood chips can be added in areas where foot traffic is heavy, and topsoil can be added as a better medium for grasses grown as cover. Snowmobile trails are easily constructed and maintained. Wooded areas provide cover for wildlife.

Building site development is limited by the seasonal high water table, droughtiness, soil blowing, and the caving of cutbanks. Construction of buildings with basements should be avoided because of the water table. Frequent watering of lawns is needed unless loamy topsoil is added. Shoring walls keeps cutbanks from caving. The included Rubicon soil is suitable as a site for single dwellings.

If possible, sanitary facilities should be connected to commercial sewers and treatment facilities. Sewage lagoons are generally unsuited unless a blanket of impervious material is provided to prevent seepage.

Capability subclass IVs; Michigan management group 5a.

GaA—Gladwin loamy sand, 0 to 2 percent slopes. This somewhat poorly drained, nearly level soil is in broad, flat areas and drainageways. Individual areas are irregular in shape and range from 3 to 320 acres in size.

Typically, the surface layer is very dark brown loamy sand about 8 inches thick. The subsurface layer is grayish brown sand about 3 inches thick. Below this is a dark brown, mottled subsoil about 18 inches thick. The upper part is very friable sand, and the lower part is friable gravelly sandy loam. The substratum to a depth of about 60 inches is very pale brown, calcareous, stratified gravel and coarse sand.

Included with this soil in mapping are small areas of the somewhat excessively drained Mancelona soil on slight rises and ridges, the somewhat poorly drained Iosco soil throughout the unit, and the poorly drained and very poorly drained Wheatley soil in wet depressions. Each of these included soils makes up about 5 percent of the unit. The Iosco soil has a loamy subsoil that is 20 to 40 inches from the surface.

Permeability is moderately rapid in the Gladwin soil, runoff is slow, and available water capacity is low. In undrained areas the seasonal high water table is within 1 foot to 2 feet of the surface during the period November through May.

Most areas are in woodland, pasture, or idle grassland. This soil has good potential for pasture. It has fair potential for cultivated crops, woodland, and upland wildlife habitat and fair to poor potential for recreation uses and building site development.

Before cultivated crops can be grown, drainage is generally needed. In undrained areas, this soil remains wet late in spring and wet depressions hinder machinery and delay planting. Locating drainage outlets is difficult in most areas. The soil tends to be droughty, especially in drained areas in midsummer. Irrigation can improve productivity. Plowing under cover crops, green manure crops, crop residue, and manure conserves soil moisture. Soil blowing is a hazard if the soil is cultivated. Cover crops, stripcropping, and windbreaks are effective in controlling soil blowing. Blinding material is needed to prevent accumulation of sediment in drainage tile.

This soil is suitable for pasture. Pasture grasses grow well, but the pasture tends to dry up when the soil moisture is depleted during the dry summer months. Overgrazing results in pasture depletion and susceptibility to soil blowing. Rotation grazing or strip grazing is needed.

This soil is suitable for woodland, but tree growth is limited by the low available water capacity. The trees should be thinned and the most productive ones saved. They are generally cut for pulpwood. After harvest, they usually regenerate without replanting. Regrowth is slow at first because seedling mortality is moderate. Spruce seedlings should be planted in the open areas as needed.

The seasonal high water table and the sandy surface layer limit recreation uses. Locating drainage outlets is difficult in most areas. Frequently watering the grass helps to overcome the droughtiness of sandy soils. Snowmobile trails are easily established and maintained. Deep and shallow ponds can be constructed, but they fill up slowly. Open and wooded areas provide a fair habitat for wildlife.

Building site development is limited by the seasonal high water table, the caving of cutbanks, droughtiness, and frost action. Construction of homes with basements should be avoided because of the high water table. Shoring walls and pumping excess water help to keep cutbanks from caving. Lawns should be watered frequently in midsummer. The frost action on sites for roads and streets can be controlled by replacing or covering the upper layer of the soil with suitable base material. The included Mancelona soil is suitable as a building site.

The seasonal high water table and the moderately rapid permeability limit this soil as a site for waste disposal systems. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IIIw; Michigan management group 4b.

GrB—Graycalm sand, 0 to 6 percent slopes. This somewhat excessively drained, nearly level and gently undulating soil is on broad plains that have slight rises. Individual areas are irregular in shape and range from 10 to 500 acres in size.

Typically, the surface layer is very dark grayish brown sand about 3 inches thick. The subsoil to a depth of about 60 inches is multicolored, very friable or loose sand that

has a few thin bands of loamy sand. In a few places the loamy sand bands in the lower part of the subsoil are not evident.

Included with this soil in mapping are small areas of the well drained Montcalm and somewhat excessively drained Mancelona and Melita soils, which are throughout the unit. These soils make up 10 to 15 percent of the unit. The Mancelona soil is underlain with sand and gravel. The Montcalm soil has sandy loam bands in the subsoil. The Melita soil has a clay loam subsoil 40 to 55 inches from the surface.

Permeability is rapid in the Graycalm soil, runoff is very slow, and available water capacity is low.

Most areas are wooded with an assortment of aspen, maple, and oak. This soil has good potential for pasture, woodland, building site development, and recreation uses. It has fair potential for cultivated crops and poor potential for wildlife habitat.

This soil is suitable for cultivated crops. Crops that grow best are those that mature early in the season before the supply of soil moisture becomes short. Row crops tend to be adversely affected by a moisture deficiency in midsummer. If the soil is cultivated, soil blowing is a hazard. Many areas could be irrigated and if properly managed could be more productive. Plowing under cover crops, green manure crops, crop residue, and manure conserves a little more soil moisture. Cover crops, minimum tillage, stripcropping, and windbreaks are effective in controlling soil blowing.

This soil is suitable for pasture. Pasture grasses grow well early in the season, but the lack of soil moisture in the dry summer months retards growth. Overgrazing results in susceptibility to erosion and soil blowing. Rotation grazing and strip grazing are effective in controlling erosion and soil blowing.

This soil is suitable for woodland. The trees can be harvested at any time of the year. After harvest, pine seedlings should be planted to keep the soil in production (fig. 10). Seedling mortality is severe. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later. Plow planting seedlings in furrows reduces plant competition.

This soil is suitable for most recreation uses. The sandy surface layer and erosion are management problems. The grass cover is usually too sparse to withstand the heavy traffic in most recreation areas. Wood chips can be added where traffic is heavy, and topsoil can be added to provide a better medium for the grass grown as cover. Playgrounds generally can be established in the less sloping areas. Snowmobile trails are easily established and maintained. The wooded areas provide cover for wildlife.

This soil is suitable for building site development, but droughtiness and the caving of cutbanks are problems. Frequent watering of lawns is needed unless loam topsoil is added. Shoring walls can keep cutbanks from caving.

If septic tank absorption fields are installed in this soil, the effluent can pollute ground water.

Capability subclass IVs; Michigan management group 5a.

GrC—Graycalm sand, 6 to 18 percent slopes. This somewhat excessively drained, gently rolling and rolling soil is on knolls. Individual areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is very dark grayish brown sand about 3 inches thick. The subsoil to a depth of about 60 inches is multicolored, very friable and loose sand that has a few thin bands of loamy sand. In a few places the loamy sand bands in the lower part of the subsoil are not evident.

Included with this soil in mapping are small areas of the well drained Montcalm, the somewhat excessively drained Mancelona, and the well drained and moderately well drained Menominee soils, which are throughout the unit. These soils make up 5 to 10 percent of the unit. The Mancelona soil is underlain with sand and gravel. The Montcalm soil has sandy loam bands in the subsoil. The Menominee soil has a clay loam subsoil 20 to 38 inches from the surface.

Permeability is rapid in the Graycalm soil, runoff is slow, and available water capacity is low.

Most areas are wooded with an assortment of aspen, maple, and oak. This soil has good potential for woodland. It has fair potential for building site development, pasture, and most recreation uses and poor potential for cultivated crops and wildlife habitat.

Cultivated crops generally are not grown because the soil is too droughty. An occasional small grain crop can be planted to help establish a hay crop.

Some areas are pastured. Pasture grasses grow well early in the season, but the pasture tends to dry up when soil moisture is depleted during the dry summer months. Overgrazing results in susceptibility to erosion and soil blowing. Rotation grazing and strip grazing are effective in controlling erosion and soil blowing.

This soil generally is used for woodland. The trees can be harvested at any time of the year. Erosion control is needed. Pine seedlings should be planted after harvest. Plant competition is moderate. It can be reduced by plow planting seedlings in furrows. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later.

This soil is suitable for paths and trails if erosion is controlled. Small camp and picnic areas can be established on the top of some of the hills. The grass cover is usually too sparse to withstand the heavy traffic in recreation areas. Wood chips can be added where traffic is heavy, and topsoil can be added to provide a better medium for the grass grown as cover. Roads and trails should be constructed on the contour if possible to limit erosion. Snowmobile trails are easily established, but they are subject to erosion because of the lack of enough plant cover. The wooded areas provide cover for wildlife.

This soil is suitable as a site for buildings. Onsite investigation is needed. The slope, the droughtiness, and the caving of cutbanks are limitations. The slope and the risk

of erosion can be reduced by land shaping and by constructing roads and streets on the contour. Shoring walls can keep cutbanks from caving.

If septic tank absorption fields are installed in this soil, the effluent can pollute ground water.

Capability subclass VIs; Michigan management group 5a.

GrD—Graycalm sand, 18 to 35 percent slopes. This somewhat excessively drained, hilly and steep soil is on uplands. Individual areas are irregular in shape and range from 10 to 160 acres in size.

Typically, the surface layer is very dark grayish brown sand about 2 inches thick. The subsoil to a depth of about 60 inches is multicolored, very friable or loose sand that has a few thin bands of loamy sand. In a few places the loamy sand bands in the lower part of the subsoil are not evident.

Included with this soil in mapping are small areas of the well drained Montcalm and Menominee soils, which are throughout the unit. These soils make up 10 to 15 percent of the unit. The Montcalm soil has sandy loam bands in the subsoil. The Menominee soil has a clay loam subsoil 20 to 38 inches from the surface.

Permeability is rapid in the Graycalm soil, runoff is medium, and available water capacity is low.

Most areas are wooded with an assortment of aspen, maple, and oak. This soil has good potential for woodland. It has poor potential for cultivated crops, pasture, wildlife habitat, recreation uses, and most engineering uses.

Cultivated crops and pasture grasses are not grown on this soil because it is hilly and very droughty. Pastures can produce very little forage.

This soil is suitable for woodland. As a result of the slope, the use of equipment is limited and erosion is a hazard during harvest. Constructing roads on the contour and properly managing the woodland during cutting help to control erosion and overcome the equipment limitation. Pine seedlings should be planted after harvest. Plant competition is moderate. It can be reduced by plow planting seedlings in furrows. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later.

This soil is suitable for paths and trails. Wood chips can be added in areas where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Snowmobile trails are easily established, but they are subject to erosion because of the lack of enough plant cover. The wooded areas provide cover for wildlife.

The slope severely limits the use of this soil as a building site or a waste disposal site.

Capability subclass VIIs; Michigan management group 5a.

GyB—Grayling sand, 0 to 6 percent slopes. This excessively drained, nearly level and gently undulating soil is on broad plains that have slight rises. Individual areas are irregular in shape and range from 30 to 600 acres in size.

Typically, the surface layer is very dark gray sand about 3 inches thick. The subsoil is about 17 inches of yellowish brown, loose sand. The substratum to a depth of about 60 inches is light yellowish brown, loose sand. In places the substratum is sand and gravel. In a few places it has a few loamy sand bands.

Included with this soil in mapping are small areas of the excessively drained Rubicon soil throughout the unit and the somewhat poorly drained Au Gres soil in shallow depressions and drainageways. The Rubicon soil makes up about 10 percent of the unit and the Au Gres soil 5 percent. Available water capacity is higher in the Rubicon soil than in the Grayling soil.

Permeability is very rapid in the Grayling soil, runoff is very slow, and available water capacity is very low. The soil is extremely droughty.

Most areas are wooded with jack pine and assorted oaks. This soil has good potential for building site development and for recreation uses. It has poor potential for cultivated crops, pasture, woodland, and all types of wildlife habitat.

Cultivated crops and pasture grasses generally are not grown because the soil is droughty. Pastures furnish very little forage for livestock. Many areas could be irrigated and if properly managed could be productive.

This soil is used chiefly for woodland. Tree growth is limited because the soil is droughty. Pulpwood-size trees can be cut after several years. The trees can be harvested at any time of the year. After harvest, replanting is needed. Seedling mortality is severe in most years. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later.

This soil is suitable for most recreation uses. The plant cover is usually too sparse on this sandy soil to withstand the heavy traffic in most recreation areas. Wood chips can be added in areas where foot traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Playgrounds generally can be established in the less sloping areas. Snowmobile trails are easily established and maintained. The wooded areas provide cover for wildlife.

This soil is suitable for building site development, but the caving of cutbanks is a limitation. Shoring walls can keep cutbanks from caving. Frequent watering of lawns is needed unless loam topsoil is added.

If septic tank absorption fields are installed in this soil, the effluent can pollute ground water. Water in wells should be tested for contamination.

Capability subclass VIs; Michigan management group 5.7a.

GyC—Grayling sand, 6 to 18 percent slopes. This excessively drained, gently rolling and rolling soil is on knolls. Individual areas are irregular in shape and range from 20 to 320 acres in size.

Typically, the surface layer is black sand about 3 inches thick. The subsoil is about 16 inches of yellowish brown, very friable sand. The substratum to a depth of about 60 inches is light yellowish brown, loose sand. In places the

substratum is sand and gravel. In a few places it has a few loamy sand bands.

Included with this soil in mapping are small areas of the excessively drained Rubicon soil throughout the unit and the somewhat poorly drained Au Gres soil in shallow depressions and drainageways. The Rubicon soil makes up about 10 percent of the unit and the Au Gres soil 5 percent. Available water capacity is higher in the Rubicon soil than in the Grayling soil.

Permeability is very rapid in the Grayling soil, runoff is slow, and available water capacity is very low. The soil is extremely droughty.

Most areas are wooded. Jack pine and assorted oaks are the most common trees. This soil has fair potential for building site development and for most recreation uses. It has poor potential for cultivated crops, pasture, woodland, and all types of wildlife habitat.

Cultivated crops and pasture grasses are not grown because the soil is droughty. Pastures furnish very little forage for livestock.

Most areas are suitable as woodland, but tree growth is limited because the soil is droughty. Pulpwood-size trees can be cut after several years. As a result of the slope, the use of equipment is limited and erosion is a hazard during harvest. Building roads on the contour and properly managing the woodland during cutting help to control erosion and overcome the equipment limitation. After harvest, replanting is needed. Seedling mortality is severe in most years. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later.

This soil is suitable for camp and picnic areas and paths and trails. Careful management is needed to control erosion. The plant cover is usually too sparse on this sandy soil to withstand the heavy foot traffic in recreation areas. Wood chips can be added in areas where foot traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Snowmobile trails are easily established, but they are subject to erosion because of the lack of enough plant cover. The wooded areas provide cover for wildlife.

The slope, the droughtiness, and the caving of cutbanks limit building site development. Onsite investigation is needed. Shaping the land and building roads and streets on the contour reduce the slope and the erosion hazard. Frequent watering of lawns is needed unless loamy topsoil is added. Shoring walls can keep cutbanks from caving.

If septic tank absorption fields are installed in this soil, the effluent can pollute ground water.

Capability subclass VIIs; Michigan management group 5.7a.

GyD—Grayling sand, 18 to 35 percent slopes. This excessively drained, hilly and steep soil is on uplands. Individual areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is dark grayish brown sand about 2 inches thick. The subsoil is about 21 inches of yellowish brown, very friable sand. The substratum to a depth of about 60 inches is light yellowish brown, loose sand. In places the lower part of the substratum has thin bands of loamy sand.

Included with this soil in mapping are small areas of the excessively drained Rubicon soil throughout the unit and the moderately well drained Croswell soil in shallow depressions and drainageways. Each of these included soils makes up about 5 percent of the unit. Available water capacity is higher in the Rubicon soil than in the Grayling soil.

Permeability is very rapid in the Grayling soil, runoff is slow, and available water capacity is very low. The soil is extremely droughty.

Most areas support jack pine and assorted oaks. This soil has poor potential for cultivated crops, pasture, woodland, wildlife habitat, recreation uses, and most engineering uses.

Cultivated crops and pasture grasses are not grown because this soil is hilly and steep and very droughty. Pastures produce very little forage.

This soil is suitable for woodland, but tree growth is limited by the droughtiness. As a result of the slope, the use of equipment is limited and erosion is a hazard during harvest. Building roads on the contour and properly managing the woodland during cutting help to control erosion and overcome the equipment limitation. After harvest, replanting is needed. Seedling mortality is severe in most years. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later.

This soil is suitable for paths and trails. Careful management is needed to control erosion. The plant cover is usually too sparse on this sandy soil to withstand the heavy traffic in most recreation areas. Wood chips can be added in areas where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Snowmobile trails are easily established (fig. 11), but they are subject to erosion because of the lack of enough plant cover. The wooded areas provide cover for wildlife.

The slope is a severe limitation if this soil is used as a site for buildings or waste disposal systems.

Capability subclass VIIs; Michigan management group 5.7a.

Hs—Histosols, ponded. This map unit consists of very poorly drained, nearly level soils in depressional areas. The soils are subject to frequent flooding for long periods. Individual areas are irregular in shape and range from 2 to 320 acres in size.

Typically, the muck ranges from 16 inches to more than 6 feet in thickness. The substratum ranges from sand to clay loam.

These soils are usually covered with water the year round. The depth of the water ranges from a few inches to 2 or 3 feet.

In most areas these soils support cattails, reeds, and other water-tolerant grasses and shrubs. Dead trees are common in some areas. The potential for wetland wildlife habitat is good. The potential for cultivated crops, pasture, woodland, recreation uses, and engineering uses is poor.

Cultivated crops and pasture grasses cannot be grown because of the instability of the soils and the lack of drainage outlets. Most trees cannot grow on these soils because the water table is too high. Building site development and recreation uses are not feasible because the high water table is too high and the soils are unstable. The soils provide excellent habitat for wetland wildlife. Deep fish ponds can be dug, but gentle side slopes are needed to prevent caving and sloughing.

Capability subclass VIIIw; not assigned to a Michigan management group.

IkA—Iosco-Kawkawlin complex, 0 to 3 percent slopes. This map unit consists of somewhat poorly drained, nearly level and gently undulating soils in nearly flat areas and on very gentle knolls. Individual areas are irregular in shape and range from 10 to 80 acres in size. They are 50 to 60 percent Iosco soil and 30 to 40 percent Kawkawlin soil. The Iosco soil is on the very gentle knolls, and the Kawkawlin soil is in the nearly flat areas. The two soils are so intricately mixed or are in areas so small that mapping them separately is not practical.

Typically, the Iosco soil has a surface layer of very dark grayish brown loamy sand about 6 inches thick. The subsurface layer is grayish brown, mottled sand about 3 inches thick. Below this is a mottled subsoil about 51 inches thick. The upper part is dark brown, friable loamy sand; the next part is brown, loose sand; and the lower part to a depth of about 60 inches is brown, firm silty clay loam.

Typically, the Kawkawlin soil has a surface layer of very dark grayish brown sandy loam about 9 inches thick. The subsurface layer is dark brown, mottled sandy loam about 6 inches thick. Below this is a mottled, firm subsoil about 26 inches thick. The upper part is dark brown clay loam, and the lower part is brown silty clay loam. The substratum to a depth of about 60 inches is brown, calcareous silty clay loam.

Included with these soils in mapping are small areas of the well drained and moderately well drained Menominee and the poorly drained and very poorly drained Brevort and Sims soils, which make up 10 to 15 percent of the unit. The Menominee soil is on the higher knolls. The Brevort and Sims soils are in the more depressed areas.

Permeability is rapid in the sandy upper part of the Iosco soil and moderately slow in the loamy lower part. It is moderately slow in the Kawkawlin soil. Available water capacity is moderate in the Iosco soil and high in the Kawkawlin soil. Runoff is slow on both soils. The shrink-swell potential is moderate in both soils, either in the subsoil or in the substratum. In undrained areas of both soils, the seasonal high water table is within 1 foot to 2 feet of the surface during the period November through May.

These soils are commonly used for pasture or woodland and in a few areas are cultivated. They have good potential for pasture and woodland wildlife habitat. They have fair potential for cultivated crops and woodland, fair to poor potential for recreation uses, and poor potential for most engineering uses.

Drained areas are suitable for cultivated crops. In many areas locating drainage outlets is difficult. Wet depressions hinder machinery and delay planting. In undrained areas the soils warm up more slowly in spring because of the seasonal high water table. Soil blowing is a hazard if the soils are drained. Windbreaks, cover crops, and strip-cropping help to reduce the risk of soil blowing.

These soils are suited to pasture. Many of the small depressed areas are ponded in the spring. Overgrazing or grazing when the soils are too wet results in surface compaction, puddling, and a susceptibility to soil blowing. Proper stocking rates, rotation grazing or strip grazing, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

These soils are suitable for woodland. After harvest, the trees usually regenerate without replanting. Regrowth is slow at first because of plant competition and seedling mortality. Spruce seedlings can be planted in the open areas if necessary.

The seasonal high water table in both soils and the sandy surface layer in the Iosco soil limit recreation uses. Locating drainage outlets is difficult. Frequent watering of grass helps to control droughtiness. Snowmobile trails are easily established and maintained. Deep and shallow ponds can be dug, but they fill up slowly. Wooded areas serve as excellent habitat for wildlife.

Building site development is limited by the seasonal high water table. Also, the moderate shrink-swell potential is a problem. The water table can be lowered by tiling or by digging ditches. On sites for local roads and streets, the shrinking and swelling can be controlled by replacing or covering the upper layer of the soil with suitable base material. On sites for dwellings and small buildings without basements, it can be controlled by backfilling around foundations with suitable material and by providing drainage around the foundations.

The seasonal high water table and the moderately slow permeability limit these soils as sites for waste disposal systems. If available, commercial sewers should be used.

Capability subclass IIIw; Michigan management group 4/2b, 1.5b.

KwB—Kawkawlin loam, 0 to 4 percent slopes. This somewhat poorly drained, nearly level and gently undulating soil is on slight rises and low knolls. Individual areas are irregular in shape and range from 3 to 160 acres in size.

Typically, the surface layer is very dark gray loam about 6 inches thick. The subsoil is about 18 inches thick. The upper part is light brownish gray, friable loam and brown, firm silty clay loam, and the lower part is dark brown, mottled, firm silty clay loam. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous silty clay loam.

Included with this soil in mapping are small areas of the well drained and moderately well drained Nester soil on the higher knolls, the somewhat poorly drained sandy Iosco soil on slight rises, and the poorly drained and very poorly drained Sims soil in drainageways and shallow depressions. Each of these included soils makes up about 5 percent of the unit.

Permeability is moderately slow in the Kawkawlin soil, runoff is slow, and available water capacity is high. The shrink-swell potential is moderate below the surface layer. In undrained areas the seasonal high water table is within 1 foot to 2 feet of the surface during the period October through May. The surface layer is friable and can be easily tilled. It tends to crust or puddle, however, after hard rains or when the soil is wet.

Most areas are cultivated or pastured. This soil has good potential for cultivated crops, pasture, and woodland and as habitat for upland wildlife. It has fair to poor potential for recreation uses and poor potential for engineering uses.

Cultivated crops, such as corn, oats, and wheat, are commonly grown in drained areas. Some areas where locating drainage outlets is difficult remain undrained. In these areas wet depressions hinder machinery, delay planting, and reduce productivity. The soil puddles and crusts if it is tilled when wet. Also, it warms up in spring more slowly than sandy soils.

Undrained areas commonly are pastured. Grazing when the soil is too wet causes surface compaction and poor tilth. Timely deferment of grazing and restricted use during wet periods keeps the pasture and the soil in good condition.

Trees are suited to this soil. They should be harvested during winter. After harvest, they usually regenerate without replanting. Plant competition is moderate, and the stand can be thinned if necessary.

This soil is suitable for most recreation uses if it is drained. Wetness is a limitation after heavy rains. Deep or shallow ponds can be dug, but they fill up slowly. Open and wooded areas provide excellent habitat for wildlife.

Building site development is limited by the seasonal high water table, the shrink-swell potential, and low strength. Also, frost action is a problem if local roads and streets are built on this soil. It can be reduced by replacing or covering the upper layer of the soil with suitable base material. The adverse effects of shrinking and swelling can be reduced by constructing dwellings and small buildings without basements, by designing foundations and footings to prevent structural damage, by backfilling around foundations with suitable material, and by providing drainage around foundations.

The seasonal high water table and the moderately slow permeability limit this soil as a site for sanitary facilities. If possible, these facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IIw; Michigan management group 1.5b.

Lg—Loxley and Greenwood mucky peats. This map unit consists of very poorly drained, nearly level soils in broad, flat or depressional areas. These soils are subject to frequent flooding for long periods. Individual areas are irregular in shape and range from 3 to 200 acres in size. They are 20 to 90 percent Loxley soil and 0 to 70 percent Greenwood soil. The two soils make up about 90 percent of the unit. They are used and managed so similarly that mapping them separately is not practical.

Typically, the upper tiers of the Loxley soil are dark reddish brown, partly decomposed muck. The lower tiers to a depth of about 60 inches are dark reddish brown, well decomposed muck.

Typically, the upper 6 inches of the Greenwood soil is dark brown sphagnum moss roots. The lower tiers to a depth of about 60 inches are dark brown to very dark brown, partly decomposed, acid muck.

Included with these soils in mapping are small areas of the very poorly drained Markey soil, generally on the edges of the unit. This soil makes up about 10 percent of the unit. It is a shallow muck that is underlain with sand.

Permeability is moderately slow to moderately rapid in the Loxley soil and moderate or moderately rapid in the Greenwood soil. Runoff is very slow on both soils, and available water capacity is high. Both soils have a seasonal high water table that is at the surface during the period November through May.

Most areas are in leatherleaf and wild huckleberry bogs. These soils have good potential for wetland wildlife habitat. They have poor potential for cultivated crops, pasture, woodland, and recreation and engineering uses.

Cultivated crops and pasture grasses are not grown because of the instability of the soils and the lack of drainage outlets. Also, the soils are too acid for most crops. Most areas remain undrained. As a result, the soils are too unstable to support equipment and livestock.

Recreation uses generally are not practical because of the seasonal high water table and the instability of the soils. Wetland wildlife habitat can be enhanced by digging shallow ponds. If deep fish ponds are dug, gentle side slopes are needed to prevent caving and sloughing.

Building site development is not practical on these soils. The seasonal high water table and the instability of the soils are too difficult to overcome.

Capability subclass VIIIw; Michigan management group Mc-a.

Lu—Lupton muck. This very poorly drained, nearly level soil is in depressional areas. It is subject to frequent

flooding for long periods. Individual areas are irregular in shape and range from 4 to 640 acres in size.

Typically, the upper tiers of this soil are black, well decomposed muck about 50 inches thick. The bottom tier to a depth of about 60 inches is very dark brown, well decomposed muck.

Included with this soil in mapping are small areas of the somewhat poorly drained sandy Au Gres soil on slight rises and the very poorly drained Markey and Rondeau soils, generally on the edges of the unit. The Au Gres soil makes up about 5 percent of the unit and the Markey and Rondeau soils 10 percent. The Markey soil is a shallow muck that is underlain with sand and the Rondeau soil a shallow muck that is underlain with marl.

Permeability is moderately slow to moderately rapid in the Lupton soil, runoff is very slow, and available water capacity is high. The seasonal high water table is at the surface during the period September through May.

Most areas are wooded or covered with bushes. This soil has good potential for wetland wildlife habitat. It has poor potential for cultivated crops, pasture, woodland, and recreation and engineering uses.

Cultivated crops and pasture grasses are seldom grown because of the instability of the soil and the lack of drainage outlets. Most areas remain undrained. As a result, the soil is too unstable to support equipment and livestock.

Most areas are suitable as woodland. Northern white-cedar, black spruce, balsam fir, tamarack, and quaking aspen are the most common trees. The trees grow slowly because of the seasonal high water table. They are susceptible to windthrow because of the wetness and instability of the soil. They should be harvested during the winter, when the ground is frozen. Most of the trees are suitable for pulpwood. Some small saplings should be left after the trees are harvested because plant competition and seedling mortality are severe. Planting seedlings is very difficult because the soil usually is too wet.

This soil is not suitable for most recreation uses because of the seasonal high water table and the instability. Snowmobile trails can be established if suitable fill material is provided. Wetland wildlife habitat can be enhanced by digging shallow ponds. If deep fish ponds are dug, gentle side slopes are needed to prevent caving and sloughing.

Building site development is not practical on this soil. Overcoming the limitations, chiefly the seasonal high water table and the instability, is too costly.

Capability subclass Vw; Michigan management group Mc.

MaB—Mancelona loamy sand, 0 to 6 percent slopes. This somewhat excessively drained, nearly level and gently undulating soil is in flat areas and on some slight rises and low knolls. Individual areas are irregular in shape and range from 3 to 200 acres in size.

Typically, the surface layer is black loamy sand about 3 inches thick. The subsurface layer is grayish brown gravelly loamy sand about 2 inches thick. Below this is a very friable subsoil about 22 inches thick. The upper part is dark brown to brown gravelly loamy sand, the next part is dark brown gravelly sandy loam, and the lower part is dark yellowish brown gravelly loamy sand. The substratum to a depth of about 60 inches is light yellowish brown, calcareous sand and gravel.

Included with this soil in mapping are small areas of the somewhat poorly drained Au Gres and Gladwin soils in shallow depressions and drainageways. These soils make up about 5 to 10 percent of the unit.

Permeability is moderately rapid in the Mancelona soil, runoff is slow, and available water capacity is low.

This soil is used for pasture, woodland, and cropland. It has good potential for pasture, woodland, building site development, and recreation uses. It has fair potential for cultivated crops and upland wildlife habitat.

Cultivated crops are grown in many areas. This soil is droughty during the summer, and crops lack sufficient moisture unless rainfall is adequate. Irrigation can significantly improve productivity. Soil blowing and erosion are hazards, but they can be controlled by stripcropping, cover crops, and windbreaks.

This soil is suitable for pasture. Pasture grasses grow well early in spring, but the pasture tends to dry up during the summer. Overgrazing results in pasture depletion and susceptibility to soil blowing. Rotation grazing or strip grazing is needed.

This soil is suitable for woodland. Pine and hardwoods grow rapidly. The trees are usually cut for pulpwood. After harvest, aspen trees usually regenerate without replanting. Pine seedlings should be planted in the areas of other harvested trees. Seedling mortality is moderate in most years because of the droughtiness of the soil and the plant competition. Plow planting seedlings in furrows reduces the plant competition. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later.

This soil is suitable for recreation uses. Careful management is needed because the sandy upper part of the soil is droughty. The grass cover is usually not dense enough to withstand the heavy foot traffic in most recreation areas. Wood chips can be added where foot traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Playgrounds generally can be established in the less sloping areas. Snowmobile trails are easily established and maintained. The open and wooded areas provide fair habitat for wildlife.

This soil is suitable for building site development. Wall shoring is needed to keep cutbanks in excavations from caving. Frequent watering of lawns is needed unless loamy topsoil is added.

If septic tank absorption fields are installed in this soil, the effluent can pollute ground water because permeability is moderately rapid. Sewage lagoons generally are unsuited unless a blanket of impervious material can be provided to prevent seepage.

Capability subclass IIIs; Michigan management group 4a.

MaC—Mancelona loamy sand, 6 to 12 percent slopes. This somewhat excessively drained, gently rolling soil is on knolls. Individual areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 2 inches thick. The subsurface layer is grayish brown loamy sand about 2 inches thick. Below this is a dark yellowish brown, very friable subsoil about 26 inches thick. The upper part is loamy sand, and the lower part is gravelly sandy loam. The substratum to a depth of about 60 inches is light yellowish brown, calcareous sand and gravel.

Included with this soil in mapping are small areas of the somewhat poorly drained Gladwin soil in depressions and drainageways and the well drained Menominee soil throughout the unit. Each of these included soils makes up about 5 percent of the unit. The Menominee soil has a clay loam subsoil 20 to 38 inches from the surface.

Permeability is moderately rapid in the Mancelona soil, runoff is slow, and available water capacity is low.

This soil is used for woodland, pasture and cropland. It has good potential for pasture and woodland and fair potential for cultivated crops, upland wildlife habitat, most recreation uses, and building site development.

Cultivated crops are grown in many areas. This soil is droughty during the summer. Small grain is better suited than other crops because it normally matures before the amount of available water becomes limited. Plowing under cover crops, green manure crops, crop residue, and manure conserves soil moisture. Soil blowing and erosion can be controlled by cover crops, stripcropping, windbreaks, grassed waterways, and minimum tillage or no-till planting.

This soil is suitable for pasture. Pasture grasses grow well early in spring, but the lack of soil moisture in the dry summer months retards their growth. Overgrazing results in pasture depletion and a susceptibility to soil blowing and erosion. Rotation grazing or strip grazing is needed.

The soil is suitable for woodland. Pine and hardwoods grow rapidly. The trees are usually cut for pulpwood. After harvest, aspen trees usually regenerate without replanting. Pine seedlings should be planted in the areas of other harvested trees. Seedling mortality is moderate in most years because of the droughtiness and the plant competition. Plow planting seedlings in furrows reduces the plant competition. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later.

This soil is suitable for paths and trails. Careful management is needed to control erosion. The grass cover is usually not dense enough to withstand the heavy foot traffic in most recreation areas. Wood chips can be added in areas where foot traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Snowmobile trails are easily established, but they are susceptible to erosion. The open and wooded areas provide fair habitat for wildlife.

This soil is suitable for building site development, but the slope, the droughtiness, and the caving of cutbanks are limitations. Shaping the land and building roads and streets on the contour help to overcome the limitation imposed by slope. Frequent watering of lawns is needed unless loamy topsoil is added. Shoring walls can keep cutbanks from caving.

If septic tank absorption fields are installed in this soil, the effluent can pollute ground water.

Capability subclass IIIe; Michigan management group 4a.

Mb—Markey muck. This very poorly drained, nearly level soil is in depressional areas. It is subject to frequent flooding for long periods. Individual areas are irregular in shape and range from 3 to 400 acres in size.

Typically, the organic tiers of this soil are very dark brown and very dark grayish brown, well decomposed muck about 32 inches thick. The substratum to a depth of about 60 inches is gray sand.

Included with this soil in mapping are small areas of the very poorly drained Lupton and poorly drained and very poorly drained Roscommon soils. The Lupton soil is a deep muck, and the Roscommon soil is deep and sandy. The Lupton soil generally is in the middle of the mapped areas, and the Roscommon soil is on the edges. The Lupton soil makes up about 10 percent of the unit and the Roscommon soil 5 percent.

Permeability is moderately slow in the Markey soil, runoff is very slow, and available water capacity is high. The seasonal high water table is at the surface during the period November through June.

Most areas are wooded or covered with marsh grass (fig. 12). This soil has good potential for wetland wildlife habitat. It has poor potential for cultivated crops, pasture, woodland, and recreation and engineering uses.

Cultivated crops and pasture grasses are seldom grown because of the instability of the soil and the lack of drainage outlets. Most areas remain undrained. As a result, the soil is too unstable to support equipment and livestock.

This soil is suitable for woodland. Northern white-cedar, black spruce, balsam fir, tamarack, black ash, and quaking aspen are the most common trees. The trees grow slowly because of the seasonal high water table. They are susceptible to windthrow because the soil is wet and unstable. They should be harvested during the winter, when the ground is frozen. Most of the trees are suitable for pulpwood. Some small saplings should be left after the trees are harvested because of plant competition and seedling mortality. Planting seedlings is very difficult because the soil usually is too wet.

Recreation uses generally are not practical because of the seasonal high water table and the instability of the soil. Snowmobile trails can be built if suitable fill material is provided. Wetland wildlife habitat can be enhanced by

digging shallow ponds. If deep fish ponds are dug, gentle side slopes are needed to prevent caving and sloughing.

Building site development is not practical. Overcoming the seasonal high water table and the instability of the soil is too difficult. Special assistance from engineers is needed before roads are built.

Capability subclass VIw; Michigan management group M/4c.

McB—McBride sandy loam, 2 to 6 percent slopes. This moderately well drained, gently undulating soil is on slight rises and low knolls. Individual areas are irregular in shape and range from 4 to 120 acres in size.

Typically, the surface layer is black sandy loam about 3 inches thick. The subsurface layer is grayish brown sandy loam about 3 inches thick. The subsoil is about 49 inches thick. The upper part is dark brown, very friable sandy loam; the next part is brown and dark yellowish brown, brittle loamy sand; and the lower part is dark brown, firm sandy clay loam. The substratum to a depth of about 60 inches is dark brown sandy loam.

Included with this soil in mapping are small areas of the well drained Montcalm soil on the higher rises and the well drained and moderately well drained Menominee and Nester soils throughout the unit. The Montcalm soil makes up 5 to 10 percent of the unit and the Menominee and Nester soils about 5 percent. The deep sandy Montcalm soil has sandy loam bands in the subsoil. The sandy Menominee soil has clay loam in the lower part of the subsoil. The Nester soil has a finer textured subsoil than the McBride soil.

Permeability is moderately rapid above the brittle layer of loamy sand in the McBride soil and slow in the brittle layer. Runoff is medium, and available water capacity is low. The brittle layer, at a depth of about 15 inches, restricts roots. The water table is perched above the brittle layer during the period November through April. The surface layer is very friable and can be easily tilled.

Most areas are wooded, commonly with sugar maple, red oak, quaking aspen, and red maple. This soil has good potential for pasture, woodland, and recreation uses. It has fair potential for cultivated crops and openland wildlife habitat and fair to poor potential for engineering uses.

Cultivated crops are suited to this soil, but they are seldom grown. Planting is delayed because of seasonally wet depressions that usually are dry by the summer. In some areas where only a few wet depressions are evident, crops can be planted on time. The shallow root zone can significantly reduce productivity in dry years.

Open areas are pastured. Many wet depressions are in most pastures, and cobbles are on the surface in a few areas. The wet depressions usually dry up during the summer. Grazing when the soil is too wet causes surface compaction and poor tilth. Timely deferment of grazing and restricted use during wet periods keep the pasture and the soil in good condition.

Most areas are used for woodland. The trees are subject to windthrow because of the shallow root zone. They can be harvested at any time of the year. After harvest, they regenerate without replanting. Regrowth is slow at first because of plant competition and seedling mortality. Spruce seedlings can be planted in the open areas if necessary.

This soil is suitable for picnic areas and paths and trails. Camp areas and playgrounds are limited by the slow permeability of the subsoil. Wetness is a limitation after heavy rains. Playgrounds generally can be established in the less sloping areas if the land is shaped. Open areas provide fair habitat for wildlife.

Building site development is severely limited by the perched water table. Also, frost action is a limitation if roads and streets are built on this soil. It can be reduced by replacing or covering the upper layer of the soil with suitable base material. Single dwellings can be built on the included well drained Montcalm soil.

Septic tank absorption fields do not function properly because of the slow permeability in the subsoil and the perched water table. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IIe; Michigan management group 3a.

McC—McBride sandy loam, 6 to 12 percent slopes. This moderately well drained, gently rolling soil is on knolls. Individual areas are irregular in shape and range from 4 to 60 acres in size.

Typically, the surface layer is very dark brown sandy loam about 3 inches thick. The subsurface layer is light brownish gray loamy sand about 2 inches thick. The subsoil is about 47 inches thick. The upper part is dark brown, very friable sandy loam; the next part is pale brown, brittle loamy sand; and the lower part is brown, friable sandy clay loam. The substratum to a depth of about 60 inches is yellowish brown, calcareous sandy loam.

Included with this soil in mapping are small areas of the well drained Montcalm and Menominee soils, which are throughout the unit. The Montcalm soil makes up about 10 percent of the unit and the Menominee soil 5 percent. The Montcalm soil is deep and sandy and has sandy loam bands. The Menominee soil has sandy material in the upper part of the subsoil and clay loam in the lower part.

Permeability is moderately rapid above the brittle layer in the McBride soil and slow in the brittle layer. Runoff is medium, and available water capacity is low. The brittle layer restricts roots. The water table is perched above the brittle layer during the period November through April. The surface layer is very friable and can be easily tilled.

Most areas are wooded, commonly with sugar maple, red oak, and quaking aspen. This soil has good potential for pasture and woodland. It has fair potential for cultivated crops, openland wildlife habitat, and most recreation uses. It has fair to poor potential for engineering uses.

Cultivated crops are suited to this soil, but they are seldom grown. Planting is delayed because of seasonally wet depressions that usually are dry by the summer. The shallow root zone can significantly reduce productivity in dry years. Erosion is a hazard. Stripcropping, cover crops, grassed waterways, and minimum tillage or no-till planting reduce the risk of erosion.

This soil is suitable for pasture. Many seasonally wet depressions are in most pastures. They usually are dry during the summer. Grazing when the soil is too wet causes surface compaction and poor tilth. Timely deferment of grazing and restricted use during wet periods keep the pasture and the soil in good condition.

This soil is suitable for woodland. The trees are subject to windthrow because of the shallow root zone. They can be harvested at any time of the year. After harvest, they regenerate without replanting. Regrowth is slow at first because plant competition and seedling mortality are moderate. Spruce seedlings can be planted in the open areas if necessary.

Some recreation uses are suitable on this soil. Most are limited by the slope. Paths and trails can be laid out with little difficulty. Land shaping can correct the slope in some areas. Roads and trails should be built on the contour if possible to limit erosion. Snowmobile trails are easily established and maintained. Open areas provide fair habitat for wildlife.

Building site development is limited by the perched water table, the slope, and frost action. The slope can be reduced by shaping the land and by building roads or streets on the contour. Frost action on roads and streets can be reduced by replacing or covering the upper layer of the soil with suitable base material. Single dwellings can be built on the included well drained Montcalm soil.

Septic tank absorption fields do not function properly because of the perched water table and the slow permeability in the subsoil. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IIIe; Michigan management group 3a.

MeB—Melita sand, 0 to 6 percent slopes. This somewhat excessively drained, nearly level and gently undulating soil is in flat areas and on slight rises. Individual areas are irregular in shape and range from 3 to 80 acres in size.

Typically, the surface layer is very dark brown sand about 2 inches thick. The subsurface layer is grayish brown sand about 3 inches thick. The subsoil is about 52 inches thick. The upper 48 inches is dark brown to yellowish brown, very friable and loose sand, and the lower 4 inches is brown, mottled clay loam. The substratum to a depth of about 60 inches is brown, mottled, calcareous clay loam. In places a thin layer of sand and gravel overlies the clay loam part of the subsoil. In a few places the substratum is within a depth of 40 inches.

Included with this soil in mapping are small areas of the somewhat excessively drained Graycalm and well drained Montcalm soils, which are throughout the unit. These soils make up 10 to 15 percent of the unit. They are deep sandy soils that have bands of loamy sand or sandy loam in the subsoil.

Permeability is rapid in the sandy upper part of the Melita soil and moderately slow in the loamy lower part. Runoff is slow, and available water capacity is low. The shrink-swell potential is moderate in the substratum.

Most areas are wooded, commonly with sugar maple, quaking aspen, red pine, and red maple. This soil has good potential for pasture, woodland, building site development, and recreation uses. It has fair potential for cultivated crops and poor potential for wildlife habitat.

Cultivated crops are seldom grown because the soil is droughty. If the soil is cultivated, soil blowing is a hazard. Many areas could be irrigated and if properly managed could be more productive. Plowing under cover crops, green manure crops, crop residue, and manure conserves a little more soil moisture. Cover crops, stripcropping, and windbreaks are effective in controlling soil blowing.

This soil is suitable for pasture. Pasture grasses grow well early in spring, but the pasture tends to dry up in summer. Overgrazing, especially in the summer, causes pasture depletion and a susceptibility to soil blowing. Rotation grazing or strip grazing is needed.

This soil is suitable for woodland, but tree growth is limited by the low available water capacity. Pine and hardwoods are common. The trees are usually cut for pulpwood. After harvest, pine seedlings can be planted. Seedling mortality is severe in most years because of droughtiness and plant competition. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later. Planting trees in plow furrows reduces plant competition.

Recreation uses are suitable, but careful management of this droughty sandy soil is needed. The grass cover is usually not dense enough to withstand the heavy foot traffic in most recreation areas. Wood chips can be added in areas where foot traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Playgrounds generally can be established in the less sloping areas. Snowmobile trails are easily established and maintained. The wooded areas provide cover for wildlife.

This soil is suitable for building site development, but the droughtiness and the caving of cutbanks are limitations. Frequent watering of lawns is needed unless loamy topsoil is added. Wall shoring can keep cutbanks from caving. Sewage lagoons are generally unsuited unless a blanket of impervious material from the substratum can be placed on the side walls.

Capability subclass IVs; Michigan management group 5/2a.

MnB—Menominee loamy sand, 0 to 6 percent slopes. This moderately well drained, nearly level and

gently undulating soil is in flat areas and on slight rises. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark brown loamy sand about 4 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is about 35 inches thick. The upper part is reddish brown and yellowish brown, friable loamy sand; the next part is a mixture of strong brown and pale brown, friable sandy loam and brown and reddish brown, firm clay loam; and the lower part is dark brown, mottled, firm clay loam. The substratum to a depth of about 64 inches is light brown, mottled, calcareous clay loam. In a few places the sandy upper part of the subsoil extends to a depth of more than 40 inches.

Included with this soil in mapping are small areas of the well drained and moderately well drained loamy Nester soil on knolls, the somewhat excessively drained Mancelona and well drained Montcalm soils throughout the unit, and the somewhat poorly drained Kawkawlin and Iosco soils in drainageways and shallow depressions. The Nester soil makes up about 5 percent of the unit, the Mancelona and Montcalm soils 5 percent, and the Kawkawlin and Iosco soils 5 percent. The Mancelona soil has a sand and gravel substratum 20 to 40 inches from the surface. The Montcalm soil is deep and sandy and has sandy loam bands in the subsoil.

Permeability is rapid in the sandy upper part of the Menominee soil and moderately slow in the loamy lower part. Runoff is slow, and available water capacity is moderate. The shrink-swell potential is moderate in the substratum. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas are pastured or wooded. A few are cultivated. This soil has good potential for pasture, woodland, and recreation uses. It has fair potential for cultivated crops and building site development and as habitat for woodland and openland wildlife.

This soil is suitable for cultivated crops. It lacks available water during the dry summer months. Many areas could be irrigated and if properly managed could be more productive. The soil is easy to work. Excessive tillage increases the hazards of soil blowing and erosion. Drainage is needed in some scattered wet depressions and drainageways. Plowing under cover crops, green manure crops, crop residue, and manure conserves the available water. Stripcropping, cover crops, grassed waterways, and minimum tillage help to control soil blowing and erosion. Windbreaks also control soil blowing. Contour strips in places control erosion.

This soil is suited to pasture. Pasture grasses grow well early in the season, but the lack of soil moisture in the dry summer months retards growth. Overgrazing results in a susceptibility to erosion and soil blowing. Rotation grazing and strip grazing are effective in controlling erosion and soil blowing.

This soil is suitable for woodland. The trees can be harvested at any time of the year. After harvest, they usually regenerate without replanting. The regrowth is slow at first because plant competition and seedling mortality are moderate. Pine seedlings can be planted if they are needed in the open areas.

Most recreation uses are suitable, but careful management is needed to control droughtiness and erosion. The grass cover is usually too sparse to withstand the heavy traffic in most recreation areas. Wood chips can be added in areas where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Playgrounds generally can be established in the less sloping areas. Snowmobile trails are easily established and maintained. The open and wooded areas serve as fair habitat for wildlife.

Building site development is limited by the droughtiness and the shrink-swell potential and low strength in the substratum. The shrinking and swelling can be controlled by constructing dwellings and small buildings without basements, by backfilling around foundations with suitable material, and by providing drainage around foundations. Frequent watering of lawns is needed in midsummer unless loam topsoil is added.

The moderately slow permeability limits this soil as a septic tank absorption field. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities. The soil generally is suited to sewage lagoons. The included Montcalm and Mancelona soils are suitable as septic tank absorption fields.

Capability subclass IIIs; Michigan management group 4/2a.

MnC—Menominee loamy sand, 6 to 12 percent slopes. This well drained, gently rolling soil is on knolls. Individual areas are irregular in shape and range from 5 to 30 acres in size.

Typically, the surface layer is black loamy sand about 3 inches thick. The subsurface layer is brown sand about 3 inches thick. The subsoil is about 38 inches thick. The upper part is dark brown, very friable sand; the next part is yellowish brown, friable loamy sand; and the lower part is dark brown, firm clay loam. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous clay loam. In a few places the surface layer and the upper part of the subsoil are sandy loam.

Included with this soil in mapping are small areas of the well drained loamy Nester soil on knolls, the well drained Montcalm soil throughout the unit, and the somewhat poorly drained Kawkawlin and Iosco soils in drainageways and shallow depressions. The Nester soil makes up 5 percent of the unit, the Montcalm soil 5 percent, and the Kawkawlin and Iosco soils 5 percent. The Montcalm soil is deep and sandy and has sandy loam bands in the subsoil.

Permeability is rapid in the sandy upper part of the Menominee soil and moderately slow in the loamy lower part. Runoff is medium, and available water capacity is moderate. The shrink-swell potential is moderate in the

substratum. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas are pastured or wooded. A few are cultivated. This soil has good potential for pasture and woodland. It has fair potential for cultivated crops, building site development, and most recreation uses and as habitat for woodland and openland wildlife.

This soil is suitable for cultivated crops. It lacks available water during the dry summer months. It is easy to work. Excessive tillage increases the hazards of soil blowing and erosion. Drainage is needed in some of the scattered wet depressions and drainageways. Plowing under cover crops, green manure crops, crop residue, and manure conserves available water. Stripcropping, cover crops, grassed waterways, and minimum tillage help to reduce the risks of soil blowing and erosion. Windbreaks also reduce the risk of soil blowing. Contour strips in places reduce the risk of erosion.

This soil is suitable for pasture. Pasture grasses grow well early in the season, but the lack of soil moisture in the dry summer months retards growth. Overgrazing results in susceptibility to erosion and soil blowing. Rotation grazing and strip grazing are effective in controlling erosion and soil blowing.

This soil is suitable as woodland. Care should be taken to control erosion. The trees can be harvested at any time of the year. After harvest, they usually regenerate without replanting. Regrowth is slow at first because plant competition and seedling mortality are moderate. Pine seedlings can be planted if they are needed in the open areas.

Only a few limitations affect the use of this soil for paths and trails. Careful management is needed to control droughtiness and erosion. The grass cover is usually too sparse to withstand the heavy traffic in most recreation areas. Wood chips can be added in areas where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Roads and trails should be constructed on the contour if possible to limit erosion. Snowmobile trails are easily established, but they are subject to erosion because of the lack of enough plant cover. The open and wooded areas serve as a fair habitat for wildlife.

Building site development is limited by the shrink-swell potential and low strength, the slope, and the droughtiness. The shrinking and swelling and low strength can be controlled by constructing dwellings and small buildings without basements, by backfilling around foundations with suitable material, and by providing drainage around foundations. Shaping the land and constructing roads and streets on the contour help to overcome the limitation imposed by slope. Frequent watering of lawns is needed in midsummer unless loam topsoil is added.

The moderately slow permeability limits this soil as a septic tank absorption field. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IIIe; Michigan management group 4/ 2a.

MoC—Menominee-Montcalm loamy sands, 6 to 18 percent slopes. This map unit consists of well drained, gently rolling and rolling soils on knolls. It is about 55 percent Menominee soil and 30 percent Montcalm soil. The Menominee soil is on the tops and upper sides of the knolls, and the Montcalm soil is on the sides of the knolls. These two soils are so intricately mixed or are in areas so small that mapping them separately is not practical. Individual areas are irregular in shape and range from 15 to 60 acres in size.

Typically, the Menominee soil has a surface layer of black loamy sand about 3 inches thick. The subsurface layer is brown sand about 3 inches thick. The subsoil is about 38 inches thick. The upper part is dark brown, very friable sand; the next part is yellowish brown, friable loamy sand; and the lower part is dark brown, firm clay loam. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous clay loam.

Typically, the Montcalm soil has a surface layer of very dark grayish brown loamy sand about 2 inches thick. The subsurface layer is light brownish gray loamy sand about 2 inches thick. The subsoil is very friable loamy sand about 56 inches thick. The upper 28 inches is dark yellowish brown and yellowish brown, and the lower 28 inches is light yellowish brown and has bands of dark brown sandy loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Iosco and Otisco soils, which make up about 15 percent of the unit. These included soils are in the drainageways and depressions between the knolls.

Permeability is rapid in the sandy upper part of the Menominee soil and moderately slow in the loamy lower part. Runoff is medium, and available water capacity is moderate. The shrink-swell potential is moderate in the substratum. In the Montcalm soil, permeability is rapid and available water capacity is low. Runoff is medium.

Most areas are wooded, commonly with sugar maple, quaking aspen, red oak, eastern white pine, and red pine. These soils have good potential for woodland and pasture. They have fair potential for cultivated crops, upland wildlife habitat, most recreation uses, and building site development.

Cultivated crops are seldom grown because of slope and droughtiness. If the soils are cultivated, soil blowing and erosion are hazards. Small grain is more suitable than other crops because it normally matures before the supply of soil moisture is short and because the risk of erosion is less in areas where small grain is grown. Drainage is needed in some of the scattered wet depressions and drainageways. Plowing under cover crops, green manure crops, crop residue, and manure conserves available water. Cover crops, stripcropping, grassed waterways, windbreaks, and minimum tillage are effective in controlling soil blowing and erosion.

Pasture grasses are grown in a few areas. They grow well early in the season, but the lack of soil moisture in the dry summer months retards growth. Overgrazing results in pasture depletion and susceptibility to soil blowing and erosion. Rotation grazing or strip grazing are effective in reducing the risks of erosion and soil blowing.

These soils are suitable as woodland. Care should be taken to control erosion. The trees can be harvested at any time of the year. After harvest, they usually regenerate without replanting. Regrowth is slow at first because plant competition and seedling mortality are moderate. Pine seedlings should be planted in the open areas.

These soils are suitable for paths and trails. Careful management is needed to control droughtiness and erosion. The grass cover is usually too thin to withstand the heavy traffic in most recreation areas. Wood chips can be added where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Roads and trails should be constructed on the contour if possible to limit erosion. Snowmobile trails are easily established, but are subject to erosion because of the lack of enough plant cover. The open and wooded areas provide fair habitat for wildlife.

Building site development is limited on both soils by the slope and the droughtiness. It is also limited on the Menominee soil by shrinking and swelling and low strength and on the Montcalm soil by the caving of cutbanks. A site for a few dwellings can be prepared by shaping the deep, sandy hillsides. Some wall shoring can keep cutbanks from caving. Foundations of dwellings should be designed to prevent the structural damage caused by shrinking and swelling. Constructing local roads and streets on the contour helps to control erosion. Frequent watering of lawns is needed in midsummer.

If septic tank absorption fields are installed in the Menominee soil, an absorption area that is larger than is typical is needed.

Capability subclass IIIe; Michigan management group 4/2a, 4a.

MtB—Montcalm loamy sand, 0 to 6 percent slopes. This well drained, nearly level and gently undulating soil is on broad plains that have slight rises. Individual areas are irregular in shape and range from 10 to 300 acres in size.

Typically, the surface layer is dark grayish brown loamy sand about 7 inches thick. The subsoil is about 53 inches thick. The upper 14 inches is dark yellowish brown and yellowish brown, very friable loamy sand, and the lower 39 inches is grayish brown, loose sand that has bands of dark brown sandy loam. In a few places the lower part of the subsoil has pockets of sand and gravel.

Included with this soil in mapping are small areas of the somewhat excessively drained Melita and well drained and moderately well drained Menominee and Nester soils. The Melita and Menominee soils are throughout the unit. They make up about 10 percent of the unit. The loamy Nester soil is on rises and knolls. It makes up about 5 percent of the unit. The Melita soil has a clay loam subsoil 40 to 55 inches below the surface and the Menominee soil a clay loam subsoil 20 to 38 inches below the surface.

Permeability is rapid in the Montcalm soil, runoff is slow, and available water capacity is low.

Most areas are wooded. Some are cultivated or pastured. This soil has good potential for pasture, woodland, building site development and recreation uses. It has fair potential for cultivated crops and upland wildlife habitat.

This soil is suitable as cropland. Crops that grow best are those that mature early in the season before the amount of moisture in the soil is limited. Soil moisture is adequate for row crops in spring, but it can be deficient during the hot summer. The soil is easily worked, but excessive tillage increases the hazards of soil blowing and erosion. If properly managed and irrigated, the soil can be more productive. Plowing under cover crops, green manure crops, crop residue, and manure conserves available water. Cover crops, stripcropping, minimum tillage, and windbreaks are effective in controlling soil blowing and erosion.

This soil is suitable for pasture. Pasture grasses grow well early in the season, but the lack of soil moisture during the dry summer months retards growth. Overgrazing results in susceptibility to erosion and soil blowing. Rotation grazing and strip grazing are effective in controlling erosion and soil blowing.

This soil is suitable as woodland. The trees grow rapidly. They can be harvested at any time of the year. After harvest, they usually regenerate without replanting in areas where aspen is dominant. Planting pine seedlings in the other areas keeps the soil in maximum production. Seedling mortality and plant competition are moderate. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later. Plow planting seedlings in furrows reduces plant competition.

Most recreation uses are suitable, but careful management is needed to control droughtiness and erosion. The grass cover is usually too sparse to withstand the heavy traffic in most recreation areas. Wood chips can be added in areas where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Playgrounds generally can be established in the less sloping areas. Snowmobile trails are easily established and maintained. The open and wooded areas serve as fair habitat for wildlife.

This soil is suitable for building site development. Droughtiness and the caving of cutbanks, however, are limitations. Frequent watering of lawns is needed unless loam topsoil is added. Shoring walls can keep cutbanks from caving.

If septic tank absorption fields are installed in this soil, the effluent can pollute ground water.

Capability subclass IIIs; Michigan management group 4a.

MtC—Montcalm loamy sand, 6 to 12 percent slopes. This well drained, gently rolling soil is on knolls. Individual

areas are irregular in shape and range from 5 to 80 acres in size.

Typically, the surface layer is dark grayish brown loamy sand about 7 inches thick. The subsoil is very friable loamy sand about 53 inches thick. The upper 25 inches is dark yellowish brown and yellowish brown, and the lower 28 inches is light yellowish brown and has bands of dark brown sandy loam. In places the lower part of the subsoil has pockets of sand and gravel.

Included with this soil in mapping are small areas of the well drained Menominee and Nester soils. Each of these included soils makes up about 5 percent of the unit. The Menominee soil is throughout the unit, and the loamy Nester soil is on the knolls. The Menominee soil has a clay loam subsoil 20 to 38 inches from the surface.

Permeability is rapid in the Montcalm soil, runoff is medium, and available water capacity is low.

Most areas are wooded. Some are cultivated or pastured. This soil has good potential for pasture and woodland. It has fair potential for cultivated crops, upland wildlife habitat, and most recreation and engineering uses.

This soil is suitable as cropland. It is easily worked, but the hazards of erosion and soil blowing and the low available water capacity limit the use for crops. Shallow-rooted crops cannot attain optimum growth in dry years and are not so suitable as a deep-rooted crop, such as alfalfa. Small grain is suitable because it normally matures before the amount of available water is limited. Plowing under cover crops, green manure crops, crop residue, and manure conserves available water. Cover crops, stripcropping, windbreaks, minimum tillage, and a good crop rotation are effective in controlling soil blowing and erosion.

This soil is suitable for pasture. Pasture grasses grow well early in the season, but the lack of soil moisture in the dry summer months retards growth. Overgrazing results in susceptibility to erosion and soil blowing. Rotation grazing and strip grazing are effective in controlling erosion and soil blowing.

This soil is suitable as woodland. Erosion control is needed. The trees can be harvested at any time of the year. After harvest, aspen trees usually regenerate without replanting. Pine seedlings should be planted in the areas of other harvested trees. Seedling mortality and plant competition are moderate. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later. Plow planting seedlings in furrows reduces plant competition.

Paths and trails are suitable on this soil, but careful management is needed to control droughtiness and erosion. The grass cover is usually too sparse to withstand the heavy traffic in most recreation areas. Wood chips can be added in areas where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Snowmobile trails are easily established, but they are subject to erosion because of the lack of enough plant cover. The open and wooded areas serve as fair habitat for wildlife.

The slope, the droughtiness, and the caving of cutbanks limit building site development. Shaping the land and building roads and streets on the contour help to overcome the limitation imposed by slope and reduce the risk of erosion. Frequent watering of lawns is needed unless loam topsoil is added. Shoring walls can keep cutbanks from caving.

The effluent from septic tank absorption fields in this soil can pollute ground water.

Capability subclass IIIe; Michigan management group 4a.

MtD—Montcalm loamy sand, 12 to 18 percent slopes. This well drained, rolling soil is on hills. Individual areas are irregular in shape and range from 5 to 60 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 2 inches thick. The subsurface layer is light brownish gray loamy sand about 2 inches thick. The subsoil is very friable loamy sand about 56 inches thick. The upper part is dark yellowish brown, the next part is yellowish brown, and the lower part is light brownish gray and has bands of dark brown sandy loam. In places the lower part of the subsoil has pockets of sand and gravel.

Included with this soil in mapping are small areas of the well drained Menominee and Nester soils, each of which makes up about 5 percent of the unit. The Menominee soil is throughout the unit, and the loamy Nester soil is on knolls. The Menominee soil has a clay loam subsoil 20 to 38 inches from the surface.

Permeability is rapid in the Montcalm soil, runoff is medium, and available water capacity is low.

Most areas are wooded. A few are cultivated or pastured. This soil has good potential for pasture and woodland. It has fair potential for cultivated crops, upland wildlife habitat, and most recreation and engineering uses.

This soil is seldom used as cropland. It is easily worked, but the hazards of erosion and soil blowing and the low available water capacity limit the use for crops. Shallow-rooted crops cannot attain optimum growth in dry years and are not so suitable as a deep-rooted crop, such as alfalfa. Small grain is suitable because it normally matures before the supply of available water in the soil becomes limited. Plowing under cover crops, green manure crops, crop residue, and manure conserves available water. Cover crops, stripcropping, windbreaks, minimum tillage, and a good crop rotation are effective in controlling soil blowing and erosion.

This soil is suitable for pasture. Pasture grasses grow well early in the season, but the lack of soil moisture in the dry summer months retards growth. Overgrazing results in susceptibility to erosion and soil blowing. Rotation grazing and strip grazing are effective in controlling erosion and soil blowing.

This soil is suitable as woodland. Erosion control is needed. The trees can be harvested at any time of the year. After harvest, aspen trees usually regenerate without replanting. Pine seedlings should be planted in the areas

of other harvested trees. Seedling mortality and plant competition are moderate. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later. Plow planting seedlings in furrows reduces plant competition.

Paths and trails are suitable on this soil, but careful management is needed to control droughtiness and erosion. The grass cover is usually too sparse to withstand the heavy traffic in most recreation areas. Exposed areas should be kept to a minimum. Wood chips can be added in areas where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Snowmobile trails are easily established, but they are subject to erosion because of the lack of enough plant cover. The open and wooded areas serve as fair habitat for wildlife.

The slope, the droughtiness, and the caving of cutbanks limit building site development. Shaping the land and building roads and streets on the contour help to overcome the limitation imposed by slope and reduce the risk of erosion. Frequent watering of lawns is needed unless loam topsoil is added. Shoring walls can keep cutbanks from caving.

The effluent from septic tank absorption fields in this soil can pollute ground water.

Capability subclass IVe; Michigan management group 4a.

MtE—Montcalm loamy sand, 18 to 35 percent slopes. This well drained, hilly and steep soil is on uplands. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 3 inches thick. The subsurface layer is pale brown loamy sand about 1 inch thick. The subsoil is very friable loamy sand about 56 inches thick. The upper 21 inches is dark yellowish brown and yellowish brown, and the lower 35 inches is pale brown and has bands of dark yellowish brown sandy loam. In places the lower part of the subsoil has pockets of sand and gravel.

Included with this soil in mapping are small areas of the well drained Menominee soil throughout the unit and the well drained loamy Nester soil on hilltops. Each of these included soils makes up about 5 percent of the unit. The Menominee soil has a clay loam subsoil 20 to 38 inches from the surface.

Permeability is rapid in the Montcalm soil. Runoff is medium, and available water capacity is low.

Most areas are wooded. This soil has good potential for woodland. It has fair potential for pasture and for upland wildlife habitat and poor potential for cultivated crops, recreation uses, and most engineering uses.

Cultivated crops generally are not grown because the steep slopes hinder farm machinery. Soil blowing and the shortage of soil moisture also limit the use of this soil for cultivated crops.

The limitations of this soil for pasture are severe. Pasture grasses could grow well early in the season, but the lack of soil moisture in the dry summer months would retard growth. Overgrazing results in susceptibility to erosion and soil blowing. Rotation grazing and strip grazing can help in controlling erosion and soil blowing.

This soil is suitable as woodland. As a result of the slope, the use of equipment is limited and erosion is a hazard during harvest. Planting trees on the contour and building logging and skid trails on the contour help to reduce the risk of erosion and overcome the equipment limitation. Pine seedlings can be planted after the harvest. Plant competition and seedling mortality are moderate. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later. Plow planting seedlings in furrows reduces plant competition.

This soil is suitable for paths and trails, but careful management is needed to control the erosion that results from the heavy traffic in most recreation areas. Exposed areas should be kept to a minimum. Wood chips can be added in areas where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Snowmobile trails are easily established, but they are subject to erosion because of the lack of enough plant cover. The open and wooded areas serve as fair habitat for wildlife.

Building site development and waste disposal are severely limited on this soil because of the slope. Other limitations are the droughtiness, the possible pollution of ground water by effluent from septic tank absorption fields, and the caving of cutbanks in excavations. Shaping the land and building roads and streets on the contour help to overcome the limitation imposed by slope and reduce the risk of erosion. Frequent watering of lawns is needed unless loam topsoil is added. Shoring walls can keep cutbanks from caving.

Capability subclass VIe; Michigan management group 4a.

NeB—Nester loam, 2 to 6 percent slopes. This well drained and moderately well drained, gently undulating soil is on knolls and slight rises. Individual areas are irregular in shape and range from 3 to 200 acres in size.

Typically, the surface layer is dark grayish brown loam about 10 inches thick. The subsoil is about 28 inches thick. The upper part is strong brown, firm clay loam and light brownish gray, friable loam. The next part is strong brown, very firm clay loam and pale brown loam. The lower part and substratum to a depth of about 60 inches are multicolored, very firm clay loam. In places the subsoil is less than 20 inches thick.

Included with this soil in mapping are small areas of the well drained Montcalm and well drained and moderately well drained Menominee soils on knolls and ridges and the somewhat poorly drained Kawkawlin soil in drainageways and shallow depressions. The Montcalm and the Menominee soils make up 5 to 10 percent of the unit and the Kawkawlin soil 5 to 10 percent. The sandy Montcalm soil is deep and has sandy loam bands in the subsoil. The

Menominee soil is sandy in the upper part of the subsoil and has clay loam in the lower part and in the substratum.

Permeability is moderately slow in the Nester soil, runoff is slow, and available water capacity is high. The shrink-swell potential is moderate in the subsoil and substratum. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains, especially in areas where the plow layer contains subsoil material.

Most areas are cultivated. This soil has good potential for cultivated crops, pasture, and woodland and as habitat for openland and woodland wildlife. It has good to fair potential for recreation uses and fair to poor potential for most engineering uses.

Cultivated crops commonly are grown on this soil. Erosion is the major hazard. The soil warms up more slowly in spring than more sandy soils. Drainage is needed in some of the scattered wet depressions and drainageways. If the soil is worked when it is too wet, machinery bogs down and puddling and crusting occur. Plowing the soil at the right moisture content keeps the puddling and crusting to a minimum and maintains good tilth. Plowing under green manure crops, crop residue, and manure also maintains tilth. Stripcropping, cover crops, grassed waterways, and minimum tillage or no-till planting help to control erosion.

This soil is suited to pasture. Using the soil as pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotation grazing or strip grazing, deferment of grazing, and restricted use during wet periods keep the pasture and the soil in good condition.

This soil is suited to woodland. The trees grow rapidly and can be harvested at any time of the year. After harvest, they usually regenerate without replanting. Plant competition is moderate, and the stand can be thinned if necessary.

This soil is suitable for picnic areas and paths and trails. It is limited as a site for camp areas and playgrounds by the moderately slow permeability. Wetness is a limitation after heavy rains. Playgrounds generally can be established in the less sloping areas. The wooded and open areas provide excellent habitat for wildlife.

Building site development is limited by the moderate shrink-swell potential and low strength. The shrinking and swelling can be controlled by constructing dwellings and small buildings without basements, by backfilling around foundations with suitable material, and by providing drainage around foundations. If local roads and streets are built on this soil, replacing or covering the upper layer of the soil with suitable base material helps to overcome the shrinking and swelling and low strength.

The moderately slow permeability severely limits this soil as a septic tank absorption field. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities. The soil generally is suited to sewage lagoons, but some land shaping may be needed. The included well drained Montcalm soil is suitable as a septic tank absorption field.

Capability subclass IIe; Michigan management group 1.5a.

NeC—Nester loam, 6 to 12 percent slopes. This well drained, gently rolling soil is on knolls. Individual areas are irregular in shape and range from 3 to 60 acres in size.

Typically, the surface layer is dark grayish brown loam about 6 inches thick. The subsoil is about 18 inches thick. The upper part is yellowish brown, friable loam that has grayish brown coatings on faces of peds, and the lower part is brown, firm silty clay loam. The substratum to a depth of about 60 inches is brown, calcareous silty clay loam. In places the subsoil is less than 20 inches thick. In some areas the surface layer is clay loam.

Included with this soil in mapping are small areas of the well drained sandy Montcalm and Menominee soils on hillsides and the somewhat poorly drained Kawkawlin and Iosco soils in drainageways and shallow depressions. The Montcalm and the Menominee soils make up about 10 percent of the unit and the Iosco and Kawkawlin soils 5 percent. The Montcalm soil is deep and has sandy loam bands in the subsoil. The Menominee soil is sandy in the upper part of the subsoil and has clay loam in the lower part of the subsoil and in the substratum.

Permeability is moderately slow in the Nester soil, runoff is medium, and available water capacity is high. The shrink-swell potential is moderate in the subsoil and the substratum. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains, especially in areas where the plow layer contains subsoil material.

Most areas are cultivated. This soil has good potential for pasture and woodland and as habitat for woodland and openland wildlife. It has fair potential for cultivated crops, fair to poor potential for most engineering uses, and good to fair potential for most recreation uses.

This soil is suitable for cultivated crops. A cropping system that includes row crops for no more than 2 consecutive years and a high percentage of close-growing crops generally is needed to control runoff and erosion. Stripcropping, cover crops, grassed waterways, and minimum tillage or no-till planting also help to control erosion. In areas that are row cropped, the soil is likely to be droughty because much of the rainfall runs off. Runoff and erosion are less, however, in areas of close-growing crops, which can be grown year after year.

This soil tends to warm up more slowly in spring than more sandy soils. Drainage is needed in some of the scattered wet depressions and drainageways. If the soil is worked when too wet, machinery bogs down and puddling and crusting occur. Plowing the soil at the right moisture content keeps puddling and crusting to a minimum and maintains good tilth. Plowing under green manure crops, crop residue, and manure also maintains tilth. Erosion can

be controlled and equipment more safely used if plowing and planting follow the contour of the land.

This soil is suitable as pastureland. Using the soil as pastureland or hayland is very effective in controlling erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotation grazing or strip grazing, deferment of grazing, and restricted use during wet periods keep the pasture and the soil in good condition.

This soil is suitable as woodland. Trees can be harvested at any time of the year. After harvest, they usually regenerate without replanting. Plant competition is moderate, and the stand can be thinned if necessary.

This soil is suitable for paths and trails, but other recreation uses are limited by the slope and the moderately slow permeability. Some land shaping can be done to lessen the slope. Wetness is a limitation after heavy rains. Keeping exposed areas to a minimum helps to control erosion. Wood chips help to control erosion in the areas where traffic is heavy. The wooded and open areas provide excellent habitat for wildlife.

Building site development is limited by the moderate shrink-swell potential, the low strength, and the slope. The shrinking and swelling can be controlled by constructing dwellings and small buildings without basements, by backfilling around foundations with suitable material, and by providing drainage around foundations. Replacing or covering the upper layer of the soil with suitable base material helps to ensure that local roads or streets function properly. Roads and streets should be built on the contour. Land shaping can lessen the slope.

The moderately slow permeability is a limitation if septic tank absorption fields are installed in this soil. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IIIe; Michigan management group 1.5a.

NeD—Nester loam, 12 to 18 percent slopes. This well drained, rolling soil is on hills. Individual areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsurface layer is pale brown loam about 2 inches thick. The subsoil is dominantly dark brown, firm clay loam about 18 inches thick. The substratum to a depth of about 60 inches is dark brown, calcareous clay loam. In places the subsoil is less than 20 inches thick. In some areas the surface layer is clay loam.

Included with this soil in mapping are small areas of the well drained sandy Montcalm and Menominee soils on hillsides. These soils make up about 15 percent of the unit. The Montcalm soil has sandy loam bands in the subsoil. The Menominee soil is sandy in the upper part of the subsoil and has clay loam in the lower part of the subsoil and in the substratum.

Permeability is moderately slow in the Nester soil, runoff is rapid, and available water capacity is high. The shrink-swell potential is moderate in the subsoil and substratum. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It is easily eroded, however, and tends to crust or puddle after hard rains, especially in areas where the plow layer contains subsoil material.

Most areas are pastured or wooded. This soil has good potential for pasture and woodland and as habitat for woodland wildlife. It has fair potential for cultivated crops and poor potential for most recreation uses and for building site development.

This soil is suitable for cultivated crops, but the hazard of erosion is severe if row crops are grown (fig. 13). Stripcropping, cover crops, grassed waterways, minimum tillage or no-till planting, and close-growing crops help to control erosion. A cropping system that includes close-growing crops for a long period reduces the hazard. Droughtiness is a hazard to crops because much of the rainfall runs off.

This soil warms up more slowly in spring than more sandy soils. Drainage is needed in a few scattered wet depressions and drainageways. If the soil is worked when too wet, machinery bogs down and puddling and crusting occur. Plowing the soil at the right moisture content keeps puddling and crusting to a minimum and maintains good tilth. Plowing under green manure crops, crop residue, and manure also maintains tilth. Erosion can be controlled and equipment more safely used if plowing and planting follow the contour of the land.

This soil is suitable as pastureland. Using the soil as pastureland or hayland is very effective in controlling erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, rotation grazing or strip grazing, deferment of grazing, and restricted use during wet periods keep the pasture and the soil in good condition.

This soil is suitable as woodland. Trees can be harvested at any time of the year. After harvest, they usually regenerate without replanting. Plant competition is moderate, and the stand can be thinned if necessary.

Most recreation uses are limited by the slope and the moderately slow permeability. Paths and trails can be developed if care is taken to control erosion. Camp and picnic areas generally are difficult to establish because of the complex slopes. Keeping exposed areas to a minimum helps to control erosion. Wood chips on the paths and trails also help to control erosion. Wooded areas provide excellent habitat for wildlife.

Building site development is limited by the moderate shrink-swell potential and low strength. The shrinking and swelling can be controlled by constructing dwellings and small buildings without basements, by backfilling around foundations with suitable material, and by providing drainage around foundations. Replacing or covering the upper layer of the soil with suitable base material helps to ensure that roads and streets function properly. Roads and streets should be built on the contour. Land shaping can lessen the slope.

The moderately slow permeability is a limitation if septic tank absorption fields are installed in this soil. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IVe; Michigan management group 1.5a.

OtA—Otisco loamy sand, 0 to 2 percent slopes. This somewhat poorly drained, nearly level soil is in flat areas and depressions. Individual areas are irregular in shape and range from 3 to 20 acres in size.

Typically, the surface layer is dominantly very dark brown loamy sand about 4 inches thick. The subsurface layer is light brownish gray, mottled sand about 7 inches thick. The subsoil is about 39 inches of multicolored, very friable or loose sand that has sandy loam bands. The substratum to a depth of about 60 inches is brown, mottled sand. In places no sandy loam bands are in the lower part of the subsoil.

Included with this soil in mapping are small areas of the somewhat poorly drained Iosco soil throughout the unit and the poorly drained and very poorly drained Roscommon soil in wet depressions. The Iosco soil makes up about 10 percent of the unit and the Roscommon soil 5 percent. The Iosco soil is sandy in the upper part of the subsoil and has clay loam in the lower part of the subsoil and in the substratum.

Permeability is moderately rapid or rapid in the Otisco soil, runoff is slow, and available water capacity is low. In undrained areas the seasonal high water table is within 1/2 foot to 1 1/2 feet of the surface during the period November through May.

Most areas are wooded or pastured. This soil has good potential for pasture and for woodland wildlife habitat. It has fair potential for cultivated crops and woodland, fair to poor potential for recreation uses, and poor potential for most engineering uses.

Before cultivated crops can be grown, drainage generally is needed. Unless drained, the soil remains wet late in spring and the wet depressions hinder machinery and delay planting. Locating drainage outlets is difficult in most areas. The soil tends to be droughty. If drained and cropped, it becomes more droughty in midsummer. Irrigation can increase productivity. Plowing under cover crops, green manure crops, crop residue, and manure conserves available water. Soil blowing is a hazard if the soil is cultivated. Cover crops, stripcropping, and windbreaks are effective in controlling soil blowing. Blinding material is needed to prevent accumulation of sediment in drainage tile.

Many of the undrained areas are pastured. Pasture grasses grow well, but the pasture tends to dry up when the soil moisture is depleted during the dry summer months. Overgrazing results in pasture depletion and susceptibility to soil blowing. Rotation grazing or strip grazing is needed.

This soil is suitable for woodland. Tree growth is limited by the low available water capacity. Trees should be thinned and the most productive ones saved. They are usually cut for pulpwood. After harvest, they usually regenerate without replanting. Regrowth is slow at first because seedling mortality is severe. Spruce seedlings should be planted in the open areas as needed.

Recreational uses generally are not practical because of the seasonal high water table and the sandy surface layer. Locating drainage outlets is difficult. Frequent watering of grass helps to overcome the droughtiness of this sandy soil. Snowmobile trails are easily established and maintained. Deep and shallow ponds can be dug, but they fill up slowly. The wooded areas provide excellent habitat for wildlife.

Building site development is severely limited by the seasonal high water table, the caving of cutbanks, and the droughtiness. Construction of dwellings with basements should be avoided because of the seasonal high water table. Shoring walls and pumping excess water help to keep cutbanks from caving. Frequent watering of lawns is needed in midsummer.

The seasonal high water table limits this soil as a site for sewage disposal systems. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities.

Capability subclass IIIw; Michigan management group 4b.

Pt—Pits. This map unit consists of areas that have been excavated for sand or gravel (fig. 14). The excavations range from 4 or 5 to more than 40 feet in depth. Some excavations are below the water table. Drainage varies. Individual areas are irregular in shape and range from 2 to 60 acres in size.

The original soils cannot be identified. The remaining material ranges from sand to clay loam.

Most areas are idle and support little or no vegetation. The potential for all uses varies. Onsite investigation is needed to determine the suitability of a site for a given use.

In most areas a tree-planting program is needed to restore production and control soil blowing and erosion. Pine seedlings generally are suitable.

Not assigned to a capability subclass or a Michigan management group.

Rn—Rondeau muck. This very poorly drained, nearly level soil is in depressional areas. It is subject to frequent flooding for long periods. Individual areas are irregular in shape and range from 3 to 80 acres in size.

Typically, the organic tiers are black, well decomposed muck about 30 inches thick. The substratum to a depth of about 60 inches is light olive gray and light gray, calcareous marl. In places the muck is only 10 to 16 inches thick.

Included with this soil in mapping are small areas of the very poorly drained Lupton soil throughout the unit. This included soil makes up about 15 percent of the unit. It is a deep, well decomposed muck.

Permeability is slow or very slow in the Rondeau soil, runoff is ponded, and available water capacity is high. The

water table is usually very close to the surface throughout the year.

Most areas are covered with marsh grass or are wooded. This soil has good potential for wetland wildlife habitat. It has poor potential for cultivated crops, pasture, woodland, and recreation and engineering uses.

Cultivated crops and pasture grasses are seldom grown because of the instability of the soil and the lack of drainage outlets. The soil has a shallow root zone because of the limited depth to underlying marl. Most areas remain undrained. As a result, the soil is too unstable to support equipment and livestock.

Recreation uses generally are not practical because of the high water table and instability of the soil. Snowmobile trails can be established if some fill material is provided. Wetland wildlife habitat can be enhanced by digging shallow ponds. If deep fish ponds are dug, gentle side slopes are needed to prevent caving and sloughing.

Building site development is not practical on this soil. Overcoming the high water table and the instability of the soil is too difficult. Special assistance from engineers is needed before roads can be built.

Capability subclass Vw; Michigan management group M/mc.

Ro—Roscommon mucky loamy sand. This poorly drained and very poorly drained, nearly level soil is in flat areas and drainageways. It is subject to frequent flooding for brief periods. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black mucky loamy sand about 7 inches thick. The subsurface layer is dark grayish brown loamy sand about 3 inches thick. The substratum to a depth of about 60 inches is grayish brown sand. In places the substratum is brown to yellowish brown sand between depths of 10 and 30 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Au Gres and moderately well drained Croswell soils on slight rises and ridges and the very poorly drained mucky Markey soil in the lower areas. The Au Gres and Croswell soils make up about 10 to 15 percent of the unit and the Markey soil 5 percent.

Permeability is rapid in the Roscommon soil, runoff is very slow to ponded, and available water capacity is low. In undrained areas the seasonal high water table is at the surface or within 1 foot of the surface during the period September through June.

Most areas are wooded, commonly with quaking aspen, northern white-cedar, and red maple. This soil has good potential for wetland wildlife habitat and pasture and poor potential for cultivated crops, woodland, recreation uses, and most engineering uses.

Cultivated crops generally are not grown because of the seasonal high water table and the flood hazard. Locating drainage outlets is difficult.

This soil is not commonly pastured because of the flood hazard between September and May. Pasture grasses grow well late in May and in June, but the pasture dries up when soil moisture is depleted during July and August. Pasture can be grazed between periods of flooding. The soil is frequently flooded, but the duration is usually brief.

This soil is suitable as woodland. The trees grow slowly because of the seasonal high water table. They should be thinned and the most productive trees saved. The trees are subject to windthrow because of the wetness. They should be harvested during the winter. Equipment tends to bog down in this wet soil during the rest of the year. The trees are usually cut for pulpwood. After harvest, they usually regenerate without replanting. Regrowth is slow at first because of plant competition and seedling mortality. Planting seedlings is usually difficult because the soil is too wet.

Recreational uses generally are not practical because of the seasonal high water table and the flood hazard. Locating drainage outlets is difficult. Snowmobile trails can be established if some fill material is provided. Wetland wildlife habitat can be enhanced by digging shallow ponds. If deep fish ponds are dug, gentle side slopes are needed to prevent caving and sloughing.

The seasonal high water table and the flood hazard severely limit building site development. Also, permeability is rapid, cutbanks can cave, and the soil is droughty in midsummer. Lowering the water table is very difficult because locating drainage outlets is difficult.

Capability subclass Vlw; Michigan management group 5c.

RuB—Rubicon sand, 0 to 6 percent slopes. This excessively drained, nearly level and gently undulating soil is on broad plains that have slight rises. Individual areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is black sand about 3 inches thick. The subsurface layer is light brownish gray sand about 5 inches thick. The subsoil is about 32 inches thick. The upper part is dark brown or dark yellowish brown, very friable sand, and the lower part is yellowish brown, loose sand. The substratum to a depth of about 60 inches is light yellowish brown sand. In places, the subsurface layer is not evident. In a few places the upper part of the subsoil is dark reddish brown sand. In some areas the lower part of the substratum has thin bands of loamy sand.

Included with this soil in mapping are small areas of the somewhat excessively drained Mancelona soil throughout the unit and the moderately well drained Croswell and somewhat poorly drained Au Gres soils in shallow depressions and drainageways. The Mancelona soil makes up about 5 percent of the unit and the Croswell and Au Gres soils 5 to 10 percent. The Mancelona soil is underlain with sand and gravel.

Permeability is rapid in the Rubicon soil, runoff is slow, and available water capacity is low.

Most areas are wooded with an assortment of red pine, aspen, red maple, and oak. This soil has good potential for building site development, woodland, and recreation

uses. It has poor potential for cultivated crops, pasture, and wildlife habitat.

Cultivated crops and pasture grasses are not generally grown because the soil is droughty. Pastures furnish very little forage for livestock.

This soil is suitable as woodland. The trees can be harvested at any time of the year. After harvest, pine seedlings should be planted. Plant competition is moderate. Plow planting seedlings in furrows reduces plant competition. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later.

This soil is suitable for most recreation uses. Careful management is needed to control droughtiness, soil blowing, and erosion. The grass cover is usually too sparse to withstand the heavy traffic in most recreation areas. Wood chips can be added in areas where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Playgrounds generally can be established in the less sloping areas. Snowmobile trails are easily established and maintained. The wooded areas provide cover for wildlife.

This soil is suitable as a site for buildings and septic tank absorption fields. The droughtiness, the possible pollution of ground water by effluent from septic tank absorption fields, and the caving of cutbanks are problems. Frequent watering of lawns is needed unless loam topsoil is added. Shoring walls can keep cutbanks from caving.

Capability subclass VIs; Michigan management group 5.3a.

RuC—Rubicon sand, 6 to 18 percent slopes. This excessively drained, gently rolling and rolling soil is on knolls and hills. Individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is black sand about 2 inches thick. The subsurface layer is grayish brown sand about 5 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown or yellowish brown, very friable sand, and the lower part is yellowish brown, loose sand. The substratum to a depth of about 60 inches is light yellowish brown sand. In places the subsurface layer is not evident. In some areas the lower part of the substratum has thin bands of loamy sand.

Included with this soil in mapping are small areas of the moderately well drained Croswell soil in shallow depressions and drainageways. This included soil makes up about 5 percent of the unit.

Permeability is rapid in the Rubicon soil, runoff is slow, and available water capacity is low.

Most areas are wooded with an assortment of red pine, aspen, red maple, and oak. This soil has good potential for woodland. It has fair potential for building site development and most recreation uses and poor potential for cultivated crops, pasture, and wildlife habitat.

Cultivated crops and pasture grasses are not generally grown because the soil is too droughty. Pastures furnish very little forage for livestock.

This soil is suitable as woodland. As a result of the slope, however, the soil is subject to erosion and the use of equipment is limited during harvest. Designing roads on the contour and properly managing the woodland during cutting can help to control erosion and overcome the equipment limitation. The trees can be harvested at any time of the year. After harvest, pine seedlings should be planted. Plant competition is moderate. It can be reduced by plow planting seedlings in furrows. Planting more trees than are needed can compensate for seedling mortality, but thinning may be needed later.

This soil is suitable for paths and trails. Careful management is needed to control droughtiness and erosion. The plant cover is usually too sparse to withstand heavy foot traffic. Wood chips can be added in areas where traffic is heavy, and topsoil can be added to provide a better medium for grass grown as cover. Snowmobile trails can be easily established, but they are subject to erosion because of the lack of sufficient plant cover. The wooded areas provide cover for wildlife.

The slope, the droughtiness, the possible pollution of ground water by effluent from septic tank absorption fields, and the caving of cutbanks limit this soil as a site for buildings or waste disposal systems. Shaping the land and building roads and streets on the contour reduce the slope and the risk of erosion. Frequent watering of lawns is needed unless loam topsoil is added. Shoring walls can keep cutbanks from caving.

Capability subclass VIIs; Michigan management group 5.3a.

Sm—Sims clay loam. This poorly drained and very poorly drained, nearly level soil is in low lying areas and depressions. It is subject to frequent flooding for brief periods. Individual areas are irregular in shape and range from 3 to 60 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsoil is gray, mottled, firm silty clay loam about 19 inches thick. The substratum to a depth of about 60 inches is gray, calcareous silty clay loam. In places part of the substratum is more brightly colored.

Included with this soil in mapping are small areas of the somewhat poorly drained Kawkawlin soil on very slight rises, the very poorly drained Markey muck on the slightly lower parts of the landscape, and the poorly drained and very poorly drained Brevort soil throughout the unit. The Kawkawlin soil makes up about 5 to 10 percent of the unit, the Markey soil 5 percent, and the Brevort soil 5 percent. The Brevort soil is sandy in the upper part.

Permeability is slow in the Sims soil, runoff is very slow to ponded, and available water capacity is high. The shrink-swell potential is moderate. In undrained areas the seasonal high water table is within 1 foot of the surface during the period November through May. The surface layer is friable to firm and is more difficult to till than that of most other soils. The soil tends to puddle and crust when wet, for example, after hard rains.

Most areas are pastured or wooded. The wooded areas commonly support red maple, sugar maple, white ash, quaking aspen, and American basswood. This soil has good potential for woodland and as habitat for wetland wildlife. It has fair potential for pasture and poor potential for cultivated crops and for recreation and engineering uses.

Cultivated crops are seldom grown because of the seasonal high water table, the crop damage caused by frost, and the flood hazard. Most areas remain undrained because locating drainage outlets is difficult.

Many areas are pastured. The soil is frequently flooded for brief periods in April and May. Grazing when the soil is too wet causes surface compaction and poor tilth. Deferment of grazing and restricted use during periods of flooding and during other wet periods keep the pasture and the soil in good condition.

This soil is suitable as woodland, but tree growth is restricted by the seasonal high water table. The trees should be harvested during the winter. Equipment tends to bog down in this wet soil during the rest of the year. The trees are subject to windthrow because the soil is wet. They are usually cut for pulpwood. After harvest, they regenerate without replanting. Regrowth is slow at first because of plant competition and seedling mortality. Planting seedlings is usually difficult because the soil is too wet.

Recreation uses generally are not practical because of the seasonal high water table. Locating drainage outlets is difficult. Snowmobile trails can be built if some fill material is provided. Wetland wildlife habitat can be improved by digging shallow ponds. Deep fish ponds can be dug. Wooded areas provide cover for wildlife.

Waste disposal and building site development are severely limited by the seasonal high water table, the flood hazard, the slow permeability, the shrink-swell potential, and the low strength. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities. Construction of buildings with basements should be avoided because of the water table. Frost action on sites for local roads and streets can be reduced by replacing or covering the upper layer of the soil with suitable base material. The shrinking and swelling can be controlled on building sites by constructing dwellings and small buildings without basements, by designing foundations and footings to prevent structural damage, by backfilling around foundations with suitable material, and by providing drainage around foundations.

Capability subclass Vw; Michigan management group 1.5c.

UbB—Ubly sandy loam, 2 to 6 percent slopes. This well drained and moderately well drained, gently undulating soil is on slight rises. Individual areas are irregular in shape and range from 4 to 80 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 4 inches thick. The subsurface layer is light brownish gray sandy loam about 3 inches thick. The subsoil is about 24 inches thick. The upper part is dominantly dark brown, friable sandy loam; the next part is strong brown, friable loam; and the lower part is brown, firm loam. The substratum to a depth of about 60 inches is brown, calcareous loam. In a few places the soil is gently rolling.

Included with this soil in mapping are small areas of the somewhat poorly drained Kawkawlin soil in depressions and drainageways and the well drained and moderately well drained sandy Menominee soil on rises. The Kawkawlin soil makes up about 5 to 10 percent of the unit and the Menominee soil 5 percent.

Permeability is moderately rapid in the upper part of the Ubly soil and moderately slow in the lower part. Runoff is slow, and available water capacity is high. The shrink-swell potential is moderate in the lower part of the subsoil and in the substratum. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

This soil is used for cultivated crops, pasture, and woodland. It has good potential for cultivated crops, pasture, and woodland and as habitat for upland wildlife; good to fair potential for recreation uses; and fair to poor potential for building site development.

Cultivated crops are grown on this soil. The soil can be tilled very easily, but careful management is needed to control erosion. Drainage is needed in some of the scattered wet depressions and drainageways. Stripcropping, cover crops, grassed waterways, and minimum tillage help to control erosion.

Use of this soil as pastureland or hayland is effective in controlling erosion. Overgrazing the pasture causes surface compaction and excessive runoff. Rotation grazing or strip grazing keeps the pasture and the soil in good condition.

This soil is suitable as woodland. The trees can be cut for pulpwood or logs at any time of the year. After harvest, they usually regenerate without replanting. Plant competition is moderate, and the stand can be thinned if necessary.

Most recreation uses are suitable on this soil. Playgrounds generally can be established in the less sloping areas. Some land shaping is needed. Wooded and open areas provide excellent habitat for wildlife.

Building site development is limited by the shrinking and swelling of the soil. The shrink-swell potential can be reduced by constructing dwellings and small buildings without basements, by designing foundations and footings to prevent structural damage, by backfilling around foundations with suitable material, and by providing drainage around foundations. On local roads and streets suitable base material is needed to replace or cover the upper part of the soil.

The moderately slow permeability and the high content of clay limit this soil as a site for waste disposal systems. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities. The soil generally

is suitable as a site for sewage lagoons. Some land shaping is needed.

Capability subclass IIe; Michigan management group 3/2a.

Wh—Wheatley loamy sand. This poorly drained and very poorly drained, nearly level soil is in broad, flat areas and in drainageways. It is subject to frequent flooding for long periods. Individual areas are irregular in shape and range from 3 to 640 acres in size.

Typically, the surface layer is very dark brown loamy sand about 8 inches thick. The upper part of the substratum is grayish brown, mottled sand and gravelly sand, and the lower part to a depth of about 60 inches is grayish brown, calcareous sand and gravel.

Included with this soil in mapping are small areas of the somewhat poorly drained Gladwin soil on slight rises, the very poorly drained Markey muck on the lower parts of the landscape, and the poorly drained and very poorly drained Brevort soil throughout the unit. Each of these included soils makes up about 5 percent of the unit. The Brevort soil has a silt loam substratum 20 to 40 inches from the surface.

Permeability is rapid in the Wheatley soil, runoff is very slow or ponded, and available water capacity is low. In undrained areas the seasonal high water table is at or near the surface during the period October through May.

Most areas are woodland, pasture, or idle grassland. This soil has fair potential for pasture and as habitat for wetland wildlife. It has poor potential for cultivated crops, woodland, and recreation and engineering uses.

Cultivated crops are seldom grown because of the seasonal high water table, the damage to crops caused by frost, and the flood hazard. Most areas remain undrained because locating drainage outlets is difficult. In undrained areas the soil remains wet late in spring and the wetness hinders machinery.

Many undrained areas are pastured. This soil is often flooded in April and can be flooded after heavy rains in other periods. Grazing when the soil is too wet causes pasture depletion. Deferment of grazing and restricted use during periods of flooding and during other wet periods keep the pasture in good condition.

This soil is suitable as woodland. The trees grow slowly because of the seasonal high water table. Also, they are susceptible to windthrow because the soil is wet. The trees should be thinned and the most productive ones saved. They should be harvested during the winter. Equipment tends to bog down in this wet soil during the rest of the year. The trees are usually cut for pulpwood. After harvest, they usually regenerate without replanting. Regrowth is slow at first because plant competition and seedling mortality are severe. Planting seedlings is usually difficult because the soil is too wet.

Most recreation uses are not practical because of the seasonal high water table. Locating drainage outlets is difficult. Wetland wildlife habitat can be improved by digging shallow ponds. If deep fish ponds are dug, gentle side slopes are needed to prevent caving and sloughing.

This soil is severely limited as a site for buildings or waste disposal systems by the seasonal high water table, the caving of cutbanks, droughtiness, and the flood hazard. If possible, sanitary facilities should be connected to commercial sewers and treatment facilities. Construction of buildings with basements should be avoided because of the water table. Shoring walls and pumping excess water help to keep cutbanks from caving. Frequent watering of lawns is needed in midsummer. Frost action on sites for local roads and streets can be reduced by replacing or covering the upper layer of the soil with suitable base material.

Capability subclass Vw; Michigan management group 5c.

Wn—Winterfield-Evart complex. This map unit consists of somewhat poorly drained to very poorly drained, nearly level soils on flood plains next to rivers. These soils are frequently flooded by the rivers for brief to long periods. Individual areas are long and irregular in shape and range from 3 to 320 acres in size. They are about 50 percent the somewhat poorly drained Winterfield soil on slight rises and 40 percent the very poorly drained or poorly drained Evart soil in depressions. The two soils are so intricately mixed or are in areas so small that mapping them separately is not practical.

Typically, the Winterfield soil has a surface layer of very dark brown loamy sand about 7 inches thick. The substratum to a depth of about 60 inches is multicolored sand.

Typically, the Evart soil has a surface layer of very dark brown loam about 8 inches thick. The substratum to a depth of about 60 inches dominantly is grayish brown, mottled sand.

Included with these soils in mapping are small areas of the somewhat poorly drained Colonville soil throughout the unit and the moderately well drained Croswell soil on the higher rises. These included soils make up about 10 percent of the unit. The Colonville soil is finer textured than the Winterfield soil.

Permeability is rapid in the Winterfield and Evart soils, and available water capacity is low. Runoff is slow on the Winterfield soil and very slow to ponded on the Evart soil. The Winterfield soil has a seasonal high water table that is 1 foot to 2 feet from the surface during the period November through May. The Evart soil has a seasonal high water table that is at or near the surface during the period November through June.

Most areas are wooded, commonly with quaking aspen, white ash, basswood, and northern white-cedar. These soils have good to fair potential for wetland wildlife habitat. They have fair to poor potential for woodland and poor potential for cultivated crops, pasture, and recreation and engineering uses.

Cultivated crops and pasture grasses are not grown because of the flood hazard and the seasonal high water table. Also, the soils are droughty. The soils are very

difficult to drain because they are in the lowest position on the landscape.

These soils are suitable as woodland. The trees grow at a slow to moderate rate because of the seasonal high water table. Those in low depressions are susceptible to windthrow because the soils are wet. The trees should be harvested during the winter. Equipment tends to bog down in these wet soils during the rest of the year. The trees are usually cut for pulpwood. After harvest, they generally regenerate without replanting. Regrowth is slow at first because of plant competition and seedling mortality. Planting seedlings is usually difficult because the soils are too wet.

These soils are suitable for some summer recreation uses. Floods are likely during the rest of the year. Some land shaping generally is needed to fill in the low wet spots. Snowmobile trails can be established, but some fill material is needed. Shallow ponds can be dug to attract wetland wildlife. Deep fish ponds should be protected from floodwater.

Building site development is not practical on these soils. Overcoming the flood hazard is very costly, and lowering the seasonal high water table is very difficult. Other limitations are the rapid permeability, the droughtiness, and the caving of cutbanks.

Capability subclass VIIw; Michigan management group L-4c.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates wetness or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

More than 43,500 acres in the survey area was used for crops and pasture in 1974, according to the U.S. Census of Agriculture. Of this total, 13,250 acres was used for permanent pasture; 7,800 acres for row crops, mainly corn; 3,100 acres for close-grown crops, mainly wheat and oats; 13,900 acres for hay crops; and 150 acres for specialty crops, mainly sweet corn and other vegetables and orchards. The rest was idle cropland.

The potential of the soils in Clare County for increased food production is fair. About 10,000 acres of potentially good cropland is currently used as woodland and about 5,000 acres as pasture. Food production could be increased by bringing this potential cropland into production and by extending the latest crop production technology to all cropland in the county.

The acreage in crops and pasture has slowly been decreasing as the marginal cropland has been taken out of production. The use of this soil survey to help make land-use decisions that will influence the future role of farming in the county is described under the heading "General soil map for broad land-use planning."

Soil erosion is a major hazard on about two-thirds of the cropland in Clare County. It is a hazard on soils with slopes of more than 2 percent, for example, on McBride and Nester soils.

Loss of the surface layer through erosion is damaging for two reasons. First, crop yields are reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging to soils with a loamy subsoil, such as Nester soils, and to soils with a fragipan, such as McBride soils. Secondly, soil erosion results in sediment entering streams and lakes. Erosion control minimizes the pollution of streams and lakes by sediment and improves the water quality for recreation uses, for municipal use, and for fish and wildlife.

On the clayey spots in many fields in the county, seedbed preparation and tilling are difficult because much of the original surface layer has eroded away. Such spots are common on Nester soils.

Erosion control provides protective surface cover, helps to reduce runoff, and increases infiltration. A cropping system that keeps plant cover on the soil for extended periods can hold soil erosion losses to an amount that will not reduce the productive capacity of the soil. Including legume and grass forage crops in the cropping system not only provides nitrogen and improves tilth for the following crop but also reduces the risk of erosion.

Slopes are so short and irregular that contour tillage is not practical in some areas of the sloping Mancelona, McBride, Montcalm, Menominee, and Nester soils. On these soils, a cropping system that provides substantial plant cover is needed to control erosion unless minimum tillage or no-tillage is practiced. Keeping tillage to a minimum and leaving crop residue on the surface or planting a cover crop increase the infiltration rate and reduce the hazard of erosion. These practices can be adapted to several of the soils in the survey area but are less successful on the eroded soils. No-tillage for corn, which is common on an increasing acreage, is effective in reducing erosion on sloping soils and is suitable on most soils in the survey area.

Terraces and diversions can help to control runoff and erosion. They are most practical on deep, well drained soils that have regular slopes. Most soils in Clare County, however, are not suitable for terraces and diversions because the slopes are too complex and irregular.

Contouring and stripcropping can help to control erosion on some soils, especially those with smooth and uniform slopes. In most areas of the county, however, the slopes are too short and too complex.

Soil blowing is a hazard on about half of the cropland in Clare County. It is a hazard on Au Gres, Brevort, Croswell, Gladwin, Graycalm, Mancelona, McBride, Melita, Menominee, Montcalm, Otisco, Roscommon, Rubicon, and Wheatley soils. Soil blowing can damage these soils in a few hours if strong winds prevail and the soils are dry and bare of plant cover or surface mulch. Overgrazing on these soils can result in blowouts and severe erosion. No-tillage, surface mulch, cover crops, stripcropping, windbreaks, and a permanent plant cover help to control soil blowing.

Information about the design of erosion-control practices for each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil drainage is a management need on about a fourth of the acreage used for crops and pasture. It improves the air-water relationship in the root zone. Spring planting, spraying, and harvesting are hampered and weed control is more difficult in areas where drainage is poor. Tile drains or surface drainageways, or both, can remove excess water if they are properly designed. Some soils are naturally so wet that the production of the crops common to the area is generally not possible. These soils generally cannot be drained because good outlets are not available. These are the poorly drained and very poorly drained Brevort, Evart, Greenwood, Loxley, Lupton, Markey, Rondeau, Roscommon, Sims, and Wheatley soils.

Unless artificially drained, the somewhat poorly drained soils are so wet that crops are damaged during most years. Examples are Au Gres, Gladwin, Kawkawlin, Iosco, and Otisco soils.

In Nester and Ubly soils natural drainage is good during most of the year, but these soils tend to dry out slowly after rains. Small areas of wetter soils along drainageways and in swales are commonly adjacent to these soils, especially to the ones that have slopes of 2 to 6 percent. Artificial drainage is needed in some of these wetter areas.

McBride soils have a water table perched on a fragipan in the subsoil. As a result, many depressions are wet in spring, but they usually dry up in summer. Timely planting of crops is difficult unless some of these wet depressions are drained.

The design of surface and subsurface drainage systems varies with the kind of soil. Tile drainage is needed in most areas of the somewhat poorly drained soils that are intensively row cropped. Finding outlets for tile drainage systems is difficult in some areas of Au Gres, Gladwin, Iosco, Kawkawlin, and Otisco soils. In some wet areas diversions can carry surface runoff away. In low lying areas the growing season can be shortened by frost late in spring and early in fall.

Information about the design of drainage systems for each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil fertility is naturally medium to high in the loamy Kawkawlin, McBride, Nester, and Sims soils. It is low in most sandy soils, such as Au Gres, Graycalm, and Montcalm soils.

Many sandy soils are naturally strongly acid to slightly acid. Unless these soils have been limed, applications of ground limestone are needed to raise the pH level sufficiently for good growth of alfalfa and other crops that grow best on nearly neutral soils. Available phosphorus and potash levels are naturally low to medium in most of these soils.

Lime and fertilizer should be applied according to soil tests (*3*), the need of the crop, and the expected crop yield. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply (*4*).

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous.

Some of the soils used for crops in the survey area have a loamy surface layer that is light in color and low in content of organic matter. Generally, the structure of such soils is weak, and a surface crust forms after intense rainfall. Once the crust forms, it reduces the infiltration rate and increases runoff. Regular additions of crop residue, manure, and other organic material can improve tilth and help to prevent crust formation.

Fall plowing is generally not desirable on the light colored soils that have a loamy surface layer because a surface crust forms during winter and spring. Many of the soils plowed in the fall are nearly as dense and hard when planted as they were before they were plowed. Also, about half of the cropland in the county consists of sloping soils that are subject to damaging erosion if they are plowed in the fall.

Field crops suited to the soils and climate of the survey area include a few that are not commonly grown. Corn is the most commonly grown row crop. Grain sorghum, sunflowers, potatoes, and similar crops can be grown if economic conditions are favorable.

Wheat and oats are the most common close-growing crops. Rye, barley, and buckwheat can be grown, and grass seed can be produced from bromegrass, fescue, red clover, redtop, and bluegrass.

Special crops are not commonly grown in the survey area for commercial use. On only a very small acreage, such crops as strawberries, sweet corn and other vegetables, and apples are grown for sale. Large areas, however, could be managed for special crops, such as blueberries, strawberries, raspberries, vegetables, and orchards. If irrigated, the well drained soils that warm up early in spring are especially well suited to these special crops. The Graycalm, Mancelona, Melita, Menominee, and Montcalm soils that have slopes of less than 6 percent are examples. Planting and harvesting of these crops usually can be done sooner on these soils than on other soils. Applications of lime are needed for all of these crops but blueberries, which are suited to an acid soil.

Most of the well drained soils in the survey area are suited to orchards and nursery plants. Those on south facing slopes generally are better suited. Soils in low positions where frost is frequent and air drainage is poor generally are poorly suited to early vegetables and orchards.

The latest information about growing special crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for forest trees or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. The capability class and subclass are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII (*9*). The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are 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, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that 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.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

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

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is indicated in table 6. All soils in the survey area except those named at a level higher than the series are included. Some of the soils that are well suited to crops and pasture may be in low-intensity use, for example, soils in capability classes I and II. Data in this table can be used to determine the farming potential of such soils.

The capability subclass and Michigan management group are identified in the description of each soil map unit in the section "Soil maps for detailed planning." They are listed at the end of each description. For the soil complexes the soil management groups are listed in the same order as the named series. These management groups are used for making recommendations about applications of lime and fertilizer, about artificial drainage, and about other practices. For an explanation of these groups, refer to Michigan State University Research Report 254, "Soil management units and land use planning" (*6*).

Woodland management and productivity

Table 7 contains information useful to woodland owners or forest managers planning use of soils for wood crops. Map unit symbols for soils suitable for wood crops are listed. The soils are rated for a number of factors to be considered in management. *Slight, moderate,* and *severe* are used to indicate the degree of major soil limitations.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if some measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Considered in the ratings of *windthrow hazard* are characteristics of the soil that affect the development of tree

roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate*, that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* (*7*). This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Windbreaks and environmental plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can ensure a high degree of plant survival.

Table 8 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 8, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from nurserymen.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9)

predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 9 shows, for each kind of soil, the degree and kind of limitations for building site development; table 10, for sanitary facilities. Table 12 shows the kind of limitations for water management. Table 11 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 9. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 9 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Slope and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 9 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 10 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special

planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the same as the terms *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, and susceptibility to flooding. Stones and boulders interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel are less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 10 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 11 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil

horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 15 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor.*

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 11 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 15.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel and stones.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick, soils having large amounts of gravel or stones, steep soils, and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 12 the soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water-control structures.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Aquifer-fed excavated ponds are bodies of water made by excavating a pit or dugout into a ground-water aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Ratings in table 12 are for ponds that are properly designed, located, and constructed. Soil properties and site features that affect aquifer-fed ponds are depth to a permanent water table, permeability of the aquifer, quality of the water, and ease of excavation.

Drainage of soil is affected by such soil properties as permeability; texture; hardpan or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 13 according to limitations that affect their suitability for recrea-

tion uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 13 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 10, and interpretations for dwellings without basements and for local roads and streets, given in table 9.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil is generally sufficient to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 14, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bluegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are dandelions, goldenrod, ragweed, lambsquarters, and quackgrass.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of native plants are oak, poplar, cherry, ash, apple, hawthorn, dogwood, maple, blackberry, and blueberry. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and hemlock.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, arrowhead, wildrice, and cattail and rushes, sedges, and reeds.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, killdeer, field sparrow, cottontail rabbit, and red fox.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, owls, raccoon, deer, and bear.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, loons, blackbirds, muskrat, mink, and beaver.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features.

Engineering properties

Table 15 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 15 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 15 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*11*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The estimated classification, without group index numbers, is given in table 15. Also in table 15 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 16 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.
5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.
6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 17 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams and runoff from adjacent slopes. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of dis-

tinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table, that is, perched or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*8*). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Au Gres series

The Au Gres series consists of somewhat poorly drained, rapidly permeable soils. These soils formed in sandy deposits on outwash plains, lake plains, and till plains. Slopes range from 0 to 2 percent.

Au Gres soils are similar to Otisco soils and are commonly adjacent to Croswell, Grayling, Roscommon, and Rubicon soils on the landscape. Croswell soils have mottles between depths of 20 and 40 inches. They are on the slightly higher rises. Grayling and Rubicon soils are on the higher rises. They have no mottles. Also, Grayling soils lack albic and spodic horizons. Roscommon soils are grayer directly below the surface layer than Au Gres soils and lack an albic horizon. They are in wet depressions. Otisco soils have sandy loam bands in the lower part of the subsoil.

Typical pedon of Au Gres loamy sand, 0 to 2 percent slopes, 2,442 feet west and 429 feet south of the northeast corner of sec. 15, T. 18 N., R. 6 W.

A1—0 to 4 inches; black (10YR 2/1) loamy sand; weak medium granular structure; very friable; many fine roots; 1 percent pebbles; medium acid; abrupt wavy boundary.

A2—4 to 13 inches; light brownish gray (10YR 6/2) sand; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium granular structure; very friable; few fine roots; 1 percent pebbles; slightly acid; abrupt wavy boundary.

Bir—13 to 21 inches; dark brown (7.5YR 4/4) sand; few medium distinct dark reddish brown (5YR 3/4) mottles; weak medium subangular blocky structure; very friable and about 20 percent firmly cemented ortstein chunks; very few very fine roots; 1 percent pebbles; slightly acid; abrupt wavy boundary.

C1—21 to 33 inches; yellowish brown (10YR 5/4) sand; few fine distinct dark brown (7.5YR 4/4) mottles; single grained; loose; 1 percent pebbles; slightly acid; clear wavy boundary.
C2—33 to 48 inches; dark yellowish brown (10YR 4/4) sand; single grained; loose; 1 percent pebbles; neutral; clear wavy boundary.
C3—48 to 60 inches; brown (10YR 5/3) sand; single grained; loose; 1 percent pebbles; neutral.

The thickness of the solum ranges from 20 to 36 inches. Pebbles are in some pedons, but they make up less than 5 percent of the volume. The solum ranges from strongly acid to slightly acid.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly loamy sand but in some pedons is sand. It is 2 to 4 inches thick. In cultivated areas an Ap horizon is evident. It is 6 to 9 inches thick. The A2 horizon has hue of 10YR, value of 6 or 7, and chroma of 1 or 2. It ranges from 4 to 12 inches in thickness.

The Bir horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 4 or 6. The darker colors are in the upper part. The content of ortstein ranges from 0 to 30 percent. Some pedons have a B3 horizon.

The C horizon has hue of 10YR, value of 4 to 7, and chroma of 2 to 4. It is medium acid to neutral.

Brevort series

The Brevort series consists of poorly drained and very poorly drained soils that are rapidly permeable in the upper part and moderately slowly permeable in the lower part. These soils formed in sandy deposits overlying calcareous loamy deposits on lake plains and till plains. Slopes range from 0 to 2 percent.

Brevort soils are commonly adjacent to Iosco and Wheatley soils on the landscape. Iosco soils have a dark brown and brown mottled subsoil. They are slightly above Brevort soils on the landscape. Wheatley soils lack a loamy IIC horizon and are underlain with sand and gravel. Brevort and Wheatley soils are in similar positions on the landscape.

Typical pedon of Brevort loamy sand, 528 feet east and 100 feet north of the southwest corner of sec. 13, T. 17 N., R. 3 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loamy sand; moderate medium granular structure; very friable; many fine roots; 1 percent pebbles; mildly alkaline; abrupt smooth boundary.
C1g—8 to 19 inches; grayish brown (10YR 5/2) loamy sand; common fine distinct yellowish brown (10YR 5/4, 5/6) mottles; weak medium subangular blocky structure; very friable; very dark gray (10YR 3/1) root channels; common fine roots; 2 percent pebbles; mildly alkaline; clear wavy boundary.
C2g—19 to 31 inches; grayish brown (10YR 5/2) sand that has globular masses of loamy sand 1 inch to 3 inches in diameter; common fine distinct yellowish brown (10YR 5/6) and many medium distinct yellowish brown (10YR 5/4) mottles; single grained; loose; few fine roots; 5 percent pebbles; mildly alkaline; abrupt wavy boundary.
IIC3g—31 to 60 inches; grayish brown (2.5Y 5/2) silt loam; common medium distinct gray (10YR 5/1) and many medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; 2 percent pebbles; strong effervescence; mildly alkaline.

The depth to the IICg horizon and to carbonates ranges from 20 to 40 inches. Pebbles and cobbles make up 0 to 5 percent of the volume.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is 6 to 10 inches thick. In uncultivated areas an A1 horizon is evident. It is 2 to 7 inches thick. It has hue of 10YR, value of 2 or 3, and chroma of 1. The A horizon is dominantly loamy sand but in some pedons is sandy loam or mucky loamy sand. It ranges from medium acid to mildly alkaline.

The Cg horizon has hue of 10YR, value of 4 to 6, and chroma of 1 or 2. It ranges from slightly acid to mildly alkaline. The IICg horizon has hue of 10YR, 5Y, or 2.5Y; value of 5 or 6; and chroma of 1 or 2. It is loam, silt loam, clay loam, or silty clay loam.

Colonville series

The Colonville series consists of somewhat poorly drained, moderately rapidly permeable soils. These soils formed in calcareous sandy and loamy deposits on flood plains. Slopes range from 0 to 2 percent.

Colonville soils are similar to Evart soils, which also are on flood plains. Evart soils are grayer in the upper part of the substratum than Colonville soils, are coarser textured in the upper part of the substratum, and are less alkaline.

Typical pedon of Colonville fine sandy loam, 120 feet south and 1,056 feet east of the northwest corner of sec. 27, T. 17 N., R. 3 W.

A11—0 to 10 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; friable; many fine roots; strong effervescence; moderately alkaline; clear smooth boundary.
A12—10 to 17 inches; very dark grayish brown (10YR 3/2) fine sandy loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium granular structure; friable; common fine roots; strong effervescence; moderately alkaline; clear smooth boundary.
C1—17 to 29 inches; dark brown (10YR 4/3) fine sandy loam; many medium faint grayish brown (10YR 5/2) and many medium distinct dark brown (7.5YR 4/4) mottles; moderate medium subangular blocky struc-

ture; friable; few fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

C2—29 to 38 inches; yellowish brown (10YR 5/4) sand; many medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; single grained; loose; very dark grayish brown (10YR 3/2) organic stains; slight effervescence; moderately alkaline; abrupt smooth boundary.

C3—38 to 44 inches; brown (10YR 5/3) sand; common fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; slight effervescence; moderately alkaline; abrupt smooth boundary.

C4—44 to 56 inches; strong brown (7.5YR 5/6) sand; common fine distinct brown (10YR 5/3) mottles; single grained; loose; slight effervescence; moderately alkaline; abrupt smooth boundary.

C5—56 to 60 inches; grayish brown (10YR 5/2) sand; single grained; loose; 10 percent pebbles; slight effervescence; moderately alkaline.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly fine sandy loam but in some pedons is sandy loam, loamy fine sand, or loam. It ranges from 11 to 18 inches in thickness. In some pedons the upper 10 inches is neutral.

The C horizon has hue of 10YR or 7.5YR, value of 3 to 6, and chroma of 2 to 6. It is fine sandy loam, sandy loam, loamy fine sand, loam, loamy sand, sand, or gravelly sand.

Croswell series

The Croswell series consists of moderately well drained, rapidly permeable soils. These soils formed in sandy deposits on till plains, outwash plains, and low moraines. Slopes range from 0 to 4 percent.

Croswell soils are commonly adjacent to Au Gres, Grayling, Roscommon, and Rubicon soils on the landscape. Au Gres soils are mottled in the upper part of the subsoil. They are in the slightly lower depressions. Grayling and Roscommon soils lack albic and spodic horizons. Also, Roscommon soils have a grayer control section than Croswell soils. They are in the wettest depressions. Grayling and Rubicon soils have no mottles. They are in the slightly higher areas.

Typical pedon of Croswell sand, 0 to 4 percent slopes, 60 feet south and 1,750 feet west of the center of sec. 17, T. 18 N., R. 6 W.

A1—0 to 3 inches; very dark brown (10YR 2/2) sand; weak fine granular structure; very friable; many very fine roots; 1 percent pebbles; medium acid; abrupt smooth boundary.

A2—3 to 7 inches; light brownish gray (10YR 6/2) sand; weak fine granular structure; very friable; common very fine roots; 1 percent pebbles; medium acid; abrupt wavy boundary.

B21ir—7 to 12 inches; dark brown (7.5YR 4/4) sand; weak fine subangular blocky structure; very friable; few very fine roots; 1 percent pebbles; slightly acid; clear wavy boundary.

B22ir—12 to 20 inches; brown (7.5YR 5/4) sand; weak fine subangular blocky structure; very friable; very few very fine roots; 1 percent pebbles; slightly acid; clear wavy boundary.

B3—20 to 29 inches; yellowish brown (10YR 5/4) sand; common medium faint brownish yellow (10YR 6/6) mottles; single grained; loose; 1 percent pebbles; slightly acid; clear wavy boundary.

C1—29 to 50 inches; light yellowish brown (10YR 6/4) sand; many medium distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; single grained; loose; 1 percent pebbles; slightly acid; clear wavy boundary.

C2—50 to 60 inches; light yellowish brown (10YR 6/4) sand; few medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose; 1 percent pebbles; slightly acid.

The thickness of the solum ranges from 27 to 40 inches. Pebbles make up 0 to 1 percent of the volume. The solum ranges from very strongly acid to slightly acid.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly sand but in some pedons is loamy sand. It ranges from 1 inch to 4 inches in thickness. In cultivated areas an Ap horizon is evident. It ranges from 6 to 10 inches in thickness. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2.

The Bir horizon has hue of 5YR, 7.5YR, or 10YR; value of 3 to 5; and chroma of 4 to 6. Ortstein ranges from 0 to 20 percent of the volume. Some pedons do not have a B3 horizon.

The C horizon has hue of 10YR, value of 5 or 6, and chroma of 3 or 4. It is medium acid or slightly acid.

Evart series

The Evart series consists of poorly drained and very poorly drained, rapidly permeable soils. These soils formed in sandy deposits on flood plains. Slopes range from 0 to 2 percent. The Evart soils in this survey area have a thinner dark surface layer than is defined as the range for the series, but this difference does not alter the use or behavior of the soils.

Evart soils are similar to Colonville soils and are commonly adjacent to Winterfield soils on the landscape. The upper part of the substratum of Colonville and Winterfield soils is brighter than that of Evart soils. It is mottled. Also, Colonville soils are finer textured and more alkaline than Evart soils. In this survey area Winterfield soils are mapped with Evart soils.

Typical pedon of Evart loam, in an area of Winterfield-Evart complex, 700 feet west and 100 feet north of the center of sec. 21, T. 19 N., R. 6 W.

A1—0 to 8 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; friable; common fine roots; neutral; abrupt smooth boundary.
C1—8 to 20 inches; grayish brown (10YR 5/2) sand; single grained; loose; few fine roots; neutral; abrupt smooth boundary.
C2—20 to 35 inches; grayish brown (10YR 5/2) sand; many medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose; very few very fine roots; neutral; abrupt wavy boundary.
A1b—35 to 37 inches; very dark grayish brown (10YR 3/2) sand; common fine distinct grayish brown (10YR 5/2) mottles; single grained; loose; neutral; abrupt wavy boundary.
C3—37 to 60 inches; grayish brown (10YR 5/2) sand; common fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; neutral.

The A1 horizon has hue of 10YR, value of 2, and chroma of 1 or 2. It is dominantly loam but in some pedons is sand, loamy sand, or sandy loam. It ranges from slightly acid to mildly alkaline and is 7 to 10 inches thick.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is sand, gravelly sand, or sand and gravel. It is slightly acid to moderately alkaline; the pH increases with increasing depth. The content of pebbles ranges, by volume, from 0 to 50 percent.

Gladwin series

The Gladwin series consists of somewhat poorly drained, moderately rapidly permeable soils. These soils formed in calcareous sand and gravel deposits on outwash plains and lake plains. Slopes range from 0 to 2 percent.

Gladwin soils are commonly adjacent to Mancelona and Wheatley soils on the landscape. Mancelona soils lack mottles in the upper part of the subsoil. They are above Gladwin soils on the landscape. Wheatley soils have a grayer subsoil than Gladwin soils. They are in the wetter depressions and drainageways.

Typical pedon of Gladwin loamy sand, 0 to 2 percent slopes, 2,540 feet east and 285 feet north of the southwest corner of sec. 25, T. 17 N., R. 3 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loamy sand; weak fine granular structure; very friable; many fine roots; 3 percent pebbles; slightly acid; abrupt smooth boundary.
A2—8 to 11 inches; grayish brown (10YR 5/2) sand; single grained; loose; common fine roots; 2 percent pebbles; neutral; clear wavy boundary.
B21ir—11 to 22 inches; dark brown (7.5YR 4/4) sand; few fine distinct yellowish brown (10YR 5/6) and light yellowish brown (10YR 6/4) mottles; weak coarse subangular blocky structure; very friable; many fine roots; 2 percent pebbles; slightly acid; abrupt wavy boundary.
B22t—22 to 29 inches; dark brown (7.5YR 4/4) gravelly sandy loam; common coarse distinct light yellowish brown (10YR 6/4) and light gray (10YR 7/2) mottles; weak medium subangular blocky structure; friable, slightly sticky; few fine roots; few thin clay films on faces of peds and in pores; 20 percent pebbles; mildly alkaline; abrupt wavy boundary.
IIC—29 to 60 inches; very pale brown (10YR 7/4) stratified gravel and coarse sand; single grained; loose; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to carbonates range from 24 to 40 inches. Pebbles make up 2 to 20 percent of the volume. The solum ranges from slightly acid to mildly alkaline.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is 2 to 4 inches thick. In cultivated areas an Ap horizon is evident. It ranges from 6 to 10 inches in thickness. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2 or 3. It is sand or loamy sand.

The Bir horizon has hue of 10YR, 7.5YR, or 5YR; value of 3 to 5; and chroma of 3 or 4. It is sand or loamy sand. Some pedons have an A'2 horizon. The Bt horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. It is gravelly sandy loam, sandy loam, or gravelly loamy sand.

The IIC horizon has hue of 10YR, value of 5 to 7, and chroma of 3 or 4. It is gravel and coarse sand or sand and gravel.

Graycalm series

The Graycalm series consists of somewhat excessively drained, rapidly permeable soils. These soils formed in sandy deposits on outwash plains, till plains, and moraines. Slopes range from 0 to 35 percent.

Graycalm soils are commonly adjacent to the Grayling and Montcalm soils on the landscape. Grayling soils lack a spodic horizon and have no bands of loamy sand. Montcalm soils have bands of sandy loam. Grayling soils and both of the adjacent soils are in similar positions on the landscape.

Typical pedon of Graycalm sand, 0 to 6 percent slopes, 2,310 feet west and 700 feet north of the southeast corner of sec. 6, T. 20 N., R. 4 W.

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) sand; moderate medium granular structure; very friable; many fine roots; very strongly acid; clear wavy boundary.
B21—3 to 6 inches; dark brown (7.5YR 4/4) sand; weak fine granular structure; very friable; common fine roots; strongly acid; clear irregular boundary.

B22—6 to 13 inches; strong brown (7.5YR 5/6) sand; weak fine granular structure; very friable; few fine roots; medium acid; gradual wavy boundary.
B3—13 to 22 inches; yellowish brown (10YR 5/6) sand; single grained; loose; few fine roots; slightly acid; gradual wavy boundary.
A2—22 to 35 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; very few fine roots; slightly acid; abrupt broken boundary.
A&B—35 to 60 inches; light yellowish brown (10YR 6/4) sand (A'2); single grained; loose; lamellae and bands of brown (7.5YR 5/4) and reddish brown (5YR 5/4) loamy sand (B't); weak medium subangular blocky structure; friable; individual bands are 1/4 inch to 2 inches thick and combined are 5 inches thick; 5 percent pebbles; slightly acid.

The thickness of the solum ranges from 40 to more than 60 inches. Depth to the Bt horizon ranges from 35 to 48 inches. Pebbles make up 0 to 5 percent of the volume. The solum ranges from very strongly acid to slightly acid.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly sand but in some pedons is loamy sand. It is 2 to 5 inches thick. In cultivated areas an Ap horizon is evident. It has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. It is 7 to 10 inches thick. Some pedons have an A'2 horizon.

The B2 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. The B3 horizon has hue of 10YR, value of 5 to 7, and chroma of 4 to 6. The A2 horizon has hue of 10YR, value of 5 to 7, and chroma of 3 to 6. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It occurs as bands 1/16 inch to 2 inches thick. The total thickness of the bands within a depth of 60 inches is less than 6 inches.

Some pedons have a C horizon.

Grayling series

The Grayling series consists of excessively drained, very rapidly permeable soils. These soils formed in sandy deposits on outwash plains. Slopes range from 0 to 35 percent.

Grayling soils are commonly adjacent to the Au Gres, Croswell, Graycalm, and Rubicon soils on the landscape. All of these adjacent soils but Graycalm soils have albic and spodic horizons. Au Gres soils have mottles in the upper part of the subsoil. They are in wet depressions and drainageways. Croswell soils have mottles between depths of 20 and 40 inches. They are in slight depressions. Graycalm soils have loamy sand bands, generally below a depth of 40 inches. Grayling, Graycalm, and Rubicon soils are in similar positions on the landscape.

Typical pedon of Grayling sand, 6 to 18 percent slopes, 1,650 feet north and 264 feet east of the southwest corner of sec. 5, T. 20 N., R. 3 W.

A1—0 to 3 inches; black (10YR 2/1) sand; weak medium granular structure; very friable; 50 percent grayish brown (10YR 5/2) uncoated sand grains; common very fine roots; very strongly acid; abrupt smooth boundary.
B21ir—3 to 9 inches; yellowish brown (10YR 5/4) sand; weak fine subangular blocky structure; very friable; few very fine roots; strongly acid; clear smooth boundary.
B22ir—9 to 19 inches; yellowish brown (10YR 5/6) sand; weak fine subangular blocky structure; very friable; few very fine roots; slightly acid; clear wavy boundary.
C—19 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; slightly acid.

The thickness of the solum ranges from 15 to 30 inches. Pebbles make up 0 to 5 percent of the volume.

The A1 horizon has hue of 10YR, value of 2 to 4, and chroma of 1 or 2. It is 2 to 3 inches thick. Some pedons have an A2 horizon.

The Bir horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 4 to 8. Some pedons have a B3 horizon.

The C horizon has hue of 10YR, value of 6 or 7, and chroma of 2 to 4. In some pedons it contains coarse sand.

Greenwood series

The Greenwood series consists of very poorly drained, moderately permeable or moderately rapidly permeable, acid peat soils on moraines and outwash plains. These soils formed in old lakes that were engulfed with herbaceous plants and are now leatherleaf bogs. Slopes range from 0 to 2 percent.

Greenwood soils are commonly adjacent to Loxley and Lupton soils on the landscape. Loxley soils have organic sapric tiers. In this survey area they are mapped with Greenwood soils. Lupton soils are not so acid as Greenwood soils and have organic sapric tiers. Greenwood and Lupton soils are in similar positions on the landscape.

Typical pedon of Greenwood mucky peat, in an area of Loxley and Greenwood mucky peats, 300 feet east and 825 feet south of the northwest corner of sec. 16, T. 18 N., R. 6 W.

Oi1—0 to 6 inches; dark brown (7.5YR 4/4) broken face and rubbed fibric material; about 95 percent fiber, 90 percent rubbed; massive; friable; herbaceous fibers; primarily live roots and sphagnum moss; extremely acid; clear smooth boundary.
Oe1—6 to 10 inches; very dark brown (10YR 2/2) broken face and rubbed hemic material; about 80 percent fiber, 20 percent rubbed; massive; friable; herbaceous fibers; many fine roots; extremely acid; gradual smooth boundary.
Oe2—10 to 35 inches; dark brown (7.5YR 3/2) broken face and rubbed hemic material; about 80 percent

fiber, 20 percent rubbed; massive; friable; herbaceous fibers; common fine roots; extremely acid; gradual smooth boundary.

Oe3—35 to 60 inches; dark brown (7.5YR 3/2) broken face and rubbed hemic material; about 90 percent fiber, 35 percent rubbed; massive; friable; herbaceous fibers; few very fine roots; very strongly acid.

The thickness of the organic tiers ranges from 51 to more than 60 inches. The tiers consist of primarily herbaceous fibers. They have hue of 5YR, 7.5YR, or 10YR; value of 2 to 5; and chroma of 2 to 4. Some pedons have a surface tier of hemic or sapric material. In some pedons the lower two tiers have layers of fibric or sapric material that combined, are less than 10 inches thick.

Iosco series

The Iosco series consists of somewhat poorly drained soils that are rapidly permeable in the upper part and moderately slowly permeable in the lower part. These soils formed in sandy deposits over loamy deposits on till plains, outwash plains, and lake plains. Slopes range from 0 to 3 percent.

Iosco soils are commonly adjacent to the Brevort, Kawkawlin, McBride, Melita, and Menominee soils on the landscape. Brevort soils typically have a grayish brown substratum. They are in wet depressions. Kawkawlin soils are finer textured in the upper part of the subsoil than Iosco soils. In this survey area they are mapped with Iosco soils. McBride soils have a fragipan. Melita soils are sandy in the upper 40 to 60 inches of the solum. McBride, Melita, and Menominee soils have no mottles in the upper part of the subsoil. They are on the higher knolls and hills.

Typical pedon of Iosco loamy sand, in an area of Iosco-Kawkawlin complex, 0 to 3 percent slopes, 120 feet east and 1,090 feet south of the northwest corner of sec. 8, T. 20 N., R. 4 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) loamy sand; weak medium granular structure; very friable; many fine roots; 1 percent cobbles; slightly acid; abrupt smooth boundary.

A2—6 to 9 inches; grayish brown (10YR 5/2) sand; common fine distinct dark brown (7.5YR 4/4) mottles; weak fine granular structure; very friable; few very fine roots; 1 percent cobbles; slightly acid; abrupt broken boundary.

B21ir—9 to 14 inches; dark brown (7.5YR 4/4) loamy sand; common fine distinct yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; dominantly friable but 20 to 30 percent firmly cemented ortstein; few very fine roots; 1 percent cobbles; slightly acid; abrupt wavy boundary.

B22ir—14 to 22 inches; dark brown (10YR 4/3) loamy sand; many medium faint brown (10YR 5/3) and many medium distinct dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; few very fine roots; 3 percent pebbles and cobbles; slightly acid; abrupt wavy boundary.

A'2—22 to 30 inches; brown (10YR 5/3) sand; common medium prominent dark brown (7.5YR 4/4) mottles; single grained; loose; 1 percent cobbles; slightly acid; abrupt smooth boundary.

IIB'21t—30 to 40 inches; brown (7.5YR 5/4) silty clay loam; common medium distinct grayish brown (10YR 5/2) mottles; weak coarse subangular blocky structure; firm; few thin brown (7.5YR 5/4) clay films on faces of peds; 1 percent cobbles; neutral; gradual wavy boundary.

IIB'22t—40 to 60 inches; brown (7.5YR 5/4) silty clay loam; common medium distinct grayish brown (10YR 5/2) and light olive brown (2.5Y 5/4) mottles; weak coarse subangular blocky structure; firm; few thin strong brown (7.5YR 5/6) clay films on faces of peds; 1 percent cobbles; mildly alkaline.

The thickness of the solum and the depth to carbonates range from 30 to more than 60 inches. The depth to the IIB't horizon ranges from 24 to 36 inches. Pebbles and cobbles make up 1 to 5 percent of the volume. The sandy part of the solum ranges from strongly acid to slightly acid.

The Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. It ranges from 6 to 10 inches in thickness. In uncultivated areas a 1- to 6-inch A1 horizon is evident. The A2 horizon has hue of 10YR, value of 5 to 7, and chroma of 2 or 3. It is dominantly loamy sand, but the range includes sand.

The Bir horizon has hue of 5YR, 7.5YR, or 10YR; value of 3 to 5; and chroma of 3 to 6. It is sand or loamy sand. The A'2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. The IIB't horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is clay loam, sandy clay loam, or silty clay loam. It ranges from slightly acid to mildly alkaline.

Some pedons have a IIC horizon. This horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 1 to 4. It is clay loam or silty clay loam.

Kawkawlin series

The Kawkawlin series consists of somewhat poorly drained, moderately slowly permeable soils. These soils formed in calcareous loamy till on low moraines and till plains. Slopes range from 0 to 4 percent.

Kawkawlin soils are commonly adjacent to the Iosco, Nester, Sims, and Ubly soils on the landscape. Iosco soils are sandy in the upper part of the solum. In this survey area they are mapped with Kawkawlin soils. Nester and Ubly soils do not have grayish mottles in the upper part of the subsoil. They are on the higher rises and hills. Also, Ubly soils are coarser textured in the upper part of the solum than Kawkawlin soils. Sims soils have a grayer subsoil than Kawkawlin soils. They are in wet depressions and drainageways.

Typical pedon of Kawkawlin loam, 0 to 4 percent slopes, 165 feet south and 36 feet west of the northeast corner of sec. 33, T. 18 N., R. 3 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loam; moderate medium granular structure; friable; many fine roots; 2 percent cobbles; slightly acid; gradual wavy boundary.

B&A—6 to 11 inches; brown (7.5YR 5/4) silty clay loam (B) and light brownish gray (10YR 6/2) loam (A); moderate medium angular blocky structure; firm (B), friable (A); common very fine roots; 2 percent cobbles; slightly acid; gradual wavy boundary.

B21t—11 to 18 inches; dark brown (7.5YR 4/4) silty clay loam; common fine distinct light brownish gray (10YR 6/2) and strong brown (7.5YR 5/6) mottles; moderate medium angular blocky structure; firm; continuous thin dark brown (7.5YR 4/4) clay films on faces of peds; common very fine roots; 2 percent pebbles; slightly acid; gradual wavy boundary.

B22t—18 to 24 inches; dark brown (7.5YR 4/4) silty clay loam; common fine distinct strong brown (7.5YR 5/6), yellowish brown (10YR 5/8), and light brownish gray (10YR 6/2) mottles; moderate medium angular blocky structure; firm; continuous thin dark brown (7.5YR 4/4) clay films on faces of peds; few very fine roots; 2 percent pebbles; slightly acid; clear wavy boundary.

C—24 to 60 inches; grayish brown (10YR 5/2) silty clay loam; common medium distinct light brownish gray (10YR 6/2) and yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; firm; 5 percent pebbles; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 34 inches. Pebbles and cobbles make up 1 to 10 percent of the volume. The solum ranges from medium acid to mildly alkaline.

The Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 1 to 3. It ranges from 6 to 10 inches in thickness. In undisturbed areas both an A1 horizon and an A2 horizon are evident.

The B&A horizon occurs in most pedons. The A part has hue of 10YR, value of 6, and chroma of 2 to 4. It is loam or sandy loam. The B part has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4. The Bt horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is clay loam or silty clay loam that ranges, by weighted average, from 35 to 45 percent clay. Some pedons have a B3 horizon.

The C horizon has hue of 7.5YR or 10YR, value of 5, and chroma of 2 to 4. It is clay loam or silty clay loam.

Loxley series

The Loxley series consists of very poorly drained, moderately slowly to moderately rapidly permeable, deep acid muck soils on outwash plains and moraines. These soils formed in old lakes that were engulfed with herbaceous plants and are now leatherleaf bogs. Slopes range from 0 to 2 percent.

Loxley soils are commonly adjacent to Greenwood and Lupton soils on the landscape. Greenwood soils have organic hemic tiers. In this survey area they are mapped with Loxley soils. Lupton soils are not so acid as Loxley soils and are in about the same position on the landscape as those soils.

Typical pedon of Loxley mucky peat, in an area of Loxley and Greenwood mucky peats, 150 feet south and 528 feet east of the northwest corner of sec. 32, T. 18 N., R. 6 W.

Oe1—0 to 5 inches; dark reddish brown (5YR 3/2) hemic material, dark reddish brown (5YR 2/2) rubbed; about 65 percent fibers, 35 percent rubbed; weak coarse platy structure; very friable; many fine roots; sodium pyrophosphate light yellowish brown (10YR 6/4), about 80 percent spagnum and 20 percent herbaceous; few partly decomposed woody stems; extremely acid; abrupt smooth boundary.

Oe2—5 to 13 inches; dark reddish brown (5YR 3/3) hemic material, dark reddish brown (5YR 3/2) rubbed; about 65 percent fibers, 20 percent rubbed; weak coarse platy structure; very friable; few fine roots; sodium pyrophosphate light yellowish brown (10YR 6/4), primarily herbaceous fibers; few partly decomposed woody stems; extremely acid; clear smooth boundary.

Oa1—13 to 27 inches; dark reddish brown (5YR 2/2) sapric material, black (5YR 2/1) rubbed; about 55 percent fibers, 5 percent rubbed; weak coarse platy structure; very friable; sodium pyrophosphate pale brown (10YR 6/3), primarily herbaceous fibers; extremely acid; clear smooth boundary.

Oa2—27 to 60 inches; dark reddish brown (5YR 2/2) sapric material, black (5YR 2/1) rubbed; about 35 percent fibers, 5 percent rubbed; massive; sodium pyrophosphate pale brown (10YR 6/3), primarily herbaceous fibers; extremely acid.

The thickness of the sapric material ranges from 51 to more than 60 inches. Some pedons have sandy material below a depth of 51 inches. The sapric material consists of primarily herbaceous fibers. It is extremely acid or very strongly acid.

The organic tiers have hue of 2.5YR, 5YR, or 7.5YR; value of 2 or 3; and chroma of 2 to 4. Most pedons have a surface tier of hemic material. Some have a surface covering of sphagnum moss as much as 8 inches thick.

Lupton series

The Lupton series consists of very poorly drained, moderately slowly to moderately rapidly permeable muck soils on lake plains, till plains, outwash plains, and moraines. These soils formed in old lakes that were engulfed with

herbaceous plants, then gradually were wooded in many areas, and are now wooded or marshy bogs. Slopes range from 0 to 2 percent.

Lupton soils are commonly adjacent to Greenwood, Markey, and Loxley soils on the landscape. Greenwood and Loxley soils are more acid than Lupton soils. In this survey area they are mapped together. Greenwood soils consist of organic hemic tiers. Markey soils are underlain with sand at a depth of about 32 inches. All of the adjacent soils are in about the same position on the landscape as Lupton soils.

Typical pedon of Lupton muck, 150 feet north and 825 feet east of the southwest corner of sec. 33, T. 19 N., R. 3 W.

Oa1—0 to 7 inches; black (10YR 2/1) broken face and rubbed sapric material; about 40 percent fiber, 5 percent rubbed; weak coarse subangular blocky structure; friable; herbaceous and woody fibers; common fine roots; mildly alkaline; clear smooth boundary.

Oa2—7 to 16 inches; black (10YR 2/1) broken face and rubbed sapric material; about 20 percent fiber, essentially none after rubbing; weak very coarse platy structure parting to weak fine subangular blocky; friable; herbaceous and woody fibers; few fine roots; mildly alkaline; clear smooth boundary.

Oa3—16 to 22 inches; black (10YR 2/1) sapric material, very dark brown (10YR 2/2) rubbed; about 40 percent fiber, 10 percent rubbed; weak coarse platy structure parting to weak fine subangular blocky; friable; herbaceous and woody fibers; very few very fine roots; mildly alkaline; abrupt smooth boundary.

Oa4—22 to 42 inches; black (10YR 2/1) sapric material, very dark brown (10YR 2/2) rubbed; about 50 percent fiber, 10 percent rubbed; massive; friable; woody fibers; mildly alkaline; clear smooth boundary.

Oa5—42 to 50 inches; black (10YR 2/1) broken face and rubbed sapric material; about 25 percent fiber, 5 percent rubbed; massive; friable; herbaceous and woody fibers; mildly alkaline; clear smooth boundary.

Oa6—50 to 60 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; about 40 percent fiber, 10 percent rubbed; massive; friable; herbaceous fibers; mildly alkaline.

The thickness of the sapric material ranges from 51 to more than 60 inches. Some pedons have sandy or loamy material below a depth of 51 inches. The sapric material consists of dominantly herbaceous fibers, but woody fibers and fragments can make up as much as 30 percent of the volume. The sapric material ranges from slightly acid to mildly alkaline.

The surface tier has hue of 5YR, 7.5YR, or 10YR; value of 2; and chroma of 0 to 2. The subsurface and bottom tiers have hue of 5YR, 7.5YR, or 10YR; value of 2 or 3; and chroma of 1 to 3. Some pedons have layers of hemic material that, combined, are less than 10 inches thick.

Mancelona series

The Mancelona series consists of somewhat excessively drained, moderately rapidly permeable soils. These soils formed in calcareous sandy and gravelly deposits on outwash plains and lake plains. Slopes range from 0 to 12 percent.

Mancelona soils are commonly adjacent to the Gladwin, Montcalm, and Wheatley soils on the landscape. Gladwin soils have bright mottles in the upper part of the subsoil. They are in shallow depressions. Montcalm soils have sandy loam bands in the solum and do not have a IIC horizon of sand and gravel. Mancelona and Montcalm soils are in similar positions on the landscape. Wheatley soils typically have a grayish brown substratum. They are in wet depressions and drainageways.

Typical pedon of Mancelona loamy sand, 0 to 6 percent slopes, 100 feet south and 100 feet east of the northwest corner of sec. 24, T. 20 N., R. 5 W.

A1—0 to 3 inches; black (10YR 2/1) loamy sand; moderate medium granular structure; very friable; many fine roots; 10 percent gravel; slightly acid; abrupt smooth boundary.

A2—3 to 5 inches; grayish brown (10YR 5/2) gravelly loamy sand; weak fine subangular blocky structure; very friable; black (10YR 2/1) along root channels; many fine roots; 25 percent gravel; slightly acid; clear broken boundary.

B21ir—5 to 9 inches; dark brown (7.5YR 4/4) gravelly loamy sand; weak fine subangular blocky structure; very friable; common fine roots; 30 percent gravel; slightly acid; clear wavy boundary.

B22ir—9 to 18 inches; brown (7.5YR 5/4) gravelly loamy sand; weak fine subangular blocky structure; very friable; few fine roots; 25 percent gravel; slightly acid; abrupt irregular boundary.

B2t—18 to 23 inches; dark brown (7.5YR 4/4) gravelly sandy loam; moderate fine subangular blocky structure; very friable; few thin clay bridgings between sand grains; few very fine roots; 25 percent gravel; slightly acid; clear irregular boundary.

B3—23 to 27 inches; dark yellowish brown (10YR 4/4) gravelly loamy sand; weak fine subangular blocky structure; very friable; few very fine roots; 25 percent gravel; slight effervescence; mildly alkaline; clear irregular boundary.

IIC—27 to 60 inches; light yellowish brown (10YR 6/4) sand and gravel; single grained; loose; 40 percent gravel; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to the calcareous IIC horizon of sand and gravel range from 20 to 40 inches. Pebbles make up 3 to 40 percent of the volume. The solum ranges from slightly acid to mildly alkaline; the pH increases with increasing depth.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It ranges from 2 to 5 inches in thick-

ness. In cultivated areas an Ap horizon is evident. It has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. It ranges from 6 to 9 inches in thickness. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2 or 3. It is loamy sand or gravelly loamy sand.

The Bir horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is sand, loamy sand, or gravelly loamy sand. Some pedons have an A'2 horizon. The Bt horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 or 5; and chroma of 4 or 6. It is heavy loamy sand, sandy loam, gravelly sandy loam, or sandy clay loam. Some pedons have a B3 horizon.

The IIC horizon has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. It is sand and gravel, coarse sand, or gravelly sand.

Markey series

The Markey series consists of very poorly drained, moderately slowly to moderately rapidly permeable muck soils underlain with sand. These soils are on outwash plains, lake plains, till plains, and moraines. They formed in old shallow lakes that were engulfed with herbaceous plants, then gradually were wooded in many areas, and are now wooded or grassy bogs. Slopes range from 0 to 2 percent.

Markey soils are commonly adjacent to Lupton soils on the landscape. Lupton soils are deep organic soils. They are in about the same position on the landscape as Markey soils.

Typical pedon of Markey muck, 660 feet east and 891 feet north of the southwest corner of sec. 13, T. 17 N., R. 4 W.

Oa1—0 to 9 inches; very dark brown (10YR 2/2) sapric material, black (10YR 2/1) rubbed; about 10 percent fiber, 5 percent rubbed; weak thin platy structure; very friable; herbaceous fibers; many fine roots; mildly alkaline; clear smooth boundary.

Oa2—9 to 12 inches; very dark grayish brown (10YR 3/2) sapric material, very dark brown (10YR 2/2) rubbed; about 20 percent fiber, 5 percent rubbed; weak thin platy structure; very friable; herbaceous fibers; common fine roots; mildly alkaline; clear smooth boundary.

Oa3—12 to 24 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material; about 10 percent fiber, 5 percent rubbed; moderate thick platy structure; very friable; herbaceous fibers; few fine roots; about 20 percent mineral soil material; mildly alkaline; gradual wavy boundary.

Oa4—24 to 32 inches; very dark brown (10YR 2/2) sapric material, black (10YR 2/1) rubbed; about 5 percent fiber, less than 5 percent rubbed; weak coarse subangular blocky structure; very friable; herbaceous fibers; less than 10 percent mineral soil material; mildly alkaline; abrupt smooth boundary.

IICg—32 to 60 inches; gray (N 5/0) sand; single grained; loose; mildly alkaline.

The thickness of the sapric material, or the depth to the sandy IIC horizon, ranges from 16 to 50 inches. The sapric material consists of dominantly herbaceous fibers, but woody fibers and fragments can make up as much as 15 percent of the volume. The sapric material ranges from medium acid to mildly alkaline.

The surface tier has hue of 10YR, value of 2, and chroma of 1 or 2. The subsurface and bottom tiers have hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 0 to 2.

The IIC horizon has hue of 2.5Y, 5Y, or 10YR; value of 5 or 6; and chroma of 0 to 2. It ranges from slightly acid to moderately alkaline. In some pedons it is calcareous.

McBride series

The McBride series consists of moderately well drained soils that are moderately rapidly permeable in the upper part and slowly permeable in a brittle layer in the subsoil. These soils formed in loamy till on moraines and till plains. Slopes range from 2 to 12 percent.

McBride soils are commonly adjacent to the Iosco, Kawkawlin, and Montcalm soils on the landscape. None of these adjacent soils have a fragipan. Iosco and Kawkawlin soils have bright mottles in the upper part of the subsoil. They are in slight depressions and drainageways. Also, Iosco soils are coarser textured in the upper part of the solum than McBride soils. Montcalm soils are coarser textured than McBride soils and have sandy loam bands in the solum. They are in about the same position on the landscape as McBride soils.

Typical pedon of McBride sandy loam, 2 to 6 percent slopes, 330 feet north and 2,500 feet east of the southwest corner of sec. 6, T. 20 N., R. 3 W.

A1—0 to 3 inches; black (10YR 2/1) sandy loam; weak medium granular structure; very friable; many very fine roots; 1 percent cobbles; strongly acid; abrupt smooth boundary.

A2—3 to 6 inches; grayish brown (10YR 5/2) sandy loam; weak fine subangular blocky structure; very friable; common very fine roots; 5 percent cobbles; medium acid; abrupt wavy boundary.

Bir—6 to 15 inches; dark brown (7.5YR 4/4) sandy loam; weak fine subangular blocky structure; dominantly very friable, but about 5 percent firmly cemented ortstein chunks; few very fine roots; 5 percent cobbles; medium acid; abrupt wavy boundary.

A'2x—15 to 30 inches; brown (10YR 5/3) and dark yellowish brown (10YR 4/4) loamy sand; massive; brittle and hard when dry; 70 percent of matrix is brittle; 1 percent cobbles; medium acid; clear wavy boundary.

A'&B'x—30 to 38 inches; brown (10YR 5/3) loamy sand (A'2) and dark yellowish brown (10YR 4/4) sandy clay loam (B); weak medium subangular blocky structure; firm (B), brittle when dry (A'2); A'2 surrounds peds of B; 5 percent cobbles; slightly acid; clear wavy boundary.

B'22t—38 to 55 inches; dark brown (7.5YR 4/4) sandy clay loam; weak coarse subangular blocky structure; firm; few thin brown (7.5YR 5/4) clay films on faces of peds; 5 percent cobbles; slightly acid; gradual wavy boundary.

C—55 to 60 inches; dark brown (7.5YR 4/4) sandy loam; massive; friable; 5 percent cobbles; mildly alkaline.

The thickness of the solum, which corresponds to the depth to carbonates, ranges from 40 to more than 60 inches. Pebbles and cobbles make up 1 to 15 percent of the volume. The upper part of the solum ranges from strongly acid to slightly acid, and the lower part ranges from strongly acid to neutral.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly sandy loam but in some pedons is loamy sand. It is 2 to 4 inches thick. In cultivated areas an Ap horizon is evident. It is 6 to 8 inches thick. It has hue of 10YR, value of 3 or 4, and chroma of 2. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2 or 3. It is loamy sand or sandy loam.

The Bir horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 4 to 6. The A'2x horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 2 or 3. It is loamy sand or sandy loam. In some pedons it occurs only as part of the A'&B'x horizon. The A'2 part of the A'&B'x horizon has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. The B'2 part has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. The A'2 part is sand or loamy sand, and the B'2 part is sandy loam or sandy clay loam. The B't horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or sandy clay loam.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 6. It is mildly alkaline or moderately alkaline.

Melita series

The Melita series consists of somewhat excessively drained soils that are rapidly permeable in the upper part and moderately slowly permeable in the lower part. These soils formed in sandy deposits overlying calcareous loamy deposits on till plains, outwash plains, moraines, and lake plains. Slopes range from 0 to 6 percent.

Melita soils are similar to the Menominee soils and are commonly adjacent to Iosco and Montcalm soils on the landscape. Menominee soils are sandy in the upper 20 to 38 inches of the solum. Iosco soils have bright mottles in the upper part of the solum and have a loamy IIB horizon within 40 inches of the surface. They are below Melita soils on the landscape. Montcalm soils lack the loamy IIB and IIC horizons characteristic of Melita soils and have sandy loam bands in the lower part of the solum. They generally are in about the same position on the landscape as Melita soils.

Typical pedon of Melita sand, 0 to 6 percent slopes, 2,376 feet east and 50 feet south of the northwest corner of sec. 32, T. 18 N., R. 5 W.

A1—0 to 2 inches; very dark brown (10YR 2/2) sand; weak fine granular structure; very friable; dark grayish brown (10YR 4/2) uncoated sand grains; many fine roots; 1 percent pebbles; medium acid; abrupt smooth boundary.

A2—2 to 5 inches; grayish brown (10YR 5/2) sand; weak fine granular structure; very friable; many fine roots; 1 percent pebbles; medium acid; abrupt wavy boundary.

B21ir—5 to 12 inches; dark brown (7.5YR 4/4) sand; weak fine subangular blocky structure; very friable; common fine roots; 1 percent pebbles; medium acid; clear wavy boundary.

B22ir—12 to 20 inches; brown (7.5YR 5/4) sand; weak fine subangular blocky structure; very friable; common fine roots; 1 percent pebbles; medium acid; clear wavy boundary.

B23ir—20 to 29 inches; strong brown (7.5YR 5/6) sand; weak fine subangular blocky structure; very friable; few fine roots; 1 percent pebbles; neutral; abrupt wavy boundary.

B3—29 to 53 inches; yellowish brown (10YR 5/4) sand; few fine faint yellowish brown (10YR 5/6) mottles at 40 inches; single grained; loose; very few very fine roots; 1 percent pebbles; neutral; abrupt wavy boundary.

IIB2t—53 to 57 inches; brown (10YR 5/3) clay loam; moderate coarse subangular blocky structure; firm; common thin brown (7.5YR 5/2) clay films on faces of peds; 1 percent pebbles; mildly alkaline; clear wavy boundary.

IIC—57 to 60 inches; brown (10YR 5/3) clay loam; few fine distinct grayish brown (2.5Y 5/2) mottles; massive; firm; 1 percent pebbles; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 40 to more than 60 inches. Depth to the IIB2t horizon ranges from 40 to 55 inches. Pebbles make up 0 to 5 percent of the volume. The sandy part of the solum ranges from strongly acid to neutral. The depth to free carbonates ranges from 50 to more than 60 inches.

The A1 or Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The A1 horizon is 1 inch to 3 inches thick. The Ap horizon ranges from 6 to 10 inches in thickness. The A2 horizon has hue of 10YR, value of 5 to 7, and chroma of 2.

The Bir horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 8. It is sand or loamy sand. Some pedons do not have a B3 horizon. Some have an A'2 horizon, which has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. The IIB2t horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 6. It is clay loam or silty clay loam. It is neutral or mildly alkaline.

The IIC horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 6. It is clay loam or silty clay loam.

Menominee series

The Menominee series consists of well drained and moderately well drained soils that are rapidly permeable in the upper part and moderately slowly permeable in the lower part. These soils formed in sandy deposits over loamy deposits on moraines, till plains, and outwash plains. Slopes range from 0 to 18 percent. The Menominee soils in this survey area are taxadjuncts to the Menominee series because they do not have the chemical properties characteristic of spodic horizons. This difference, however, does not alter the use or behavior of the soils.

Menominee soils are similar to Melita soils and are commonly adjacent to Iosco, Montcalm, Nester, and Ubly soils on the landscape. Melita soils are sandy in the upper 40 to 55 inches of the solum. Iosco soils have a mottled subsoil. They are in wet depressions. Montcalm soils lack the loamy IIB and IIC horizons characteristic of Menominee soils and have sandy loam bands in the solum. The upper part of the solum is loamy in Nester soils and sandy loam in Ubly soils. Montcalm, Nester, and Ubly soils are in about the same position on the landscape as Menominee soils.

Typical pedon of Menominee loamy sand, 0 to 6 percent slopes, 150 feet east and 2,145 feet south of the northwest corner of sec. 34, T. 19 N., R. 3 W.

A1—0 to 4 inches; very dark brown (10YR 2/2) loamy sand; moderate fine granular structure; very friable; many fine roots; 3 percent pebbles; strongly acid; clear wavy boundary.

A2—4 to 11 inches; pinkish gray (7.5YR 7/2) sand; weak medium granular structure; very friable; many fine roots; 3 percent pebbles; medium acid; clear wavy boundary.

B21ir—11 to 14 inches; reddish brown (5YR 4/4) loamy sand; weak medium granular structure; friable; many fine roots; 3 percent pebbles; slightly acid; clear wavy boundary.

B22ir—14 to 19 inches; reddish brown (5YR 5/4) and yellowish brown (10YR 5/6) loamy sand; moderate fine subangular blocky structure; friable; common fine roots; 3 percent pebbles; slightly acid; clear wavy boundary.

B3—19 to 23 inches; strong brown (7.5YR 5/6) sandy loam; weak medium subangular blocky structure; friable; brown (10YR 5/3) ped coatings; few fine roots; 3 percent pebbles; neutral; clear wavy boundary.

A&B—23 to 30 inches; pale brown (10YR 6/3) sandy loam (A'2) as coatings on faces of peds; brown (7.5YR 5/4) and reddish brown (5YR 5/4) clay loam (Bt); common medium distinct brownish yellow (10YR 6/6) and common fine faint strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky structure; firm; few fine roots; 5 percent pebbles; neutral; clear wavy boundary.

IIB2t—30 to 46 inches; dark brown (7.5YR 4/4) clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; moderate coarse prismatic structure parting to moderate coarse angular blocky; firm; clay films on vertical faces; few fine roots; 5 percent pebbles; few cobbles; neutral; gradual wavy boundary.

IIC—46 to 64 inches; light brown (7.5YR 6/4) clay loam; common fine prominent light brownish gray (10YR 6/2) and few fine distinct strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure parting to weak coarse angular blocky; firm; 5 percent pebbles; few cobbles; slight effervescence; moderately alkaline.

The solum ranges from 28 to 55 inches in thickness. Depth to the IIBt horizon ranges from 20 to 38 inches. Pebbles and cobbles make up 1 to 10 percent of the volume. The sandy part of the solum ranges from strongly acid to slightly acid.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It ranges from 2 to 5 inches in thickness. In cultivated areas an Ap horizon is evident. It has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. It is 7 to 9 inches thick. The A2 horizon has hue of 10YR or 7.5YR, value of 6 or 7, and chroma of 2. It is sand or loamy sand 6 to 8 inches thick. Some pedons have an A3 horizon.

The Bir horizon has hue of 5YR, 7.5YR, or 10YR; value of 4 or 5; and chroma of 3 to 6. It is sand or loamy sand. Ortstein makes up 0 to 30 percent of the volume. The A'2 horizon is mixed with the IIB2t horizon in some pedons. It has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. It is sand or loamy sand. The IIB2t horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 6. It has faint to distinct mottles in most pedons. It is clay loam or silty clay loam and ranges from slightly acid to mildly alkaline.

The IIC horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 6. It is clay loam or silty clay loam and ranges from slightly acid to moderately alkaline.

Montcalm series

The Montcalm series consists of well drained, rapidly permeable soils. These soils formed in sandy deposits on till plains, moraines, and outwash plains. Slopes range from 0 to 35 percent.

Montcalm soils are commonly adjacent to the Graycalm, Mancelona, McBride, Melita, and Menominee soils on the landscape. None of these adjacent soils have the sandy loam bands characteristic of Montcalm soils. All but the Graycalm soils have an argillic horizon. Graycalm soils have loamy sand bands, generally below a depth of 35 inches. Mancelona soils have calcareous sand and gravel within a depth of 40 inches. McBride and Menominee soils

are underlain by finer textured material at a depth of 20 to 40 inches. Also, McBride soils have a fragipan. Melita soils are underlain by finer textured material at a depth of 40 to 60 inches. All of the adjacent soils are in about the same position on the landscape as Montcalm soils.

Typical pedon of Montcalm loamy sand, 0 to 6 percent slopes, 330 feet south and 2,200 feet west of the northeast corner of sec. 7, T. 20 N., R. 3 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loamy sand; weak fine granular structure; very friable; many very fine roots; 2 percent pebbles; medium acid; abrupt smooth boundary.

B21ir—7 to 14 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; few very fine roots; 2 percent pebbles; medium acid; abrupt wavy boundary.

B22ir—14 to 21 inches; yellowish brown (10YR 5/6) loamy sand; weak fine subangular blocky structure; very friable; few very fine roots; 2 percent pebbles; slightly acid; clear wavy boundary.

A&B—21 to 60 inches; grayish brown (10YR 5/2) sand (A2); single grained; loose; bands of dark brown (7.5YR 4/4) sandy loam (Bt); massive; friable; individual bands are 1/2 inch to 2 inches thick and combined are 18 inches thick; 5 percent pebbles; slightly acid.

The solum ranges from 50 to more than 60 inches in thickness. Pebbles make up 0 to 15 percent of the volume. The solum ranges from slightly acid to strongly acid.

The Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. It ranges from 6 to 10 inches in thickness. In uncultivated areas an A1 horizon is evident. It is 1 inch to 3 inches thick. It has hue of 10YR, value of 2 to 4, and chroma of 1 or 2. Some pedons have an A2 horizon.

The Bir horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 3 to 6. It is sand or loamy sand. The A2 part of the A&B horizon has hue of 10YR, value of 5 to 7, and chroma of 2 to 4. It is sand or loamy sand. The Bt part has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 6. It occurs as bands of sandy loam or loamy sand. Depth to the first of these bands ranges from 20 to 40 inches. The bands range from 1/8 inch to 5 inches in thickness and, combined, are more than 6 inches thick.

Some pedons have a C horizon. This horizon has hue of 10YR, value of 6, and chroma of 3 or 4. It is sand or loamy sand.

Nester series

The Nester series consists of well drained and moderately drained, moderately slowly permeable soils. These soils formed in calcareous loamy till on moraines and till plains. Slopes range from 2 to 18 percent.

Nester soils are commonly adjacent to Kawkawlin, Menominee, Sims, and Ubly soils on the landscape. Kawkawlin soils have grayish mottles in the upper part of the subsoil. They are in shallow depressions and drainageways. Menominee soils have 20 to 40 inches of sand or loamy sand over a clay loam substratum. They are on knolls and rises. Sims soils have a grayer subsoil than Nester soils. They are in wet depressions and drainageways. Ubly soils are coarser textured in the upper part of the solum than Nester soils. They are in about the same position on the landscape as Nester soils.

Typical pedon of Nester loam, 2 to 6 percent slopes, 1,980 feet west and 150 feet south of the northeast corner of sec. 4, T. 17 N., R. 3 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) loam; moderate fine and medium granular structure; friable; 3 percent cobbles; medium acid; abrupt wavy boundary.

B&A—10 to 14 inches; strong brown (7.5YR 5/8) clay loam (B) and light brownish gray (10YR 6/2) loam (A), white (10YR 8/1) dry interfingering; moderate fine and medium subangular blocky structure; firm (B), friable (A); discontinuous thin dark brown (10YR 4/3) clay films on faces of peds; common fine roots; 3 percent cobbles; neutral; clear irregular boundary.

B21t—14 to 23 inches; strong brown (7.5YR 5/6) clay loam and pale brown (10YR 6/3) loam, white (10YR 8/1) dry, interfingering; moderate coarse prismatic structure parting to moderate very fine and fine angular blocky; very firm; discontinuous thin reddish brown (5YR 4/4) clay films and black (5YR 2/1) clay organic films on faces of peds; 3 percent cobbles; neutral; clear wavy boundary.

B22t—23 to 29 inches; yellowish brown (10YR 5/6) clay loam; moderate coarse prismatic structure parting to moderate fine angular blocky; very firm; discontinuous thin dark yellowish brown (10YR 4/4) clay films on faces of peds; white (10YR 8/1) lime accumulation covering 5 percent of faces of peds; few very fine roots; 3 percent cobbles; slight effervescence; moderately alkaline; gradual wavy boundary.

B3—29 to 38 inches; yellowish brown (10YR 5/6) clay loam; moderate coarse prismatic structure parting to strong medium and coarse angular blocky; very firm; discontinuous thin reddish brown (5YR 4/4) clay films on faces of peds; white (10YR 8/1) lime accumulation covering 20 percent of faces of peds; few very fine roots; 3 percent cobbles; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—38 to 44 inches; pinkish gray (7.5YR 6/2) clay loam; weak coarse prismatic structure parting to strong moderate and coarse angular blocky; very firm; white (10YR 8/1) lime accumulation covering 45 percent of faces of peds; very few very fine roots; 3 percent cobbles; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—44 to 60 inches; brown (7.5YR 5/4) clay loam; moderate coarse angular blocky structure; very firm; white (10YR 8/1) lime accumulation covering 65 percent of faces of peds; very few very fine roots; 3 percent cobbles; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. Most pedons contain cobbles, but the cobbles are less than 10 percent of the volume. The solum ranges from strongly acid to moderately alkaline; the pH increases with increasing depth.

The Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 1 to 3. It is dominantly loam but in some pedons is sandy loam. It is commonly 6 to 10 inches thick, but in some of the steeper, eroded areas it is 3 to 5 inches thick. In uncultivated areas both an A1 horizon and an A2 horizon are evident.

The B&A horizon is in most pedons. The A part has hue of 10YR, value of 5 to 7, and chroma of 2 to 4. It is loam or sandy loam. The B part has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 8. It is clay loam or silty clay loam. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is clay loam or silty clay loam and has a weighted clay content that averages between 35 and 45 percent. Clay films are discontinuous and thin in most pedons. Some pedons do not have a B3 horizon.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 to 4. It is calcareous clay loam or silty clay loam.

Otisco series

The Otisco series consists of somewhat poorly drained, moderately rapidly or rapidly permeable soils. These soils formed in sandy and loamy deposits on till plains and low moraines. Slopes range from 0 to 2 percent.

Otisco soils are similar to Au Gres soils. Au Gres soils do not have sandy loam bands.

Typical pedon of Otisco loamy sand, 0 to 2 percent slopes, 2,000 feet west and 1,000 feet south of the northeast corner of sec. 6, T. 19 N., R. 6 W.

A11—0 to 2 inches; very dark brown (10YR 2/2) loamy sand; moderate medium granular structure; very friable; many fine roots; very strongly acid; abrupt smooth boundary.

A12—2 to 4 inches; grayish brown (10YR 5/2) and very dark brown (10YR 2/2) loamy sand; moderate medium granular structure; very friable; common fine roots; very strongly acid; abrupt wavy boundary.

A2—4 to 11 inches; light brownish gray (10YR 6/2) sand; common fine distinct strong brown (7.5YR 5/6) and yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; very friable; few very fine roots; 2 percent pebbles; strongly acid; clear wavy boundary.

B21ir—11 to 17 inches; dark brown (7.5YR 4/4) sand; few fine faint strong brown (7.5YR 5/6) and few medium distinct yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; very friable; few very fine roots; 1 percent pebbles; strongly acid; gradual wavy boundary.

B22ir—17 to 22 inches; yellowish brown (10YR 5/4) sand; many medium distinct dark brown (7.5YR 4/4) and yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; very friable; few very fine roots; 1 percent pebbles; strongly acid; clear wavy boundary.

A'2—22 to 28 inches; brown (10YR 5/3) sand; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; very friable; few very fine roots; 2 percent pebbles; strongly acid; clear broken boundary.

A'&B'—28 to 50 inches; brown (7.5YR 5/4) sand (A'); single grained; loose; bands of dark brown (7.5YR 4/4) sandy loam (B'); massive; friable; individual bands are 1 inch to 3 inches thick and, combined, are 8 inches thick; 1 percent pebbles; medium acid; gradual wavy boundary.

C—50 to 60 inches; brown (7.5YR 5/4) sand; common fine distinct grayish brown (10YR 5/2) mottles; single grained; loose; 1 percent pebbles; medium acid.

The thickness of the solum ranges from 40 to 50 inches. Pebbles make up 0 to 2 percent of the volume.

The A1 horizon has hue of 10YR, value of 2, and chroma of 1 or 2. It ranges from 1 inch to 4 inches in thickness. In cultivated areas an Ap horizon is evident. It has hue of 7.5YR or 10YR, value of 3 or 4, and chroma of 2. It ranges from 7 to 10 inches in thickness. The A2 horizon has hue of 10YR, value of 5 to 7, and chroma of 2 or 3. It is sand or loamy sand. It has faint to distinct mottles in most pedons. The A horizon ranges from very strongly to slightly acid.

The Bir horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is sand or loamy sand. It has faint to distinct mottles and ranges from strongly acid to slightly acid. In some pedons the A'2 horizon occurs as part of the A'&B' horizon. It has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 3 or 4. It is sand or loamy sand and ranges from strongly acid to slightly acid. The Bt part of the A'&B' horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 6. It occurs as bands of sandy loam or sandy clay loam. These bands range from 1/8 inch to 5 inches in thickness and, combined, are more than 6 inches thick. Depth to the first of these bands ranges from 20 to 40 inches. The A'&B' horizon ranges from medium acid to mildly alkaline.

The C horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 3 or 4. It is sand or loamy sand. It ranges from medium acid to mildly alkaline and is calcareous in some pedons.

Rondeau series

The Rondeau series consists of very poorly drained, slowly permeable or very slowly permeable muck soils underlain with marl. These soils formed in old lakes that filled with snail shells and decaying herbaceous plants. These old lakes are now bogs on outwash plains and moraines. Slopes range from 0 to 2 percent.

Typical pedon of Rondeau muck, 500 feet west and 2,475 feet south of the northeast corner of sec. 7, T. 18 N., R. 3 W.

Oa1—0 to 9 inches; black (10YR 2/1) broken face and rubbed sapric material; about 10 percent fiber, essentially none after rubbing; weak medium granular structure; friable; herbaceous fibers; many fine roots; mildly alkaline; clear smooth boundary.

Oa2—9 to 15 inches; black (10YR 2/1) broken face and rubbed sapric material; about 35 percent fiber, less than 10 percent rubbed; weak coarse subangular blocky structure; friable; herbaceous fibers; few fine roots; mildly alkaline; clear smooth boundary.

Oa3—15 to 21 inches; black (10YR 2/1) broken face and rubbed sapric material; about 60 percent fiber, less than 15 percent rubbed; massive; friable; herbaceous fibers; few fine roots; mildly alkaline; clear smooth boundary.

Oa4—21 to 30 inches; black (10YR 2/1) broken face and rubbed sapric material; about 70 percent fiber, less than 15 percent rubbed; massive; friable; herbaceous fibers; mildly alkaline; abrupt smooth boundary.

Lca1—30 to 45 inches; light olive gray (5Y 6/2) marl; massive; friable; violent effervescence; mildly alkaline; gradual smooth boundary.

Lca2—45 to 60 inches; light gray (2.5Y 7/2) marl; massive; friable; violent effervescence; mildly alkaline.

The thickness of the sapric material, or the depth to marl, ranges from 16 to 50 inches. The sapric material consists of primarily herbaceous fibers. It is neutral or mildly alkaline. It has hue of 10YR, value of 2 or 3, and chroma of 1 or 2.

The Lca horizon has hue of 10YR, 2.5Y or 5Y; value of 5 to 7; and chroma of 1 or 2. It commonly contains snail shells and has the feel of a silt loam.

Roscommon series

The Roscommon series consists of poorly drained and very poorly drained, rapidly permeable soils. These soils formed in sandy deposits on outwash plains and lake plains and in glacial drainageways. Slopes range from 0 to 2 percent.

Roscommon soils are similar to the Wheatley soils and are commonly adjacent to Au Gres, Croswell, and Rubicon soils on the landscape. Wheatley soils are underlain with stratified, calcareous sand and gravel. The control section of Au Gres, Croswell, and Rubicon soils is brighter than that of Roscommon soils. That of Au Gres and Croswell soils is mottled. Au Gres and Croswell soils are higher on the landscape than Roscommon soils, and Rubicon soils are on the highest plains and rises.

Typical pedon of Roscommon mucky loamy sand, 231 feet east and 561 feet south of the northwest corner of sec. 4, T. 19 N., R. 6 W.

A1—0 to 7 inches; black (10YR 2/1) mucky loamy sand, very dark gray (10YR 3/1) dry; moderate medium granular structure; very friable; many fine roots; 2 percent pebbles; slightly acid; abrupt smooth boundary.

A3—7 to 10 inches; dark grayish brown (10YR 4/2) loamy sand; many medium distinct grayish brown (10YR 5/2) mottles; moderate medium granular structure; very friable; common fine roots; 2 percent pebbles; slightly acid; abrupt wavy boundary.

C1—10 to 13 inches; grayish brown (10YR 5/2) sand; single grained; loose; dark grayish brown (10YR 4/2) root channels; few fine roots; 2 percent pebbles; slightly acid; clear wavy boundary.

C3—13 to 48 inches; grayish brown (10YR 5/2) sand; single grained; loose; 2 percent pebbles; slightly acid; gradual wavy boundary.

C4—48 to 60 inches; grayish brown (10YR 5/2) sand; single grained; loose; 5 percent pebbles; slightly acid.

The control section ranges from slightly acid to mildly alkaline. Pebbles make up less than 5 percent of the volume.

The A2 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly mucky loamy sand but in some pedons is mucky sand, sand, or loamy sand. It ranges from 4 to 7 inches in thickness. Some pedons have an Oa horizon as much as 8 inches thick. Some do not have an A3 horizon.

The C horizon has hue of 10YR, value of 5 or 6, and chroma of 1 or 2.

Rubicon series

The Rubicon series consists of excessively drained, rapidly permeable soils. These soils formed in sandy deposits on till plains, outwash plains, and moraines. Slopes range from 0 to 18 percent.

Rubicon soils are commonly adjacent to Au Gres, Croswell, Grayling, and Roscommon soils on the landscape. Au Gres soils are mottled in the upper part of the subsoil, and Croswell soils are mottled between depths of 20 and 40 inches. Both are in slight depressions. Grayling soils lack albic and spodic horizons. They are in about the same position on the landscape as Rubicon soils. Roscommon soils have a grayer control section than Rubicon soils. They are in wet depressions.

Typical pedon of Rubicon sand, 0 to 6 percent slopes, 190 feet north and 1,782 feet west of the southeast corner of sec. 17, T. 18 N., R. 6 W.

A1—0 to 3 inches; black (10YR 2/1) sand; weak fine granular structure; very friable; many fine roots; 1 percent pebbles; very strongly acid; abrupt smooth boundary.

A2—3 to 8 inches; light brownish gray (10YR 6/2) sand; weak fine granular structure; very friable; common very fine roots; 1 percent pebbles; strongly acid; abrupt smooth boundary.

B21ir—8 to 16 inches; dark brown (7.5YR 4/4) sand; weak fine subangular blocky structure; very friable; few very fine roots; 1 percent pebbles; strongly acid; clear wavy boundary.

B22ir—16 to 22 inches; dark yellowish brown (10YR 4/4) sand; weak fine subangular blocky structure; very friable; few very fine roots; 1 percent pebbles; medium acid; gradual wavy boundary.

B3—22 to 40 inches; yellowish brown (10YR 5/6) sand; single grained; loose; 1 percent pebbles; medium acid; gradual wavy boundary.

C—40 to 60 inches; light yellowish brown (10YR 6/4) sand; single grained; loose; 1 percent pebbles; slightly acid.

The solum ranges from 30 to 42 inches in thickness and from medium acid to very strongly acid. Pebbles make up less than 5 percent of the volume.

The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is 2 or 3 inches thick. In cultivated areas an Ap horizon is evident. It is 6 to 8 inches thick. It has hue of 10YR, value of 3 or 4, and chroma of 2. The A2 horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 1 or 2.

The Bir horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. Ortstein makes up 0 to 20 percent of the volume. The B3 horizon has hue of 10YR, value of 5 or 6, and chroma of 6.

The C horizon has hue of 10YR, value of 6, and chroma of 3 or 4. It is slightly acid or medium acid.

Sims series

The Sims series consists of poorly drained and very poorly drained, slowly permeable soils. These soils formed in calcareous loamy till on low moraines and till plains. Slopes range from 0 to 2 percent.

Sims soils are commonly adjacent to the Kawkawlin and Nester soils on the landscape. Kawkawlin soils have a brighter colored mottled subsoil than Sims soils. They are on the slightly higher rises. Nester soils also have a brighter colored subsoil. They are on the highest rises and hills.

Typical pedon of Sims clay loam, 1,089 feet south and 165 feet east of the center of sec. 2, T. 17 N., R. 3 W.

A1—0 to 9 inches; black (10YR 2/1) clay loam; moderate medium granular structure; friable; many fine roots; slightly acid; clear wavy boundary.

B21g—9 to 21 inches; gray (10YR 5/1) silty clay loam; common fine faint gray (5Y 5/1) and common medium distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; firm; few fine roots; 1 percent pebbles; neutral; clear wavy boundary.

B22g—21 to 28 inches; gray (10YR 5/1) silty clay loam; common fine faint gray (5Y 5/1) and many medium distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; firm; few fine roots; 3 percent pebbles; neutral; clear wavy boundary.

C1—28 to 60 inches; gray (10YR 5/1) silty clay loam; common fine faint gray (5Y 5/1) and many medium distinct light olive brown (2.5Y 5/4) mottles; massive; firm; 5 percent pebbles; strong effervescence; moderately alkaline.

The thickness of the solum, which corresponds to the depth to carbonates, ranges from 20 to 32 inches. Pebbles and cobbles make up 0 to 5 percent of the volume. The solum ranges from slightly acid to mildly alkaline.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. It is dominantly clay loam but in some pedons is loam. It is 7 to 9 inches thick.

The Bg horizon has hue of 5Y or 10YR, value of 5 to 7, and chroma of 1 or 2. It is clay loam or silty clay loam.

The Cg horizon has hue of 5Y or 10YR, value of 5 to 7, and chroma of 1 or 2. It is clay loam or silty clay loam.

Ubly series

The Ubly series consists of well drained and moderately well drained soils that are moderately rapidly permeable in the upper part and moderately slowly permeable in the lower part. These soils formed in calcareous loamy deposits on till plains and moraines. Slopes range from 2 to 6 percent.

Ubly soils are commonly adjacent to Kawkawlin, Menominee, and Nester soils on the landscape. Kawkawlin and Nester soils are finer textured in the upper part of the solum than Ubly soils. Also, Kawkawlin soils have low chroma mottles in the upper part of the subsoil and are below Ubly soils on the landscape. Menominee soils are sandy in the upper part of the solum. Menominee and Nester soils are in about the same position on the landscape as Ubly soils.

Typical pedon of Ubly sandy loam, 2 to 6 percent slopes, 1,070 feet south and 150 feet east of the northwest corner of sec. 21, T. 20 N., R. 4 W.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; weak medium granular structure; very friable; many fine roots; medium acid; abrupt wavy boundary.

A2—4 to 7 inches; light brownish gray (10YR 6/2) sandy loam; weak medium subangular blocky structure; very

friable; common fine roots; medium acid; abrupt irregular boundary.

Bir—7 to 17 inches; dark brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; friable; common fine roots; medium acid; clear wavy boundary.

A'2—17 to 18 inches; pale brown (10YR 6/3) sandy loam; weak medium subangular blocky structure; friable; few fine roots; slightly acid; abrupt irregular boundary.

B'21t—18 to 24 inches; strong brown (7.5YR 5/6) loam; moderate coarse subangular blocky structure; friable; pale brown (10YR 6/3) sandy loam coatings on faces of some peds; few fine roots; slightly acid; clear wavy boundary.

IIB'22t—24 to 31 inches; brown (7.5YR 5/4) loam; moderate coarse angular blocky structure; firm; common thin dark brown (7.5YR 4/2) clay films on faces of peds; mildly alkaline; abrupt wavy boundary.

IIC—31 to 60 inches; brown (10YR 5/3) loam; weak medium subangular blocky structure; firm; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 50 inches. Depth to the IIBt horizon ranges from 20 to 40 inches. Pebbles and cobbles make up 0 to 3 percent of the volume. The sandy loam in the upper part of the solum is medium acid or slightly acid, and the IIB'2 horizon ranges from slightly acid to mildly alkaline.

The A1 horizon has hue of 10YR, value of 3, and chroma of 1 or 2. It is 2 to 4 inches thick. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2. In cultivated areas an Ap horizon is evident. It is about 6 to 10 inches thick. It has hue of 10YR, value of 3 or 4, and chroma of 2 or 3.

The Bir horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. The A'2 horizon has hue of 10YR, value of 6, and chroma of 2 or 3. It is loamy sand or sandy loam. Some pedons have a B't horizon or an A'2&IIB't horizon, which grades to the IIB't horizon. The IIB't horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. It is loam, sandy clay loam, or clay loam.

The IIC horizon has hue of 10YR or 7.5YR, value of 5, and chroma of 3 or 4. It is loam or clay loam.

Wheatley series

The Wheatley series consists of poorly drained and very poorly drained, rapidly permeable soils. These soils formed in calcareous sandy and gravelly deposits on outwash plains and lake plains. Slopes range from 0 to 2 percent. The Wheatley soils in this survey area contain less gravel than is defined as the range for the series, but this difference does not alter the use or behavior of the soils.

Wheatley soils are similar to Roscommon soils and are commonly adjacent to Brevort, Gladwin, and Mancelona soils on the landscape. Roscommon and Brevort soils do not contain calcareous sand and gravel in the C horizon. Also, Brevort soils have a silt loam IIC horizon and are in about the same position on the landscape as Wheatley soils. Gladwin soils are brighter colored in the mottled upper part of the control section than Wheatley soils. They are slightly above those soils on the landscape. Mancelona soils have no bright or gray mottles in the upper part of the solum. They are on the highest parts of the landscape. Gladwin and Mancelona soils have an argillic horizon.

Typical pedon of Wheatley loamy sand, 125 feet south and 1,150 feet west of the northeast corner of sec. 24, T. 17 N., R. 3 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loamy sand; moderate medium granular structure; very friable; many fine roots; 5 percent pebbles; neutral; abrupt smooth boundary.

C1g—8 to 29 inches; grayish brown (10YR 5/2) sand; many medium distinct yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure; very friable; few fine roots; 10 percent pebbles; neutral; abrupt wavy boundary.

C2g—29 to 40 inches; grayish brown (2.5Y 5/2) gravelly sand; single grained; loose; 25 percent pebbles; slight effervescence; mildly alkaline; gradual wavy boundary.

C3g—40 to 60 inches; grayish brown (2.5Y 5/2) sand and gravel; single grained; loose; 35 percent pebbles; strong effervescence; mildly alkaline.

The depth to free carbonates ranges from 15 to 30 inches.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is 7 to 9 inches thick. In uncultivated areas an A1 horizon is evident. It is 5 to 8 inches thick. It has hue of 10YR, value of 2, and chroma of 1 or 2. The A horizon is, by volume, 1 to 10 percent pebbles. It is neutral or mildly alkaline.

The Cg horizon has hue of 10YR, 5Y, or 2.5Y; value of 5 to 7; and chroma of 1 or 2. The upper part is sand or loamy sand and is 10 to 15 percent pebbles. It is neutral or mildly alkaline. The lower part is sand and gravel, gravelly sand, or coarse sand and gravel and is 25 to 40 percent pebbles.

Winterfield series

The Winterfield series consists of somewhat poorly drained, rapidly permeable soils. These soils formed in sandy deposits on flood plains. Slopes range from 0 to 2 percent.

Winterfield soils are commonly adjacent to the Evart soils on the landscape. Evart soils are grayer in the upper part of the substratum than Winterfield soils. In this survey area they are mapped with those soils.

Typical pedon of Winterfield loamy sand, in an area of Winterfield-Evart complex, 2,409 feet west and 1,320 feet south of the northeast corner of sec. 16, T. 19 N., R. 6 W.

A1—0 to 7 inches; very dark brown (10YR 2/2) loamy sand; moderate medium granular structure; very friable; many fine roots; slightly acid; abrupt smooth boundary.

C1—7 to 19 inches; brown (10YR 5/3) sand; many medium distinct yellowish brown (10YR 5/6) mottles; weak medium granular structure; very friable; few fine roots; neutral; clear wavy boundary.

C2—19 to 31 inches; yellowish brown (10YR 5/4) sand; common fine faint yellowish brown (10YR 5/6) and common medium distinct grayish brown (10YR 5/2) mottles; single grained; loose; few very fine roots; neutral; clear wavy boundary.

C3—31 to 60 inches; pale brown (10YR 6/3) sand; single grained; loose; 3 percent pebbles; neutral.

The A1 horizon has hue of 10YR, value of 2 to 4, and chroma of 2 or 3. It is dominantly loamy sand but in some pedons is sand. It is medium acid or slightly acid and is 6 to 9 inches thick.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 6. It is dominantly sand but in some pedons is gravelly sand. It is neutral or mildly alkaline. Distinct mottles that have chroma of 2 are within a depth of 40 inches.

Classification of the soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (*10*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 18, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Psamment (*Psamm*, meaning a sand texture, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Udipsamments (*Ud*, meaning udic moisture regime, plus *Psamment*, the suborder of Entisols that have a sand texture).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Udipsamments.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is mixed, frigid Typic Udipsamments.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Formation of the soils

The following paragraphs describe the factors of soil formation, relate them to the formation of soils in the survey area, and explain the processes of soil formation.

Factors of soil formation

Soil forms through the interaction of five major factors: the physical, chemical, and mineral composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the

plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the processes of soil formation have acted on the parent material (*2*).

Climate and plant and animal life are the active forces in soil formation. They slowly change the parent material into a natural body of soil that has genetically related layers, called horizons. The effects of climate and plant and animal life are conditioned by relief. The nature of the parent material also affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. It may be a long or short time, but some time is required for differentiation of soil horizons. Generally, a long time is required for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on soils that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

Parent material is the unconsolidated mass from which a soil forms. The parent materials of the soils of Clare County were deposited by glaciers or by melt water from glaciers. Some of these materials were subsequently reworked and redeposited by water and wind. These glaciers covered the county about 10,000 to 12,000 years ago. Parent material determines the limits of the chemical and mineralogical composition of the soil. Although the parent materials in this county are of common glacial origin, their properties vary greatly, sometimes within small areas, depending on how the materials were deposited. The dominant parent materials in Clare County were deposited as glacial till, outwash material, alluvium, and organic material.

Glacial till is material laid down directly by glaciers with a minimum of water action. It is a mixture of particles of different sizes. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by washing water. The glacial till in Clare County generally is calcareous. It is loam, silty clay loam, or clay loam. Nester soils, for example, formed in glacial till. Typically they are moderately fine textured and have well developed structure.

Outwash material is deposited by running water from melting glaciers. The size of the particles that make up outwash material varies according to the speed of the stream of water that carried them. When the water slows down, the coarser particles are deposited. Finer particles, such as very fine sand, silt, and clay, can be carried by slowly moving water. Outwash deposits generally consist of layers of particles of similar size, such as sandy loam, sand, gravel, and other coarse particles. Mancelona soils, for example, formed in deposits of outwash material.

Alluvium is deposited by floodwater of present streams in recent time. The texture depends on the speed of the water from which the material was deposited. The alluvium deposited along a swift stream, such as the Muskegon River, is coarser textured than that deposited along a slow, sluggish stream, such as the Tobacco River. Colonville, Winterfield, and Evart soils are examples of alluvial soils.

Organic material is a deposit of plant remains. After the glaciers withdrew from the area, water was left standing in depressions in outwash plains, flood plains, moraines, and till plains. As the grasses and sedges growing around the edges of these lakes died, the plant remains did not decompose but remained around the edge of the lakes. Later, water-tolerant trees grew in the areas. As these trees died, their residue became part of the organic accumulation. In this way, the lakes were eventually filled with organic material and developed into areas of muck. Lupton soils formed in organic material.

Plant and animal life

Plants have been the principal organisms influencing the soils in Clare County. Bacteria, fungi, and earthworms also have been important. The chief contribution of plant and animal life is the addition of organic matter and nitrogen to the soil. The kind of organic material on and in the soil depends on the kinds of plants that grew on the soil. The remains of these plants accumulate on the surface, decay, and eventually become organic matter. The roots of the plants provide channels for downward movement of water through the soil and also add organic matter as they decay. Bacteria in the soil help to break down the organic matter so that it can be used by growing plants.

The vegetation in Clare County was a mixture of deciduous and coniferous forest. Differences in natural soil drainage and minor changes in parent material affected the composition of the forest species.

In general, the well drained upland soils, such as Nester, Menominee, and Montcalm soils, were covered with sugar maple and white pine. Grayling soils were covered with scrub oak and jack pine. The wet soils were covered mainly with elm, ash, aspen, and white cedar. Roscommon and Brevort soils, which formed under wet conditions, contain a considerable amount of organic matter.

Climate

Climate is important in the formation of soils. It determines the kind of plant and animal life on and in the soil, and it determines the amount of water available for the weathering of minerals and the transporting of soil material. Climate, through its influence on soil temperature, determines the rate of chemical reaction that occurs in the soil. These influences are important, but they affect large areas rather than a small area, such as a county.

The climate in Clare County is cool and humid. It is presumably similar to the climate that existed when the soils formed. The soils in Clare County differ from the soils formed in a dry, warm climate or from those formed in a hot, moist climate. Climate is uniform throughout the

county, but its effect is modified locally by the proximity to large lakes. Only minor differences in the soils of Clare County are the results of differences in climate.

Relief

Relief, or topography, has affected the soils of Clare County through its influence on natural drainage, erosion, plant cover, and soil temperature. Slopes range from 0 to 35 percent. Natural soil drainage ranges from excessively drained on the hilltops to very poorly drained in the depressions.

Relief influences the formation of soils by affecting runoff and drainage. Drainage in turn, through its effect on aeration, determines the color of the soil. Runoff is most rapid on the steeper slopes. In low areas water is temporarily ponded. Water and air move freely through well drained soils but slowly through very poorly drained soils. Well aerated soils are brightly colored because the iron and aluminium compounds that give most soils their color are oxidized. Poorly aerated soils are dull gray and mottled. Nester soils are examples of well drained, well aerated soils, and Sims soils are examples of poorly drained, poorly aerated soils. These two formed in similar parent material.

Time

Time, usually a long time, is needed for the development of distinct horizons from parent material. Differences in length of time that the parent material has been in place are commonly reflected in the degree of development of the soil profile. Some soils form rapidly; others slowly.

The soils in Clare County range from young to mature. The glacial deposits in which many of the soils formed have been exposed to soil-forming factors for a long enough time that distinct horizons have developed. Some soils forming in recent alluvial sediments have not been in place long enough for the development of distinct horizons.

Evart soils are examples of young soils formed in alluvial material. Sims soils are more mature. Horizons are more clearly expressed because much of the lime has been leached out.

Processes of soil formation

Several processes were involved in the development of soil horizons in the soils of Clare County: (1) accumulation of organic matter, (2) leaching of lime (calcium carbonates) and other 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 horizons.

Organic matter accumulates at the surface to form an A1 horizon. The A1 horizon is mixed into a plow layer, or Ap horizon, when the soil is plowed. In the soils of Clare County, the surface layer ranges from high to low in organic-matter content. Roscommon soils, for example, have a high organic-matter content in the surface layer and Grayling soils a low organic-matter content (*5*).

Leaching of carbonates and other bases has occurred in most of the soils. Soil scientists generally agree that leaching of bases in soils usually precedes the translocation of silicate clay minerals. Many of the soils are moderately to strongly leached. For example, Melita soils are leached of carbonates to a depth of 57 inches, whereas Kawkawlin soils are leached to a depth of only 24 inches. Other factors being equal, differences in the depth of leaching are a result of time as a soil-forming factor.

The reduction and transfer of iron, a process called gleying, is evident in the somewhat poorly drained, poorly drained, and very poorly drained soils. The gray color in the subsoil indicates the reduction and loss of iron. Gleying and the reduction processes are evident, for example, in Sims soils.

Leaching of bases and translocation of silicate clays are among the more important processes in horizon differentiation in soils. In some soils translocation of clay minerals has contributed to horizon development. The eluviated, or leached, A2 horizon above an illuviated B horizon commonly has a platy structure, is lower in content of clay, and typically is lighter in color. The B horizon typically has an accumulation of clay and clay films in pores and on ped surfaces. The soils were probably leached of carbonates and soluble salts to a considerable extent before the translocation of silicate clay. Nester soils are examples of soils having translocated clay accumulated in the B horizon.

In some soils iron, aluminum, and humus have moved from the A horizon to the B horizon. The color of the B horizon in such soils is dark brown. Au Gres, Croswell, and Gladwin soils are examples of soils in which translocated iron, aluminum, and humus have affected the B horizon.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (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 moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Blinding material. Material placed on top of and around a closed drain to improve the flow of water to the drain, prevent accumulation of sediment in the drainage tile, and hold the tile in place while the trench is being backfilled.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

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 oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A map unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

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; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave. Unstable walls of cuts made by earth-moving equipment. The soil sloughs easily.

Delta. An alluvial deposit, commonly triangular in shape, formed largely beneath water and deposited at the mouth of a river or stream.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, 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 classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Forb. Any herbaceous plant not a grass or a sedge.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the assorted and unassorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal

normally lives, as opposed to the range or geographical distribution.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

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 a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Leaching. The removal of soluble material from soil or other material by percolating water.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded 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 of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse* more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by water that originated mainly from the melting of glacial ice. Glacial outwash is commonly in valleys on landforms known as valley trains, outwash terraces, eskers, kame terraces, kames, outwash fans, or deltas.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil. A pan impedes the movement of water and the growth of roots. The word "pan" is commonly combined with other words that more explicitly indicate the nature of the layer; for example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the basis of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Polypedon. A volume of soil having properties within the limits of a soil series, the lowest and most homogeneous category of soil taxonomy. A "soil individual."

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and 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 described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil."

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. 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.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Slow refill. The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and 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.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of 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 characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the

processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

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, silt loam, 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."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tile drain. Concrete, plastic, or ceramic pipe installed at suitable depths and intervals in the soil to provide water outlets from the soil.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil (engineering). A presumably fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Trace elements. The chemical elements in soils, in only extremely small amounts, essential to plant growth. Examples are zinc, cobalt, manganese, copper, and iron.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

ILLUSTRATIONS

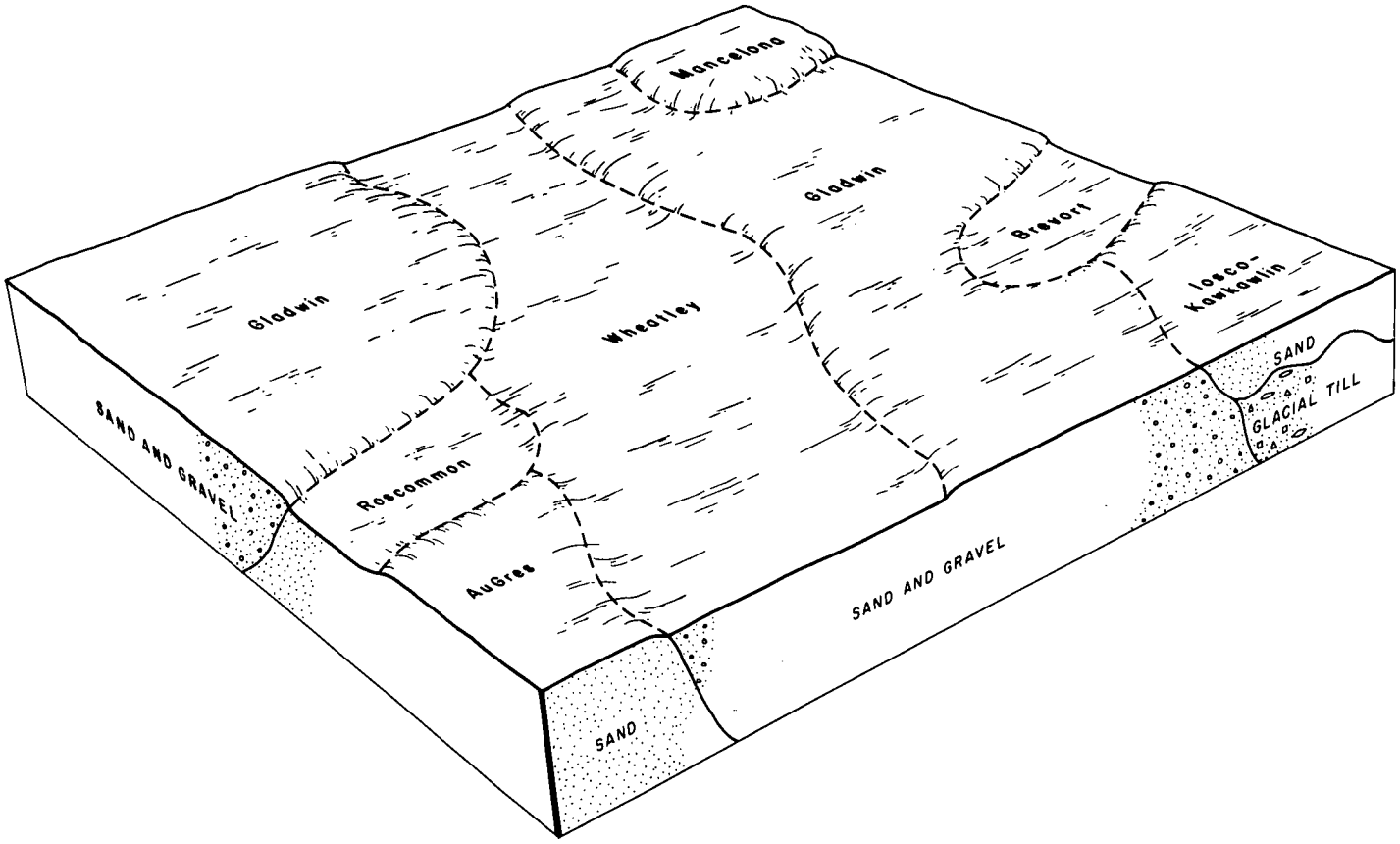

Figure 1..—Typical pattern of soils and underlying material in the Mancelona-Gladwin-Wheatley map unit.

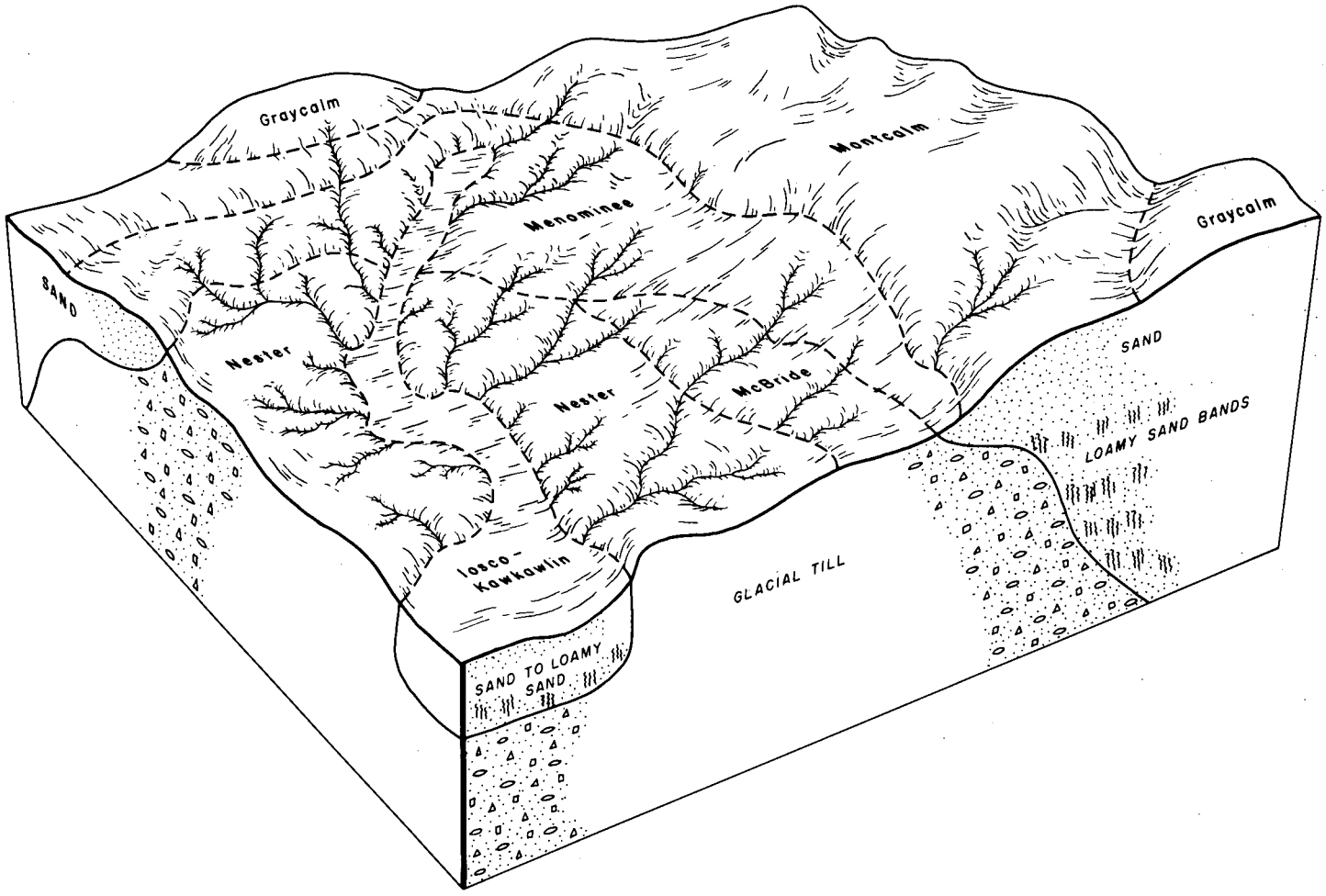

Figure 2.—Typical pattern of soils and underlying material in the Montcalm-Menominee-Nester map unit.

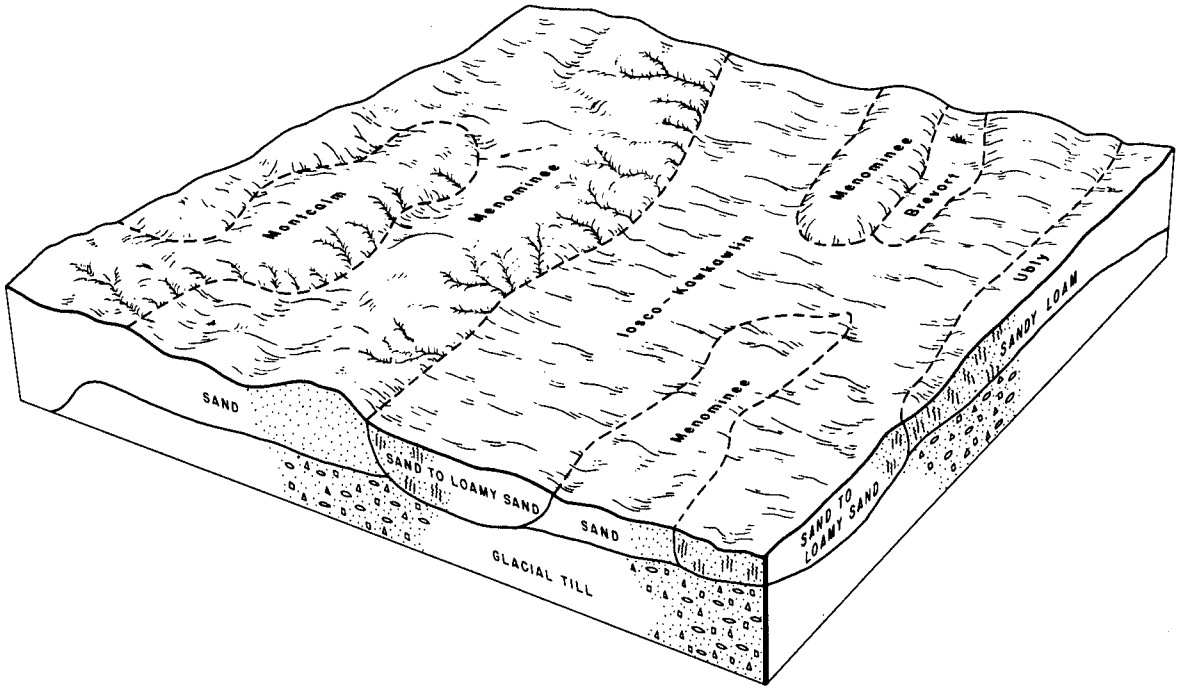

Figure 3.—Typical pattern of soils and underlying material in the Menominee-Iosco-Kawkawlin map unit.

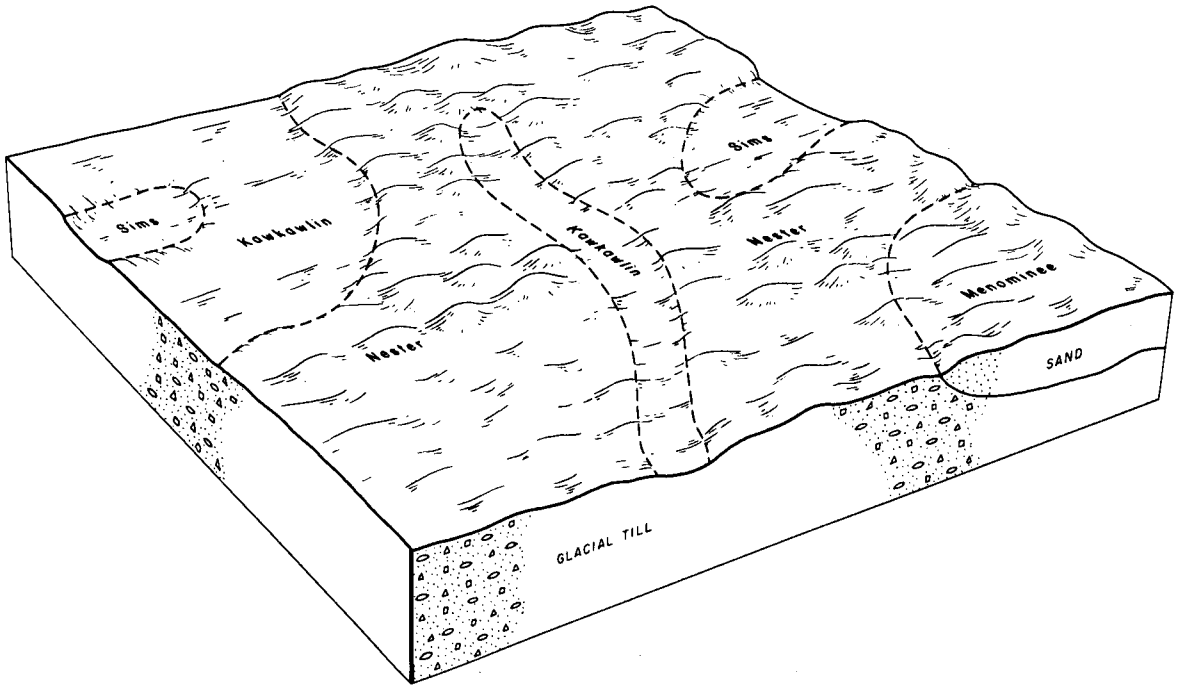

Figure 4.—Typical pattern of soils and underlying material in the Nester-Kawkawlin-Sims map unit.

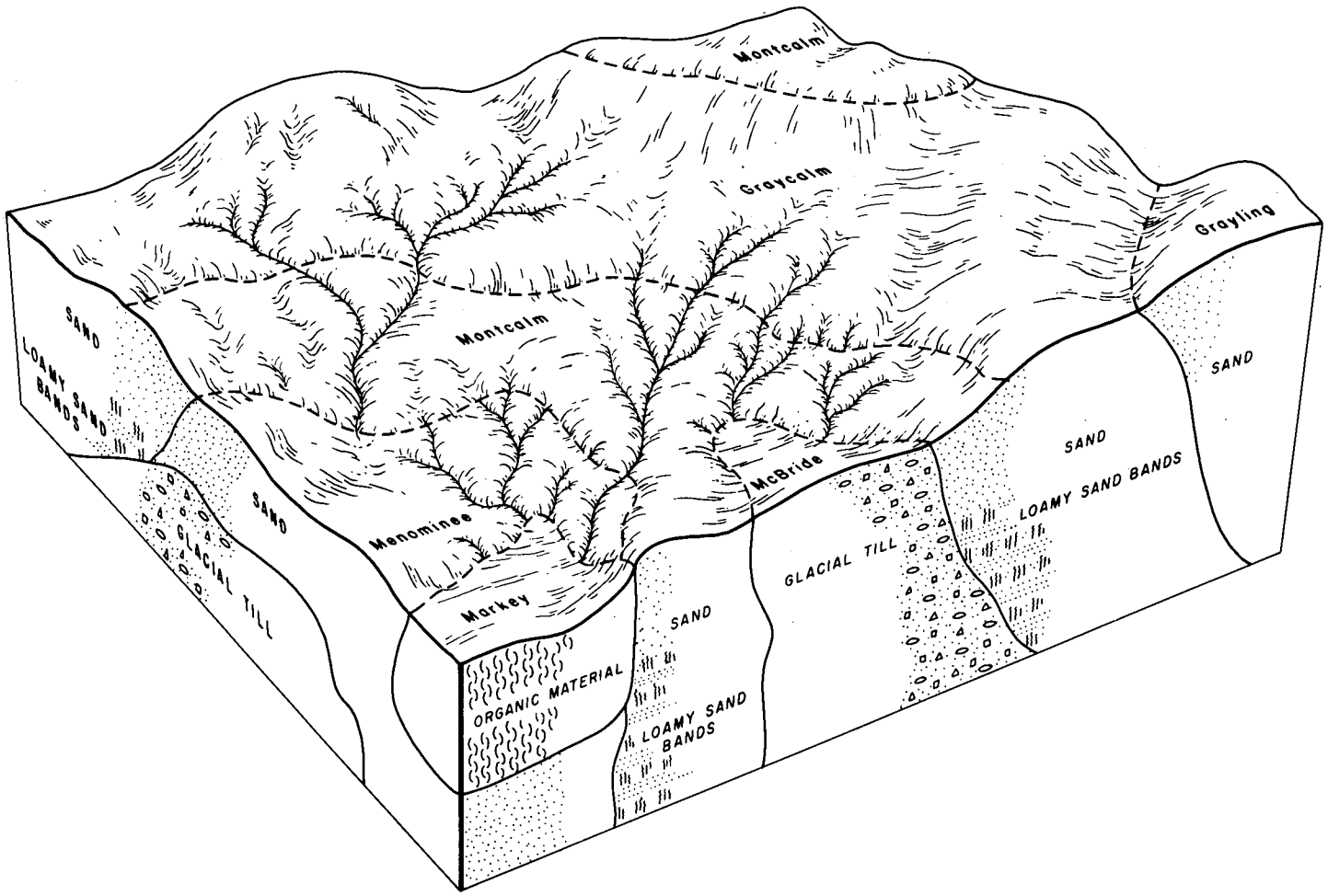

Figure 5.—Typical pattern of soils and underlying material in the Graycalm-Montcalm map unit.

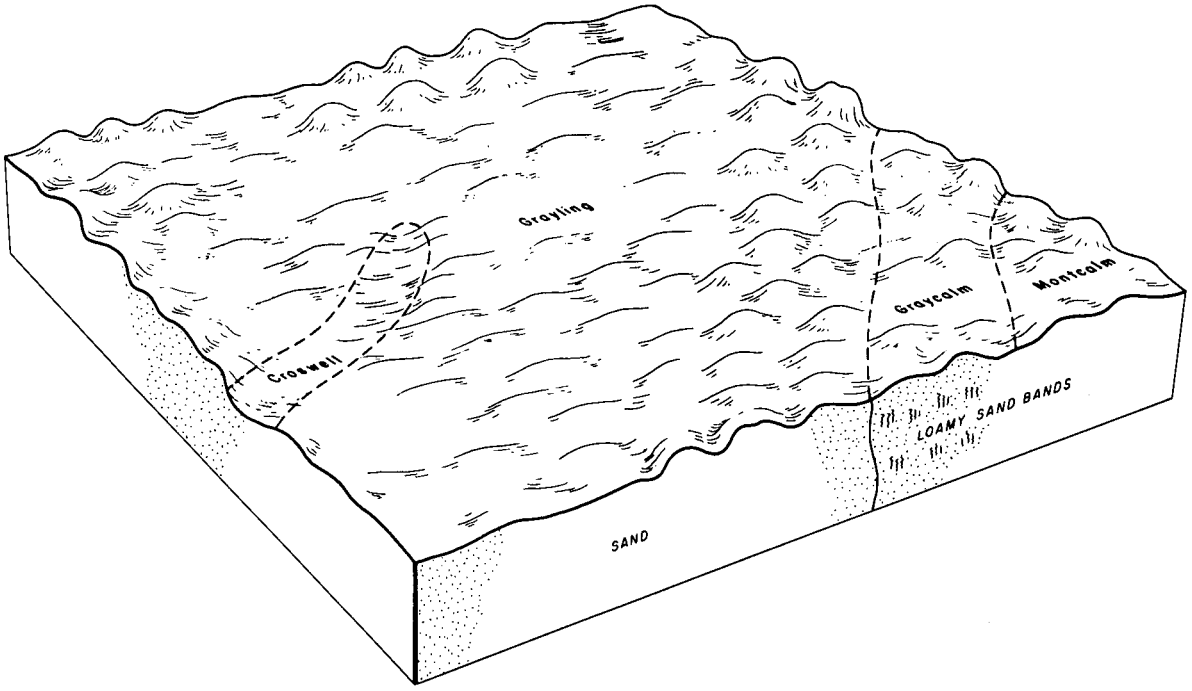

Figure 6.—Typical pattern of soils and underlying material in the Grayling map unit.

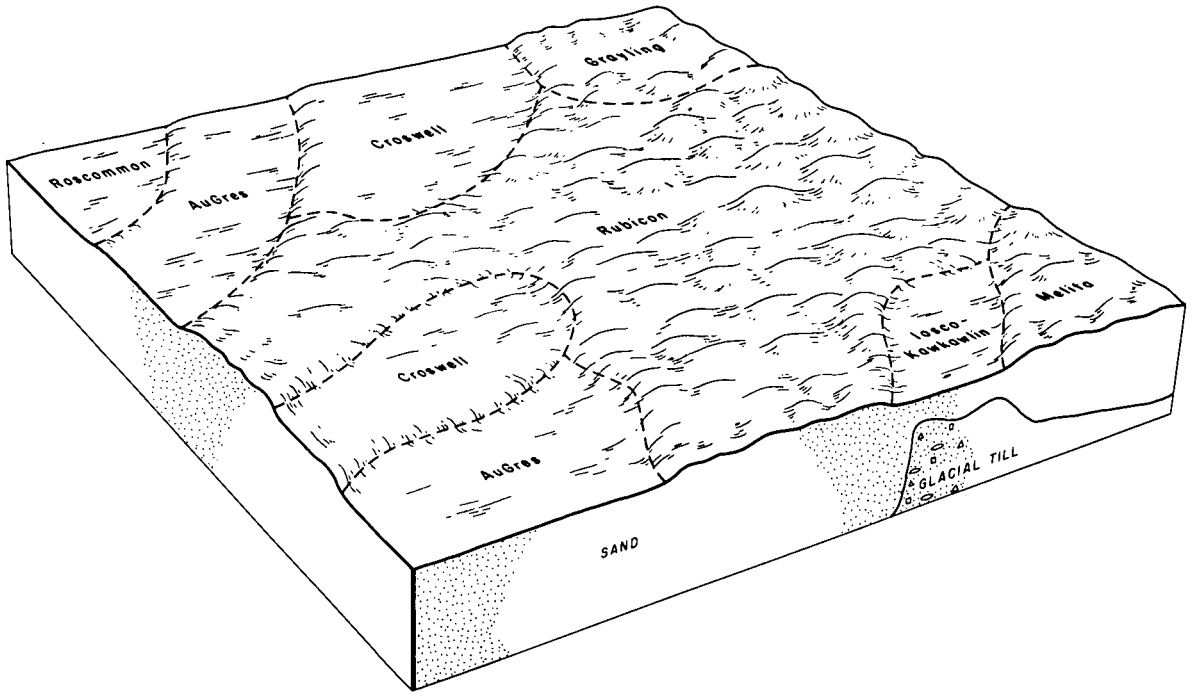

Figure 7.—Typical pattern of soils and underlying material in the Rubicon-Croswell-Au Gres map unit.

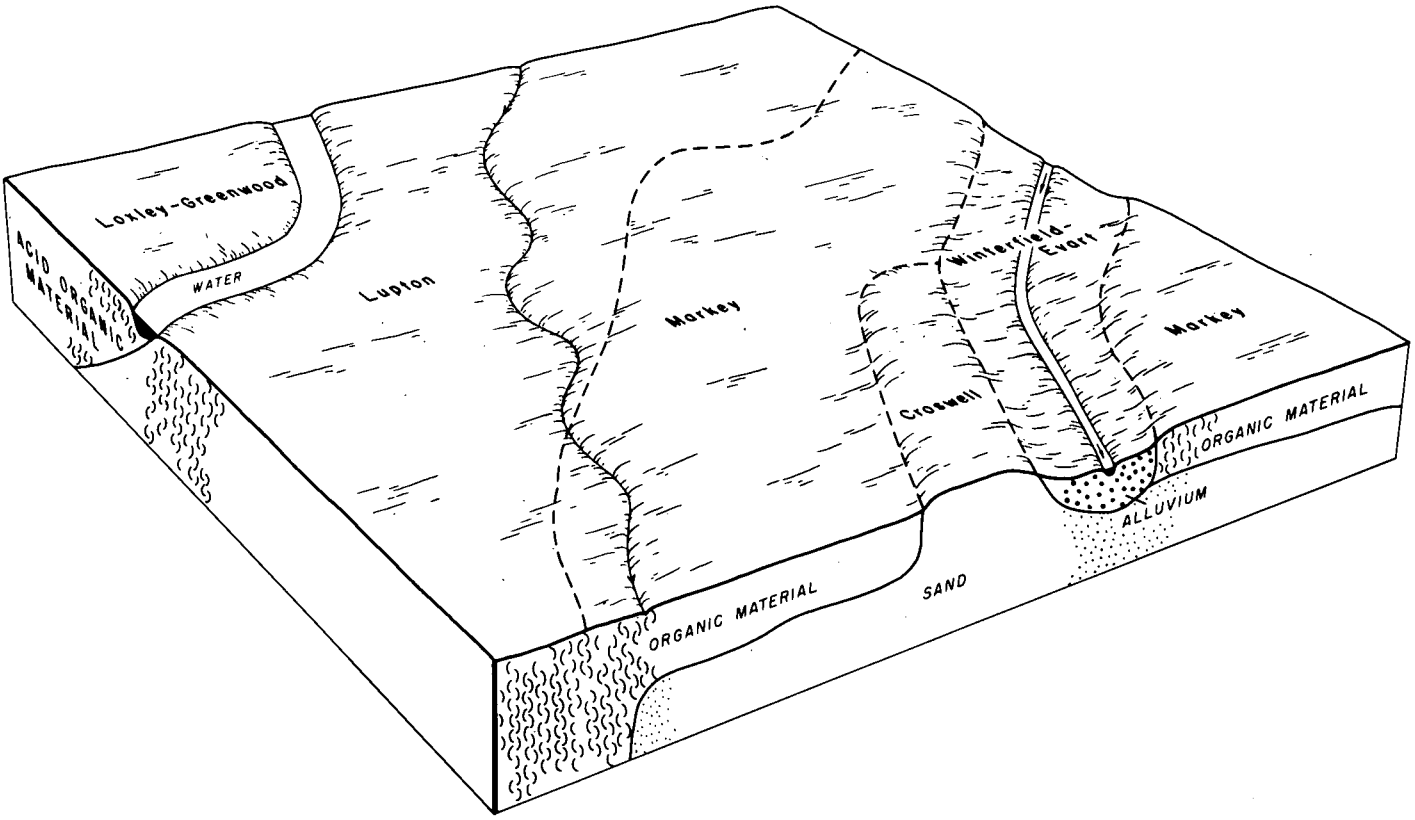

Figure 8.—Typical pattern of soils and underlying material in the Lupton-Markey map unit.

Figure 9.—Flooding in an area of Colonville fine sandy loam. The Tobacco River commonly floods this area. The house is on the boundary of the flood plain.

Figure 10.—A formerly cultivated area of Graycalm sand, 0 to 6 percent slopes, now used for timber production.

Figure 11.—A hilly area of Grayling sand, 18 to 35 percent slopes. Because the plant cover is sparse, snowmobile trails are easily established.

Figure 12.—A typical area of Markey muck, which is covered mostly with cattails and cedar. This soil is too unstable for foot traffic during most of the year.

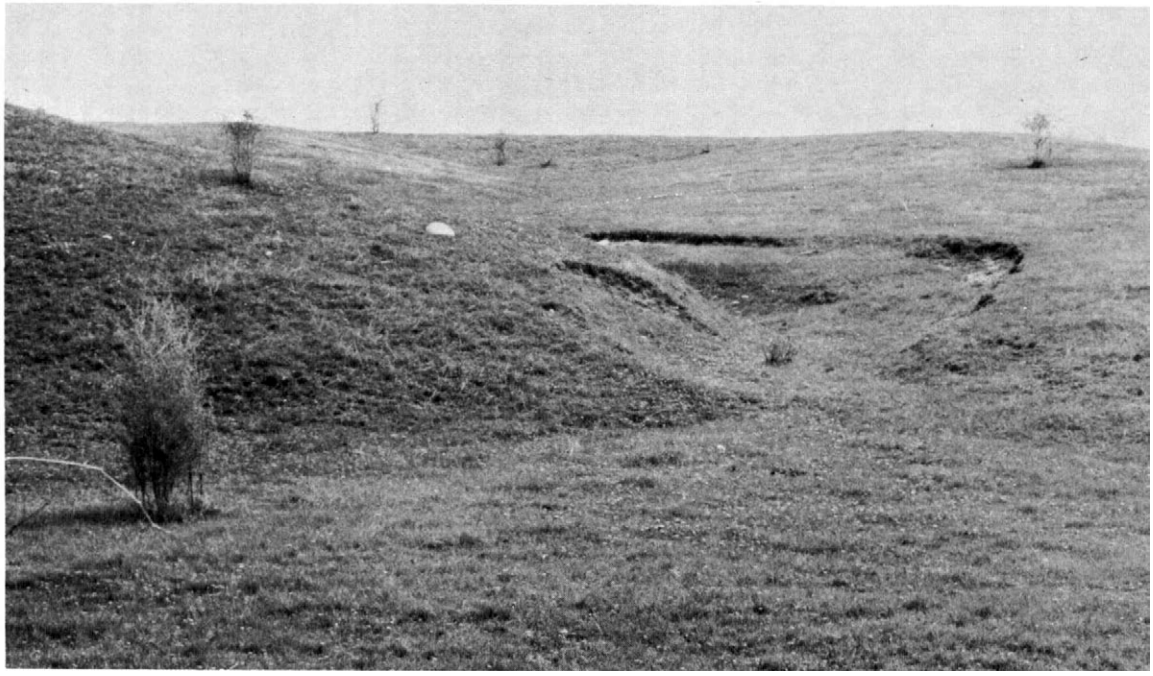

Figure 13.—Erosion on Nester loam, 12 to 18 percent slopes. The plant cover helps to control erosion.

Figure 14.—A typical area of Pits. Most of these areas are rough and have sparse plant cover.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

[Recorded in the period 1946-75 at Gladwin]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	28.8	11.2	20.0	50	-16	0	1.79	.9	2.5	5	13.1
February---	30.9	11.5	21.2	49	-15	0	1.48	.7	2.2	5	11.5
March------	39.9	20.3	30.1	68	-6	2	2.10	1.3	2.8	6	8.4
April------	55.7	32.0	43.9	82	14	47	2.93	1.8	3.9	6	2.3
May--------	67.9	41.6	54.7	89	25	199	3.04	1.8	4.2	7	T[2]
June-------	78.2	51.6	64.9	95	34	456	3.55	1.9	5.0	6	0
July-------	81.8	55.8	68.8	94	41	591	3.39	1.6	4.9	6	0
August-----	80.1	54.3	67.2	95	39	540	3.30	1.6	4.8	6	0
September--	71.4	46.1	58.8	91	27	285	3.14	1.8	4.3	7	T[2]
October----	61.6	37.5	49.5	84	18	107	2.61	1.1	3.9	6	.2
November---	44.8	27.7	36.2	69	5	8	2.56	1.7	3.3	6	4.1
December---	32.9	17.5	25.2	58	-10	0	2.41	1.2	3.5	6	11.6
Year------	56.2	33.9	45.0	98	-18	2,235	32.30	28.5	36.0	72	51.3

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

[2]Trace.

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1946-75 at Gladwin]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 5	May 19	June 3
2 years in 10 later than--	April 30	May 14	May 29
5 years in 10 later than--	April 21	May 5	May 20
First freezing temperature in fall:			
1 year in 10 earlier than--	October 4	September 22	September 9
2 years in 10 earlier than--	October 11	September 30	September 14
5 years in 10 earlier than--	October 23	October 10	September 24

TABLE 3.--GROWING SEASON LENGTH

[Recorded in the period 1946-75 at Gladwin]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	161	134	106
8 years in 10	169	142	113
5 years in 10	194	157	126
2 years in 10	199	173	139
1 year in 10	207	180	146

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
AuA	Au Gres loamy sand, 0 to 2 percent slopes	6,730	1.8
Br	Brevort loamy sand	3,460	1.0
Co	Colonville fine sandy loam	2,110	0.6
CrB	Croswell sand, 0 to 4 percent slopes	12,380	3.4
GaA	Gladwin loamy sand, 0 to 2 percent slopes	3,940	1.1
GrB	Graycalm sand, 0 to 6 percent slopes	40,160	11.0
GrC	Graycalm sand, 6 to 18 percent slopes	24,175	6.6
GrD	Graycalm sand, 18 to 35 percent slopes	4,190	1.1
GyB	Grayling sand, 0 to 6 percent slopes	29,465	8.1
GyC	Grayling sand, 6 to 18 percent slopes	3,125	0.9
GyD	Grayling sand, 18 to 35 percent slopes	515	0.1
Hs	Histosols, ponded	2,030	0.6
IkA	Iosco-Kawkawlin complex, 0 to 3 percent slopes	10,695	2.9
KwB	Kawkawlin loam, 0 to 4 percent slopes	10,725	2.9
Lg	Loxley and Greenwood mucky peats	3,100	0.9
Lu	Lupton muck	21,330	5.8
MaB	Mancelona loamy sand, 0 to 6 percent slopes	8,180	2.2
MaC	Mancelona loamy sand, 6 to 12 percent slopes	775	0.2
Mb	Markey muck	18,040	4.9
McB	McBride sandy loam, 2 to 6 percent slopes	8,735	2.4
McC	McBride sandy loam, 6 to 12 percent slopes	2,465	0.7
MeB	Melita sand, 0 to 6 percent slopes	2,590	0.7
MnB	Menominee loamy sand, 0 to 6 percent slopes	14,760	4.0
MnC	Menominee loamy sand, 6 to 12 percent slopes	3,250	0.9
MoC	Menominee-Montcalm loamy sands, 6 to 18 percent slopes	510	0.1
MtB	Montcalm loamy sand, 0 to 6 percent slopes	27,060	7.4
MtC	Montcalm loamy sand, 6 to 12 percent slopes	15,675	4.3
MtD	Montcalm loamy sand, 12 to 18 percent slopes	4,385	1.2
MtE	Montcalm loamy sand, 18 to 35 percent slopes	3,175	0.9
NeB	Nester loam, 2 to 6 percent slopes	20,000	5.5
NeC	Nester loam, 6 to 12 percent slopes	10,645	2.9
NeD	Nester loam, 12 to 18 percent slopes	3,270	0.9
OtA	Otisco loamy sand, 0 to 2 percent slopes	1,515	0.4
Pt	Pits	1,080	0.3
Rn	Rondeau muck	375	0.1
Ro	Roscommon mucky loamy sand	7,035	1.9
RuB	Rubicon sand, 0 to 6 percent slopes	9,170	2.5
RuC	Rubicon sand, 6 to 18 percent slopes	3,040	0.8
Sm	Sims clay loam	5,100	1.4
UbB	Ubly sandy loam, 2 to 6 percent slopes	2,315	0.6
Wh	Wheatley loamy sand	3,935	1.1
Wn	Winterfield-Evart complex	5,290	1.4
	Water	5,580	1.5
	Total	366,080	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[All yields were estimated for a high level of management. Only arable soils are listed. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil name and map symbol	Corn	Corn silage	Oats	Winter wheat	Grass-legume hay	Grass hay	Pasture
	Bu	Ton	Bu	Bu	Ton	Ton	AUM*
AuA---------- Au Gres	50	10	45	25	2.2	1.7	3.4
CrB---------- Croswell	50	10	45	30	2.5	1.8	3.6
GaA---------- Gladwin	65	12	60	33	2.8	2.1	4.2
GrB---------- Graycalm	50	10	40	25	2.5	1.6	3.2
GrC---------- Graycalm	---	---	---	---	2.3	1.5	3.0
GyB, GyC---------- Grayling	---	---	---	---	---	1.6	3.2
IkA---------- Iosco-Kawkawlin	87	16	80	41	3.8	3.0	6.0
KwB---------- Kawkawlin	95	16	85	45	4.0	3.2	6.4
MaB---------- Mancelona	70	13	60	40	3.0	2.4	4.8
MaC---------- Mancelona	65	12	55	35	2.6	2.2	4.8
McB---------- McBride	75	14	75	35	3.5	2.5	5.4
McC---------- McBride	70	13	70	30	3.3	2.3	5.0
MeB---------- Melita	45	8	35	25	2.2	1.8	3.0
MnB---------- Menominee	70	13	70	35	3.5	2.5	5.0
MnC---------- Menominee	65	12	65	30	3.3	2.3	4.6
MoC---------- Menominee-Montcalm	65	12	60	35	3.1	2.3	4.6
MtB---------- Montcalm	70	12	60	38	3.0	2.4	4.8
MtC---------- Montcalm	65	11	55	35	2.8	2.3	4.6
MtD---------- Montcalm	---	---	50	24	2.8	2.0	4.0
MtE---------- Montcalm	---	---	---	---	2.5	2.0	4.0
NeB---------- Nester	80	14	75	40	4.0	2.7	5.4

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Corn silage	Oats	Winter wheat	Grass-legume hay	Grass hay	Pasture
	Bu	Ton	Bu	Bu	Ton	Ton	AUM*
NeC---------- Nester	70	13	70	36	4.0	2.7	5.4
NeD---------- Nester	60	11	65	32	3.8	2.7	5.4
OtA---------- Otisco	70	13	65	30	3.0	2.5	5.0
RuB, RuC---------- Rubicon	---	---	---	---	---	1.6	3.2
UbB---------- Ubly	85	14	75	45	3.8	2.7	5.4

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

TABLE 6.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas excluded. Absence of an entry means no acreage]

Class	Total acreage	Major management concerns (Subclass)			
		Erosion (e)	Wetness (w)	Soil problem (s)	Climate (c)
		Acres	Acres	Acres	Acres
I	---	---	---	---	---
II	41,775	31,050	10,725	---	---
III	94,470	33,320	16,150	50,000	---
IV	69,515	7,655	6,730	55,130	---
V	36,310	---	36,310	---	---
VI	91,060	3,175	25,075	62,810	---
VII	16,160	---	5,290	10,870	---
VIII	5,130	---	5,130	---	---

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed in this table. Absence of an entry in a column means the information was not available]

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
AuA---------- Au Gres	Slight	Slight	Severe	Slight	Slight	Quaking aspen	60	White spruce, black spruce, eastern white pine, northern white-cedar, Norway spruce, Austrian pine, white ash.
						Bigtooth aspen	60	
						Balsam fir	53	
						Paper birch	55	
						Sugar maple	53	
						Red maple	56	
						Eastern hemlock	---	
						Eastern white pine	53	
Br---------- Brevort	Slight	Severe	Severe	Severe	Severe	Quaking aspen	40	
						Sugar maple	40	
						Balsam fir	40	
						Northern white-cedar	15	
						American basswood	40	
						Red maple	40	
						Silver maple	65	
						Black spruce	15	
Co---------- Colonville	Slight	Slight	Slight	Slight	Moderate	Red maple	61	White spruce, eastern cottonwood, eastern white pine, northern white-cedar, Norway spruce, red maple, northern red oak.
						Sugar maple	61	
						Swamp white oak	66	
						American basswood	65	
						Northern white-cedar	45	
						White ash	65	
						Balsam fir	61	
CrB---------- Croswell	Slight	Slight	Severe	Slight	Severe	Red pine	61	Red pine, eastern white pine, jack pine, black cherry, red maple.
						Quaking aspen	70	
						Jack pine	65	
						Northern red oak	66	
						Black cherry	---	
						Eastern white pine	61	
						Bigtooth aspen	70	
						Red maple	66	
GaA---------- Gladwin	Slight	Slight	Moderate	Slight	Slight	Quaking aspen	60	White spruce, black spruce, eastern white pine, northern white-cedar, Norway spruce, Austrian pine.
						Sugar maple	53	
						Eastern hemlock	---	
						Eastern white pine	53	
						Red maple	56	
						Bigtooth aspen	60	
						Balsam fir	53	
						Paper birch	55	
						White spruce	53	
GrB, GrC---------- Graycalm	Slight	Slight	Severe	Slight	Moderate	Sugar maple	61	Red pine, eastern white pine, jack pine, white spruce.
						Northern red oak	66	
						Red pine	61	
						Jack pine	65	
						Quaking aspen	70	
						Paper birch	60	
						Eastern white pine	60	
						American beech	---	
GrD---------- Graycalm	Moderate	Moderate	Severe	Slight	Moderate	Sugar maple	61	Red pine, eastern white pine, jack pine, white spruce.
						Northern red oak	66	
						Red pine	61	
						Jack pine	65	
						Quaking aspen	70	
						Paper birch	60	
						Eastern white pine	60	
						American beech	---	

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
GyB, GyC---------- Grayling	Slight	Slight	Severe	Slight	Slight	Jack pine----------	45	Jack pine, red pine.
						Northern pin oak----	45	
						White oak----------	45	
						Red pine----------	45	
						Quaking aspen-------	50	
GyD---------- Grayling	Moderate	Moderate	Severe	Slight	Slight	Jack pine----------	45	Jack pine, red pine.
						Northern pin oak----	45	
						White oak----------	45	
						Red pine----------	45	
						Quaking aspen-------	50	
IkA*:								
Iosco----------	Slight	Slight	Severe	Slight	Slight	Quaking aspen-------	60	White spruce, black spruce, eastern white pine, northern white-cedar, Norway spruce, Austrian pine.
						White ash----------	55	
						Sugar maple---------	53	
						Red maple----------	56	
						Yellow birch--------	53	
						Northern pin oak----	56	
						Eastern white pine--	53	
Kawkawlin---------	Slight	Moderate	Slight	Slight	Moderate	Sugar maple---------	61	White spruce, red pine, Norway spruce, Austrian pine.
						Northern red oak----	66	
						Swamp white oak-----	66	
						Red maple----------	66	
						White ash----------	65	
						Shagbark hickory----	---	
						American basswood---	65	
						Quaking aspen-------	70	
						Bigtooth aspen------	70	
KwB---------- Kawkawlin	Slight	Slight	Slight	Slight	Moderate	Sugar maple---------	61	White spruce, red pine, Norway spruce, Austrian pine.
						Northern red oak----	66	
						Swamp white oak-----	66	
						Red maple----------	66	
						White ash----------	65	
						Shagbark hickory----	---	
						American basswood---	65	
						Quaking aspen-------	70	
						Bigtooth aspen------	70	
Lg*:								
Loxley----------	Slight	Severe	Severe	Severe	Severe	Balsam fir----------	39	
						Black spruce--------	15	
						European larch------	---	
						Tamarack-----------	35	
						Jack pine----------	39	
						Northern white-cedar	15	
						White spruce--------	40	
Greenwood---------	Slight	Severe	Severe	Severe	Severe	Balsam fir----------	39	
						Black spruce--------	15	
						Tamarack-----------	35	
						Red maple----------	40	
						Silver maple--------	65	
						Black cherry--------	---	
Lu---------- Lupton	Slight	Severe	Severe	Severe	Severe	Balsam fir----------	42	
						Black ash----------	11	
						Northern white-cedar	26	
						Paper birch---------	45	
						Silver maple--------	66	
						Quaking aspen-------	46	
						Black spruce--------	41	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
MaB, MaC---------- Mancelona	Slight	Slight	Moderate	Slight	Moderate	Sugar maple----------	61	Red pine, eastern white pine, Austrian pine, jack pine, white spruce.
						Northern red oak----	66	
						Red pine----------	61	
						Jack pine----------	65	
						Eastern white pine--	61	
						Quaking aspen-------	70	
Mb---------- Markey	Slight	Severe	Severe	Severe	Severe	Balsam fir----------	40	
						Black spruce--------	15	
						Tamarack----------	35	
						Black ash----------	37	
						Quaking aspen-------	45	
						Northern white-cedar	15	
						Paper birch---------	40	
McB, McC---------- McBride	Slight	Slight	Moderate	Moderate	Moderate	Sugar maple---------	61	White spruce, eastern white pine, Norway spruce.
						Yellow birch--------	61	
						American basswood---	65	
						Eastern hemlock-----	---	
						Balsam fir----------	61	
						Northern red oak----	66	
						Red pine----------	61	
						Quaking aspen-------	70	
						Eastern white pine--	61	
MeB---------- Melita	Slight	Slight	Severe	Slight	Moderate	Sugar maple---------	61	Red pine, eastern white pine.
						Quaking aspen-------	70	
						Red pine----------	61	
						Red maple----------	66	
						Eastern white pine--	61	
						Yellow birch--------	61	
						American basswood---	65	
						Black cherry--------	---	
						American beech------	---	
MnB, MnC---------- Menominee	Slight	Slight	Moderate	Slight	Moderate	Sugar maple---------	61	Red pine, black walnut.
						Quaking aspen-------	---	
						Red pine----------	---	
						Silver maple--------	---	
						Paper birch---------	---	
						Yellow birch--------	---	
						American basswood---	---	
						Black cherry--------	---	
MoC*:								
Menominee---------	Slight	Slight	Moderate	Slight	Moderate	Sugar maple---------	61	Red pine, black walnut.
						Quaking aspen-------	---	
						Red pine----------	---	
						Silver maple--------	---	
						Paper birch---------	---	
						Yellow birch--------	---	
						American basswood---	---	
						Black cherry--------	---	
Montcalm----------	Slight	Slight	Moderate	Slight	Moderate	Sugar maple---------	61	Red pine, eastern white pine, Austrian pine, jack pine, white spruce.
						Quaking aspen-------	---	
						Northern red oak----	66	
						Eastern white pine--	61	
						Red pine----------	61	
MtB, MtC, MtD------ Montcalm	Slight	Slight	Moderate	Slight	Moderate	Sugar maple---------	61	Red pine, eastern white pine, Austrian pine, jack pine, white spruce.
						Quaking aspen-------	---	
						Northern red oak----	66	
						Eastern white pine--	61	
						Red pine----------	61	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
MtE---------- Montcalm	Moderate	Moderate	Moderate	Slight	Moderate	Sugar maple----------	61	Red pine, eastern white pine, Austrian pine, jack pine, white spruce.
						Quaking aspen--------	---	
						Northern red oak-----	66	
						Eastern white pine--	61	
						Red pine------------	61	
NeB, NeC, NeD------ Nester	Slight	Slight	Slight	Slight	Moderate	Sugar maple----------	61	White spruce, red pine, Norway spruce, Austrian pine.
						Quaking aspen--------	70	
						White ash-----------	65	
						American basswood----	65	
						Northern red oak-----	66	
						White oak-----------	66	
						Black cherry--------	---	
OtA---------- Otisco	Slight	Slight	Severe	Slight	Slight	Quaking aspen--------	60	White spruce, black spruce.
						Sugar maple----------	---	
						Balsam fir-----------	---	
						Red maple------------	---	
						White ash-----------	---	
						American basswood----	---	
Ro---------- Roscommon	Slight	Severe	Severe	Moderate	Severe	Quaking aspen--------	45	
						Black spruce---------	46	
						Northern white-cedar	---	
						Jack pine-----------	42	
						Silver maple---------	---	
						Red maple------------	---	
						Yellow birch---------	---	
						Balsam fir-----------	---	
						Eastern hemlock------	---	
RuB, RuC---------- Rubicon	Slight	Slight	Severe	Slight	Moderate	Red pine------------	61	Red pine, eastern white pine, jack pine.
						Bigtooth aspen------	60	
						Balsam fir-----------	40	
						Jack pine-----------	45	
						Northern red oak-----	56	
						Quaking aspen--------	60	
						Red maple------------	56	
						Paper birch----------	56	
Sm---------- Sims	Slight	Severe	Moderate	Moderate	Severe	Red maple------------	66	Eastern white pine, white spruce, northern white-cedar, Norway spruce.
						White ash-----------	65	
						American basswood----	65	
						Silver maple---------	86	
						Black spruce---------	45	
						Quaking aspen--------	70	
						Northern white-cedar	45	
						Balsam fir-----------	61	
						Bigtooth aspen------	70	
UbB---------- Ubly	Slight	Slight	Slight	Slight	Moderate	Sugar maple----------	61	White spruce, red pine, eastern white pine, Norway spruce.
						Northern red oak-----	66	
						Red pine------------	61	
						Black cherry--------	---	
						Quaking aspen--------	70	
						Eastern white pine--	61	
						White ash-----------	65	
						American beech------	---	
Wh---------- Wheatley	Slight	Severe	Severe	Severe	Severe	Quaking aspen--------	45	
						Balsam fir-----------	40	
						Northern white-cedar	15	
						Black spruce---------	15	
						Red maple------------	40	
						Eastern hemlock------	---	
						Swamp white oak------	---	
						Sugar maple----------	40	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Common trees	Site index	
Wn*:								
Winterfield	Slight	Slight	Moderate	Slight	Slight	Quaking aspen	60	White spruce, eastern white pine, black spruce, northern white-cedar.
						Yellow birch	53	
						White spruce	53	
						White ash	55	
						Balsam fir	53	
						Black spruce	32	
						Eastern white pine	53	
Evart	Slight	Severe	Severe	Severe	Severe	Quaking aspen	45	Northern white-cedar, black spruce, eastern white pine.
						American basswood	---	
						Northern white-cedar	---	
						Black spruce	---	
						Swamp white oak	---	

* See map unit description for the composition and behavior of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; the symbol > means greater than. Absence of an entry means that trees of the height class do not normally grow on this soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
AuA---------- Au Gres	---	White spruce, silky dogwood, American cranberrybush, blue spruce, Amur privet.	Black spruce, northern white-cedar, eastern white pine, Austrian pine.	---	Green ash, Carolina poplar, white ash.
Br. Brevort					
Co---------- Colonville	---	White spruce, silky dogwood, Amur honeysuckle, whitebelle honeysuckle, Amur privet, blue spruce.	Eastern white pine, tall purple willow, northern white-cedar, black spruce.	---	Green ash, Carolina poplar.
CrB---------- Croswell	Vanhoutte spirea	Lilac, arrowwood, white spruce, Amur privet, blue spruce, autumn-olive.	American mountainash, eastern white pine.	Red pine, jack pine, Scotch pine.	---
GaA---------- Gladwin	---	White spruce, black spruce, American cranberrybush, Amur honeysuckle, blue spruce, Amur privet, silky dogwood.	Northern white-cedar, Siberian crabapple, tall purple willow.	Eastern white pine	Green ash.
GrB, GrC, GrD----- Graycalm	Vanhoutte spirea	White spruce, lilac, arrowwood, blue spruce, Amur privet.	Red pine, jack pine, eastern white pine, northern pin oak, Norway spruce.	---	Carolina poplar.
GyB, GyC, GyD----- Grayling	Vanhoutte spirea	Lilac, autumn-olive, Amur privet, white spruce.	Jack pine, eastern white pine, red pine.	---	---
Hs*. Histosols					
IkA*: Iosco----------	---	White spruce, Amur honeysuckle, Amur privet, blue spruce, silky dogwood.	Black spruce, northern white-cedar.	Eastern white pine	White ash, green ash.
Kawkawlin---------	Vanhoutte spirea	White spruce, blue spruce, arrowwood, lilac, Tatarian honeysuckle.	Red pine, Scotch pine, jack pine.	Eastern white pine	Red maple, Carolina poplar.
KwB---------- Kawkawlin	Vanhoutte spirea	White spruce, blue spruce, arrowwood, lilac, Tatarian honeysuckle.	Red pine, Scotch pine, jack pine.	Eastern white pine	Red maple, Carolina poplar.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Lg*:					
Loxley	---	Black spruce, silky dogwood, arrowwood, Amur privet, white spruce.	Eastern white pine	Northern white-cedar.	Carolina poplar.
Greenwood	---	Black spruce, silky dogwood, arrowwood, Amur privet, white spruce.	Eastern white pine, Norway spruce.	Northern white-cedar.	Carolina poplar.
Lu Lupton	---	Black spruce, silky dogwood, Amur privet, white spruce.	Austrian pine, nannyberry viburnum.	Scotch pine, eastern white pine, northern white-cedar.	Green ash, Carolina poplar.
MaB, MaC Mancelona	Vanhoutte spirea	White spruce, lilac, Amur honeysuckle, blue spruce, Amur privet.	Red pine, jack pine, Scotch pine, eastern white pine, Norway spruce.	---	Carolina poplar.
Mb Markey	---	Silky dogwood, white spruce, Amur privet.	Austrian pine, eastern white pine.	Scotch pine, northern white-cedar.	Carolina poplar, green ash.
McB, McC McBride	Vanhoutte spirea	White spruce, Amur privet, lilac, silky dogwood.	Hawthorn, jack pine, red pine, black spruce, northern white-cedar.	Eastern white pine	Green ash.
MeB Melita	---	Autumn-olive, Amur honeysuckle, white spruce, blue spruce, lilac, Amur privet.	Red pine, jack pine, Scotch pine, eastern white pine, black spruce.	---	Carolina poplar.
MnB, MnC Menominee	---	Amur honeysuckle, white spruce, blue spruce.	Red pine, jack pine.	---	Red maple.
MoC*:					
Menominee	---	Amur honeysuckle, white spruce, blue spruce.	Red pine, jack pine.	---	Red maple.
Montcalm	Vanhoutte spirea	White spruce, Siberian crabapple, nannyberry viburnum, blue spruce, lilac, Amur honeysuckle, autumn-olive, Amur privet.	Red pine, Scotch pine.	---	Carolina poplar.
MtB, MtC, MtD, MtE Montcalm	Vanhoutte spirea	White spruce, Siberian crabapple, nannyberry viburnum, blue spruce, lilac, Amur honeysuckle, autumn-olive, Amur privet.	Red pine, Scotch pine.	---	Carolina poplar.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
NeB, NeC, NeD----- Nester	Vanhoutte spirea	Arrowwood, lilac, blue spruce, white spruce, Amur privet.	Red pine, Scotch pine, northern pin oak, jack pine.	Eastern white pine	Carolina poplar.
OtA----------- Otisco	---	Silky dogwood-----	Black spruce, northern white-cedar, tall purple willow.	Red maple----------	Carolina poplar, white ash.
Pt*. Pits					
Rn. Rondeau					
Ro----------- Roscommon	---	Arrowwood, hawthorn, Amur privet, nannyberry viburnum, silky dogwood, tamarack, whitebelle honeysuckle.	Eastern white pine, black spruce, northern white-cedar.	---	Carolina poplar.
RuB, RuC----------- Rubicon	Vanhoutte spirea	Autumn-olive, Amur privet, lilac, white spruce.	Hawthorn----------	Red pine, eastern white pine, jack pine.	---
Sm----------- Sims	---	Austrian pine, hawthorn, silky dogwood, white spruce.	Black spruce, northern white-cedar, eastern white pine, green ash.	---	---
UbB----------- Ubly	---	White spruce, arrowwood, lilac, silky dogwood, blue spruce, autumn-olive, Amur privet.	Red pine, Norway spruce, Scotch pine.	---	Red maple, Carolina poplar.
Wh----------- Wheatley	---	Silky dogwood, white spruce, Tatarian honeysuckle, arrowwood, Amur honeysuckle.	Northern white-cedar, tall purple willow, eastern white pine, black spruce, Norway spruce.	---	Green ash, Carolina poplar.
Wn*: Winterfield------	---	White spruce, Amur privet, silky dogwood, Amur honeysuckle, blue spruce.	Black spruce, northern white-cedar.	Eastern white pine	Red maple, Carolina poplar, green ash.
Evart----------	---	Tatarian honeysuckle, arrowwood, hawthorn, white spruce, Siberian crabapple, silky dogwood.	Eastern white pine, northern white-cedar, tamarack, green ash.	---	---

* See map unit description for the composition and behavior of the map unit.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
AuA---------- Au Gres	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Br---------- Brevort	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action, floods.
Co---------- Colonville	Severe: floods, wetness, cutbanks cave.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, frost action, wetness.
CrB---------- Croswell	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
GaA---------- Gladwin	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.
GrB---------- Graycalm	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight.
GrC---------- Graycalm	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
GrD---------- Graycalm	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
GyB---------- Grayling	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight.
GyC---------- Grayling	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
GyD---------- Grayling	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hs*. Histosols					
IkA*: Iosco----------	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.
Kawkawlin---------	Severe: wetness.	Severe: wetness, low strength.	Severe: wetness.	Severe: wetness, low strength.	Severe: frost action, low strength, wetness.
KwB---------- Kawkawlin	Severe: wetness.	Severe: wetness, low strength.	Severe: wetness.	Severe: wetness, low strength.	Severe: frost action, low strength, wetness.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Lg*:					
Loxley	Severe: wetness, floods, excess humus.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.
Greenwood	Severe: wetness, floods, excess humus.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.
Lu Lupton	Severe: wetness, floods, excess humus.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.
MaB Mancelona	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
MaC Mancelona	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Mb Markey	Severe: wetness, floods, cutbanks cave.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: low strength, wetness, floods.
McB McBride	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: frost action.
McC McBride	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: slope, wetness.	Moderate: slope, frost action.
MeB Melita	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
MnB Menominee	Severe: cutbanks cave.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, wetness, low strength.	Moderate: shrink-swell, low strength.	Slight.
MnC Menominee	Severe: cutbanks cave.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Moderate: slope.
MoC*:					
Menominee	Severe: cutbanks cave.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Moderate: slope.
Montcalm	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
MtB Montcalm	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
MtC Montcalm	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
MtD, MtE Montcalm	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
NeB---- Nester	Moderate: too clayey.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength, slope.	Severe: low strength.
NeC---- Nester	Moderate: too clayey, slope.	Moderate: low strength, shrink-swell, slope.	Moderate: shrink-swell, slope, low strength.	Severe: slope.	Severe: low strength.
NeD---- Nester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
OtA---- Otisco	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Pt*. Pits					
Rn---- Rondeau	Severe: wetness, excess humus, floods.	Severe: floods, wetness, low strength.	Severe: floods, low strength, wetness.	Severe: floods, low strength, wetness.	Severe: floods, low strength, wetness.
Ro---- Roscommon	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
RuB---- Rubicon	Severe: cutbanks cave.	Slight----	Slight----	Slight----	Slight.
RuC---- Rubicon	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Sm---- Sims	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, low strength, floods.
UbB---- Ubly	Slight----	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, low strength.	Moderate: slope, low strength, shrink-swell.	Moderate: frost action.
Wh---- Wheatley	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Wn*: Winterfield----	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Evart----	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.

* See map unit description for the composition and behavior of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils. Absence of an entry means soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
AuA--- Au Gres	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: too sandy, wetness, seepage.
Br--- Brevort	Severe: wetness, percs slowly, floods.	Severe: wetness, seepage, floods.	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Poor: wetness.
Co--- Colonville	Severe: floods, wetness.	Severe: seepage, floods, wetness.	Severe: seepage, floods, wetness.	Severe: seepage, floods, wetness.	Poor: too sandy, wetness, seepage.
CrB--- Croswell	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
GaA--- Gladwin	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, too sandy, seepage.	Severe: wetness, seepage.	Poor: wetness.
GrB--- Graycalm	Slight---	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
GrC--- Graycalm	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
GrD--- Graycalm	Severe: slope.	Severe: seepage, slope.	Severe: seepage, too sandy, slope.	Severe: seepage, slope.	Poor: too sandy, seepage, slope.
GyB--- Grayling	Slight---	Severe: seepage.	Severe: too sandy, seepage.	Severe: seepage.	Poor: too sandy, seepage.
GyC--- Grayling	Moderate: slope.	Severe: slope, seepage.	Severe: too sandy, seepage.	Severe: seepage.	Poor: too sandy, seepage.
GyD--- Grayling	Severe: slope.	Severe: slope, seepage.	Severe: too sandy, seepage, slope.	Severe: seepage, slope.	Poor: too sandy, slope, seepage.
Hs*. Histosols					
IkA*: Iosco---	Severe: wetness, percs slowly.	Severe: wetness, seepage.	Severe: wetness.	Severe: wetness, seepage.	Poor: too sandy, wetness.
Kawkawlin---	Severe: wetness, percs slowly.	Slight---	Severe: wetness.	Severe: wetness.	Poor: wetness.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
KwB---------- Kawkawlin	Severe: wetness, percs slowly.	Slight----------	Severe: wetness.	Severe: wetness.	Poor: wetness.
Lg*:					
Loxley----------	Severe: wetness, floods, percs slowly.	Severe: floods, seepage, excess humus.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness, excess humus.
Greenwood----------	Severe: wetness, floods.	Severe: wetness, excess humus, seepage.	Severe: wetness, floods.	Severe: wetness, floods, seepage.	Poor: excess humus, wetness.
Lu---------- Lupton	Severe: wetness, floods, subsides.	Severe: wetness, seepage, excess humus.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness, excess humus.
MaB---------- Mancelona	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: small stones, too sandy.
MaC---------- Mancelona	Moderate: slope.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: small stones, too sandy.
Mb---------- Markey	Severe: floods, wetness, subsides.	Severe: seepage, wetness, excess humus.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Poor: excess humus, wetness.
McB---------- McBride	Severe: percs slowly, wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: wetness, seepage.	Poor: wetness.
McC---------- McBride	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness.	Severe: wetness, seepage.	Poor: wetness.
MeB---------- Melita	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
MnB---------- Menominee	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness.	Severe: seepage, wetness.	Poor: too sandy, seepage.
MnC---------- Menominee	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Severe: seepage.	Poor: too sandy, seepage.
MoC*:					
Menominee----------	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Severe: seepage.	Poor: too sandy, seepage.
Montcalm----------	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
MtB---------- Montcalm	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
MtC---------- Montcalm	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
MtD, MtE---------- Montcalm	Severe: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage, slope.	Poor: slope, too sandy, seepage.
NeB---------- Nester	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
NeC---------- Nester	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
NeD---------- Nester	Severe: percs slowly, slope.	Severe: slope.	Moderate: too clayey, slope.	Severe: slope.	Poor: slope.
OtA---------- Otisco	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: seepage, wetness.	Fair: too sandy, seepage, wetness.
Pt*. Pits					
Rn---------- Rondeau	Severe: wetness, floods, percs slowly.	Severe: floods, seepage, wetness.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness, excess humus.
Ro---------- Roscommon	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy, seepage.
RuB---------- Rubicon	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
RuC---------- Rubicon	Moderate: slope.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
Sm---------- Sims	Severe: wetness, percs slowly, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
UbB---------- Ubly	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
Wh---------- Wheatley	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy, small stones.
Wn*: Winterfield---------	Severe: wetness, floods.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: too sandy, wetness, seepage.
Evart----------	Severe: wetness, floods.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: too sandy, wetness, seepage.

* See map unit description for the composition and behavior of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "unsuited." Absence of an entry means soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
AuA Au Gres	Poor: wetness.	Good	Unsuited: excess fines.	Poor: wetness.
Br Brevort	Poor: wetness, low strength.	Poor: thin layer.	Unsuited: excess fines.	Poor: wetness.
Co Colonville	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Good.
CrB Croswell	Fair: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
GaA Gladwin	Poor: wetness.	Good	Good	Fair: too sandy, small stones.
GrB, GrC Graycalm	Good	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
GrD Graycalm	Poor: slope.	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy, slope.
GyB, GyC Grayling	Good	Good	Unsuited: excess fines.	Poor: too sandy.
GyD Grayling	Poor: slope.	Good	Unsuited: excess fines.	Poor: too sandy, slope.
Hs*. Histosols				
IkA*: Iosco	Poor: wetness, low strength.	Poor: thin layer.	Unsuited: excess fines.	Fair: too sandy.
Kawkawlin	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
KwB Kawkawlin	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Lg*: Loxley	Poor: wetness, low strength.	Unsuited: excess humus.	Unsuited: excess humus.	Poor: wetness, excess humus.
Greenwood	Poor: wetness, low strength.	Unsuited: excess humus.	Unsuited: excess humus.	Poor: wetness, excess humus.
Lu Lupton	Poor: wetness, low strength.	Unsuited: excess humus.	Unsuited: excess humus.	Poor: wetness, excess humus.
MaB Mancelona	Good	Good	Good	Fair: too sandy.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
MaC--- Mancelona	Good	Good	Good	Fair: too sandy, slope.
Mb--- Markey	Poor: low strength, wetness.	Fair: excess fines.	Unsuited: excess fines, excess humus.	Poor: excess humus, wetness.
McB--- McBride	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer.
McC--- McBride	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer, slope.
MeB--- Melita	Fair: thin layer.	Fair: thin layer.	Unsuited: excess fines.	Poor: too sandy.
MnB--- Menominee	Poor: thin layer.	Poor: thin layer.	Unsuited: excess fines.	Fair: too sandy.
MnC--- Menominee	Poor: thin layer.	Poor: thin layer.	Unsuited: excess fines.	Fair: too sandy, slope.
MoC*: Menominee---	Poor: thin layer.	Poor: thin layer.	Unsuited: excess fines.	Fair: too sandy, slope.
Montcalm---	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer, slope.
MtB--- Montcalm	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer.
MtC--- Montcalm	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer, slope.
MtD, MtE--- Montcalm	Fair: slope.	Fair: excess fines.	Unsuited: excess fines.	Poor: slope.
NeB--- Nester	Poor: low strength.	Poor: thin layer.	Unsuited: excess fines.	Fair: thin layer.
NeC--- Nester	Poor: low strength.	Poor: thin layer.	Unsuited: excess fines.	Fair: slope, thin layer.
NeD--- Nester	Poor: low strength.	Poor: thin layer.	Unsuited: excess fines.	Poor: slope.
OtA--- Otisco	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: wetness.
Pt*. Pits				
Rn--- Rondeau	Poor: wetness, low strength.	Unsuited: excess humus, excess fines.	Unsuited: excess humus, excess fines.	Poor: wetness, excess humus.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ro---------- Roscommon	Poor: wetness.	Good----------	Unsuited: excess fines.	Poor: wetness, too sandy.
RuB, RuC---------- Rubicon	Good----------	Good----------	Unsuited: excess fines.	Poor: too sandy.
Sm---------- Sims	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
UbB---------- Ubly	Poor: low strength.	Poor: thin layer.	Unsuited: excess fines.	Good.
Wh---------- Wheatley	Poor: wetness.	Good----------	Good----------	Poor: wetness.
Wn*: Winterfield----------	Poor: wetness.	Good----------	Unsuited: excess fines.	Fair: too sandy.
Evart----------	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: wetness.

* See map unit description for the composition and behavior of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. Absence of an entry means soil was not evaluated]

Soil name and map symbol	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Terraces and diversions	Grassed waterways
AuA---------- Au Gres	Seepage, wetness.	Favorable------	Favorable------	Fast intake, droughty, wetness.	Not needed-----	Droughty, wetness.
Br---------- Brevort	Wetness---------	Slow refill----	Floods, frost action.	Fast intake, wetness, soil blowing.	Not needed-----	Wetness.
Co---------- Colonville	Piping---------	Favorable------	Floods, frost action.	Wetness, soil blowing, floods.	Wetness, too sandy, soil blowing.	Wetness.
CrB---------- Croswell	Seepage---------	Deep to water	Favorable------	Droughty, fast intake, wetness.	Too sandy, soil blowing, wetness.	Droughty.
GaA---------- Gladwin	Seepage, wetness.	Deep to water	Favorable------	Wetness, droughty, fast intake.	Not needed-----	Droughty, wetness.
GrB---------- Graycalm	Seepage---------	No water-------	Not needed-----	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
GrC---------- Graycalm	Seepage---------	No water-------	Not needed-----	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Slope, droughty.
GrD---------- Graycalm	Seepage---------	No water-------	Not needed-----	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
GyB---------- Grayling	Seepage---------	No water-------	Not needed-----	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
GyC---------- Grayling	Seepage---------	No water-------	Not needed-----	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Slope, droughty.
GyD---------- Grayling	Seepage---------	No water-------	Not needed-----	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
Hs*. Histosols						
IkA*: Iosco----------	Wetness---------	Slow refill----	Favorable------	Fast intake, wetness, soil blowing.	Not needed-----	Wetness, erodes easily.
Kawkawlin---------	Wetness---------	Slow refill----	Percs slowly, frost action.	Wetness, percs slowly, soil blowing.	Not needed-----	Percs slowly, wetness.
KwB---------- Kawkawlin	Wetness---------	Slow refill----	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Percs slowly, wetness.
Lg*: Loxley----------	Excess humus, wetness.	Favorable------	Floods, frost action.	Wetness, floods, soil blowing.	Not needed-----	Wetness.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Lg*: Greenwood	Excess humus, wetness.	Favorable	Floods, frost action.	Wetness, floods, soil blowing.	Not needed	Wetness.
Lu Lupton	Excess humus, wetness.	Favorable	Floods, frost action.	Wetness, soil blowing, floods.	Not needed	Wetness.
MaB Mancelona	Seepage, piping.	No water	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
MaC Mancelona	Seepage, piping.	No water	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Slope, droughty.
Mb Markey	Seepage, wetness, excess humus.	Slow refill	Floods, excess humus, frost action.	Wetness, soil blowing, floods.	Not needed	Wetness.
McB McBride	Wetness	Deep to water, slow refill.	Percs slowly	Droughty, wetness, soil blowing.	Wetness, rooting depth.	Wetness, droughty.
McC McBride	Wetness	Deep to water, slow refill.	Percs slowly, slope.	Droughty, wetness, soil blowing.	Wetness, rooting depth.	Wetness, slope, droughty.
MeB Melita	Seepage	No water	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
MnB Menominee	Wetness, seepage.	Deep to water, slow refill.	Favorable	Droughty, fast intake, wetness.	Wetness, too sandy, soil blowing.	Droughty.
MnC Menominee	Seepage	No water	Not needed	Droughty, soil blowing, fast intake.	Soil blowing, too sandy.	Slope, droughty.
MoC*: Menominee	Seepage	No water	Not needed	Droughty, soil blowing, fast intake.	Soil blowing, too sandy.	Slope, droughty.
Montcalm	Seepage	No water	Not needed	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Droughty, slope.
MtB Montcalm	Seepage	No water	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
MtC Montcalm	Seepage	No water	Not needed	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty, slope.
MtD, MtE Montcalm	Seepage	No water	Not needed	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Droughty, slope.
NeB Nester	Favorable	No water	Not needed	Favorable	Favorable	Favorable.
NeC Nester	Favorable	No water	Not needed	Slope, erodes easily, percs slowly.	Favorable	Slope.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Irrigation	Terraces and diversions	Grassed waterways
NeD---------- Nester	Favorable------	No water--------	Not needed------	Slope, erodes easily, percs slowly.	Slope-----------	Slope.
OtA---------- Otisco	Seepage, wetness.	Favorable-------	Favorable-------	Fast intake, wetness, droughty.	Not needed------	Wetness, droughty.
Pt*. Pits						
Rn---------- Rondeau	Excess humus, wetness.	Slow refill-----	Floods, frost action.	Wetness, percs slowly, floods.	Not needed------	Wetness, percs slowly.
Ro---------- Roscommon	Seepage, wetness.	Favorable-------	Floods----------	Wetness, droughty, fast intake.	Not needed------	Wetness, droughty.
RuB---------- Rubicon	Seepage---------	No water--------	Not needed------	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
RuC---------- Rubicon	Seepage---------	No water--------	Not needed------	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty, slope.
Sm---------- Sims	Wetness---------	Slow refill-----	Percs slowly, floods, frost action.	Wetness, percs slowly, floods.	Not needed------	Wetness, percs slowly.
UbB---------- Ubly	Favorable------	No water--------	Not needed------	Soil blowing----	Soil blowing, too sandy.	Favorable.
Wh---------- Wheatley	Seepage, wetness.	Favorable-------	Floods----------	Wetness, fast intake, droughty.	Not needed------	Wetness, droughty.
Wn*: Winterfield------	Seepage---------	Favorable-------	Floods----------	Wetness, droughty, fast intake.	Not needed------	Wetness, droughty.
Evart----------	Seepage, wetness.	Favorable-------	Floods----------	Wetness, droughty.	Not needed------	Wetness, droughty.

* See map unit description for the composition and behavior of the map unit.

TABLE 13.--RECREATIONAL DEVELOPMENT

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
AuA Au Gres	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, too sandy.
Br Brevort	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
Co Colonville	Severe: wetness, floods.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: wetness, floods.
CrB Croswell	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
GaA Gladwin	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.
GrB Graycalm	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
GrC Graycalm	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
GrD Graycalm	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy, slope.
GyB Grayling	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
GyC Grayling	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
GyD Grayling	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy, slope.
Hs*. Histosols				
IkA*: Iosco	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.
Kawkawlin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
KwB Kawkawlin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Lg*: Loxley	Severe: floods, wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness, floods.	Severe: wetness, excess humus.

See footnote at end of table.

TABLE 13.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lg*: Greenwood	Severe: floods, wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness, floods.	Severe: wetness, excess humus.
Lu Lupton	Severe: floods, wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness, floods.	Severe: wetness, excess humus.
MaB Mancelona	Moderate: too sandy.	Moderate: too sandy.	Moderate: small stones, slope.	Moderate: too sandy.
MaC Mancelona	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
Mb Markey	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.
McB McBride	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
McC McBride	Severe: wetness.	Moderate: slope, wetness.	Severe: slope, wetness.	Moderate: wetness.
MeB Melita	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
MnB Menominee	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy, slope.	Moderate: too sandy.
MnC Menominee	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
MoC*: Menominee	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
Montcalm	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: slope.	Moderate: too sandy.
MtB Montcalm	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy, slope.	Moderate: too sandy.
MtC Montcalm	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: slope.	Moderate: too sandy.
MtD, MtE Montcalm	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
NeB Nester	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight.

See footnote at end of table.

TABLE 13.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
NeC--- Nester	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
NeD--- Nester	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
OtA--- Otisco	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, too sandy.
Pt*. Pits				
Rn--- Rondeau	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.
Ro--- Roscommon	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
RuB--- Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
RuC--- Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.
Sm--- Sims	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
UbB--- Ubly	Moderate: percs slowly.	Slight---	Moderate: slope, percs slowly.	Slight.
Wh--- Wheatley	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
Wn*: Winterfield---	Severe: floods, wetness.	Moderate: floods, wetness, too sandy.	Severe: wetness, floods.	Moderate: wetness, too sandy, floods.
Evart---	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.

* See map unit description for the composition and behavior of the map unit.

TABLE 14.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
AuA---- Au Gres	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Fair	Poor	Very poor.
Br---- Brevort	Very poor.	Poor	Poor	Poor	Poor	Fair	Good	Poor	Poor	Fair.
Co---- Colonville	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
CrB---- Croswell	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Poor	Poor	Very poor.
GaA---- Gladwin	Poor	Fair	Good	Fair	Fair	Fair	Poor	Fair	Fair	Poor.
GrB, GrC---- Graycalm	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
GrD---- Graycalm	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
GyB---- Grayling	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Poor	Poor	Very poor.
GyC---- Grayling	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
GyD---- Grayling	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Hs*. Histosols										
IkA*: Iosco----	Poor	Fair	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
Kawkawlin----	Fair	Good	Good	Good	Good	Good	Fair	Good	Good	Fair.
KwB---- Kawkawlin	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Lg*: Loxley----	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Greenwood----	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Lu---- Lupton	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
MaB, MaC---- Mancelona	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Mb---- Markey	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
McB---- McBride	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Fair	Poor	Very poor.
McC---- McBride	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.

See footnote at end of table.

TABLE 14.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
MeB---------- Melita	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Poor	Poor	Very poor.
MnB, MnC---------- Menominee	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
MoC*:										
Menominee----------	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Montcalm----------	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
MtB, MtC---------- Montcalm	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
MtD, MtE---------- Montcalm	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
NeB---------- Nester	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
NeC---------- Nester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
NeD---------- Nester	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
OtA---------- Otisco	Poor	Fair	Good	Good	Good	Fair	Poor	Good	Good	Poor.
Pt*. Pits										
Rn---------- Rondeau	Fair	Fair	Poor	Poor	Very poor.	Good	Good	Fair	Very poor.	Good.
Ro---------- Roscommon	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
RuB---------- Rubicon	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Poor	Poor	Very poor.
RuC---------- Rubicon	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Sm---------- Sims	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
UbB---------- Ubly	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Wh---------- Wheatley	Very poor.	Poor	Poor	Poor	Poor	Fair	Good	Poor	Poor	Fair.
Wn*:										
Winterfield--------	Poor	Fair	Fair	Poor	Poor	Fair	Fair	Fair	Poor	Fair.
Evart----------	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.

* See map unit description for the composition and behavior of the map unit.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means greater than. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
AuA---------- Au Gres	0-13	Loamy sand------	SM, SP-SM	A-2-4	0	95-100	90-100	50-75	10-25	---	NP
	13-21	Sand, loamy sand	SP-SM, SP, SM	A-2-4, A-3	0	95-100	90-100	60-80	0-15	---	NP
	21-60	Sand----------	SP, SP-SM	A-3, A-2-4	0	95-100	90-100	50-80	0-10	---	NP
Br---------- Brevort	0-8	Loamy sand------	SP, SM, SP-SM	A-2-4, A-3	0-5	95-100	95-100	50-75	0-30	---	NP
	8-31	Sand, loamy sand, loamy fine sand.	SP, SM, SP-SM	A-2-4, A-3	0-5	95-100	95-100	50-75	0-30	<20	NP-4
	31-60	Silt loam, clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	95-100	85-100	55-95	17-45	4-22
Co---------- Colonville	0-17	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-2, A-4	0	100	100	60-85	30-55	10-20	NP-6
	17-60	Fine sandy loam, gravelly sand, sand.	SM, ML, CL, SC, SP, SP-SM	A-2, A-4, A-1, A-3	0-2	90-100	80-100	45-90	0-65	<30	NP-10
CrB---------- Croswell	0-7	Sand----------	SP-SM, SM	A-3, A-2-4	0	100	95-100	50-70	5-25	---	NP
	7-29	Sand----------	SP-SM, SM	A-3, A-2-4	0	100	95-100	50-70	5-25	---	NP
	29-60	Sand----------	SP-SM, SM	A-3, A-2-4	0	100	95-100	50-70	5-25	---	NP
GaA---------- Gladwin	0-11	Loamy sand------	SM, SP-SM	A-1, A-2, A-3	0-5	90-100	65-95	45-70	5-30	<20	NP-4
	11-22	Sand, loamy sand	SM, SP-SM	A-1, A-2, A-3	0-5	90-100	65-95	45-70	5-30	<20	NP-4
	22-29	Gravelly loamy sand, sandy loam, gravelly sandy loam.	SM, SM-SC, SC	A-2	0-5	85-100	65-90	55-75	15-35	12-35	NP-16
	29-60	Sand and gravel	SP, GP, SP-SM, GP-GM	A-1	0-10	40-80	35-70	20-45	0-10	---	NP
GrB, GrC, GrD------ Graycalm	0-3	Sand----------	SM, SP-SM	A-2	0	95-100	75-100	40-70	5-15	---	NP
	3-22	Sand, loamy sand	SP-SM, SM	A-3, A-2	0	95-100	75-100	40-75	5-20	---	NP
	22-60	Sand, loamy sand, loamy coarse sand.	SM, SP-SM	A-2	0	95-100	75-100	40-75	5-20	---	NP
GyB, GyC, GyD------ Grayling	0-19	Sand----------	SM, SP-SM	A-1, A-2, A-3	0	100	90-100	35-65	5-15	---	NP
	19-60	Sand----------	SP, SP-SM	A-1, A-3, A-2	0	100	90-100	40-55	0-10	---	NP
Hs*. Histosols											

See footnote at end of table.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
IkA*:											
Iosco	0-6	Loamy sand	SM	A-2-4	0	95-100	95-100	50-70	15-30	---	NP
	6-30	Loamy sand, sand	SM, SP-SM	A-2-4, A-3	0	95-100	95-100	50-75	5-30	<20	NP-4
	30-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-4, A-6	0	95-100	95-100	90-100	65-95	20-40	5-25
Kawkawlin	0-21	Sandy loam	SM, SC, SM-SC	A-2	0-3	95-100	90-100	55-70	20-35	<30	NP-9
	21-31	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0-3	95-100	90-100	85-100	60-90	25-55	11-30
	31-60	Clay loam, silty clay loam.	CL	A-6	0-3	95-100	90-100	85-100	60-90	25-36	11-18
KwB	0-6	Loam	ML, CL	A-4, A-6	0-3	95-100	95-100	80-100	55-85	25-40	2-15
Kawkawlin	6-24	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0-3	95-100	90-100	85-100	60-90	25-55	11-30
	24-60	Clay loam, silty clay loam.	CL	A-6	0-3	95-100	90-100	85-100	60-90	25-36	11-18
Lg*:											
Loxley	0-13	Hemic material	Pt	A-8	---	---	---	---	---	---	---
	13-60	Sapric material	Pt	A-8	---	---	---	---	---	---	---
Greenwood	0-6	Fibric material	Pt	A-8	0	---	---	---	---	---	---
	6-60	Hemic material	Pt	A-8	0	---	---	---	---	---	---
Lu	0-60	Sapric material	Pt	A-8	---	---	---	---	---	---	---
Lupton											
MaB, MaC	0-5	Loamy sand	SM	A-2, A-1-b	0-5	90-100	65-95	40-70	15-30	---	NP
Mancelona	5-18	Loamy sand, sand, gravelly loamy sand.	SM, SP-SM	A-2, A-1-b	0-5	90-100	65-95	40-60	10-30	---	NP
	18-27	Gravelly sandy loam, gravelly loamy sand, sandy clay loam.	SM, SM-SC, SC	A-2, A-4	0-5	85-100	60-95	60-70	30-45	12-30	NP-10
	27-60	Stratified gravel to sand.	GP, SP, GW, SW	A-1	5-10	40-90	35-85	20-40	0-10	---	NP
Mb	0-32	Sapric material	Pt	A-8	---	---	---	---	---	---	---
Markey	32-60	Sand, loamy sand	SP, SM, SP-SM	A-2, A-3	0	100	90-100	60-75	0-20	---	NP
McB, McC	0-15	Sandy loam	SM, SM-SC	A-2-4, A-4	0-10	90-100	85-95	55-70	25-40	<25	NP-6
McBride	15-30	Sandy loam, loamy sand.	SM, SM-SC	A-2-4, A-4, A-1-b	0-10	90-100	85-95	45-75	15-40	<25	NP-6
	30-38	Sandy loam, sandy clay loam, loamy sand.	SM, SC, SM-SC	A-2, A-4, A-6, A-1-b	0-10	90-100	85-95	45-85	15-45	<30	NP-15
	38-60	Sandy loam, sandy clay loam.	SM, SC, SM-SC	A-2, A-4, A-6	0-10	90-100	85-95	60-85	30-45	<30	NP-15
MeB	0-53	Sand	SM, SP-SM	A-2, A-3	0-5	100	100	50-75	5-30	---	NP
Melita	53-57	Loam, clay loam, silty clay loam.	ML, CL-ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	4-15
	57-60	Loam, clay loam	CL-ML, ML	A-4, A-6	0-5	95-100	95-100	85-95	60-80	25-40	4-12

See footnote at end of table.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
MnB, MnC---------- Menominee	0-11	Loamy sand------	SM, SP-SM	A-2-4	0	95-100	95-100	50-75	10-30	---	NP
	11-23	Sand, loamy sand, sandy loam.	SP, SM, SP-SM	A-2-4, A-3	0	95-100	95-100	50-75	0-15	---	NP
	23-60	Clay loam, loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-10	85-95	85-95	80-95	60-90	25-40	5-20
MoC*:											
Menominee----------	0-11	Loamy sand------	SM, SP-SM	A-2-4	0	95-100	95-100	50-75	10-30	---	NP
	11-23	Sand, loamy sand, sandy loam.	SP, SM, SP-SM	A-2-4, A-3	0	95-100	95-100	50-75	0-15	---	NP
	23-60	Clay loam, loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-10	85-95	85-95	80-95	60-90	25-40	5-20
Montcalm----------	0-7	Loamy sand------	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	7-21	Loamy sand, sand	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	21-60	Stratified sand to sandy loam.	SM, SP-SM	A-2	0-2	90-100	90-100	50-80	10-35	---	NP
MtB, MtC, MtD, MtE- Montcalm	0-7	Loamy sand------	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	7-21	Loamy sand, sand	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	21-60	Stratified sand to sandy loam.	SM, SP-SM	A-2	0-2	90-100	90-100	50-80	10-35	---	NP
NeB, NeC, NeD------ Nester	0-10	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	80-100	55-80	25-40	2-15
	10-38	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-100	65-90	35-60	15-30
	38-60	Clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	95-100	90-100	65-90	30-45	10-20
OtA---------- Otisco	0-11	Loamy sand------	SM, SP-SM, SC, SM-SC	A-2, A-3	0	95-100	95-100	50-75	5-30	<20	NP-10
	11-28	Loamy sand, sand	SM, SP-SM, SC, SM-SC	A-2, A-3	0	95-100	95-100	50-75	5-30	<20	NP-10
	28-50	Stratified sand to loam.	SM, SP-SM, CL, SC	A-2, A-4, A-3, A-6	0	95-100	95-100	50-90	5-65	15-40	NP-15
	50-60	Sand, loamy sand	SM, SC, SP-SM, SM-SC	A-2, A-3	0	95-100	95-100	50-75	5-30	<20	NP-10
Pt*. Pits											
Rn---------- Rondeau	0-30	Sapric material	Pt	A-8	0	---	---	---	---	---	NP
	30-60	Marl----------	OH, MH	A-8, A-5	0	100	95-100	80-90	60-80	50-90	NP-20
Ro---------- Roscommon	0-10	Mucky loamy sand	SM, SP-SM	A-2, A-3	0	100	95-100	50-70	5-25	---	NP
	10-60	Sand----------	SP, SP-SM, SM	A-1, A-2, A-3	0	95-100	85-100	40-70	0-15	---	NP
RuB, RuC---------- Rubicon	0-8	Sand----------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-70	5-15	---	NP
	8-22	Sand----------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-75	5-15	---	NP
	22-60	Sand----------	SP, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-65	0-10	---	NP

See footnote at end of table.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Sm	0-9	Clay loam	CL	A-6	0-5	95-100	90-100	85-90	65-85	26-40	12-20
Sims	9-28	Clay loam, silty clay loam.	CL, CH	A-6, A-7	0-5	95-100	90-100	90-95	65-85	36-55	15-28
	28-60	Clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	90-100	90-95	70-85	32-45	14-24
UbB	0-7	Sandy loam	SM, SM-SC	A-2, A-4	0-3	95-100	90-95	55-70	25-40	<28	2-7
Ubly	7-24	Sandy loam, loamy sand, loam.	SP-SM, SM, SM-SC, SC	A-1, A-2, A-4	0-3	90-100	85-95	40-75	10-40	<30	NP-8
	24-31	Sandy clay loam, clay loam, loam.	SC, CL	A-6	1-5	95-100	90-100	75-100	35-90	20-40	10-25
	31-60	Loam, clay loam, silty clay loam.	CL	A-6	1-5	95-100	90-100	80-100	55-90	20-40	10-25
Wh	0-8	Loamy sand	SM, SP-SM	A-2-4, A-1-b	0-5	85-95	80-95	45-75	10-30	---	NP
Wheatley	8-40	Gravelly sand, gravelly loamy sand, sand.	SM, SP-SM	A-2-4, A-1-b	0-5	85-95	80-90	40-60	10-20	---	NP
	40-60	Stratified gravel to sand.	GW, SW, GP, SP	A-1	5-10	20-80	20-80	20-40	0-5	---	NP
Wn*:											
Winterfield	0-7	Loamy sand	SM	A-2-4, A-4	0	100	95-100	50-90	15-45	---	NP
	7-31	Sand, loamy sand, loamy fine sand.	SM, SP-SM	A-2-4, A-3, A-4	0	100	95-100	50-90	5-45	---	NP
	31-60	Sand, gravelly sand, loamy sand.	SM, SP-SM, SP	A-3, A-1-b, A-2-4	0	90-100	80-100	45-80	0-35	---	NP
Evart	0-8	Loam	ML, CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-95	50-80	25-38	3-15
	8-60	Sand, loamy sand	SM, SP-SM, SM-SC	A-1, A-3, A-2	0-5	95-100	85-100	40-75	5-15	<20	NP-7

* See map unit description for the composition and behavior of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means greater than. The erosion tolerance factor (T) is for the entire profile. Wind erodibility group is for the surface layer. Absence of an entry means data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
						K	T	
	In	In/hr	In/in	pH				
AuA	0-13	6.0-20	0.07-0.09	4.5-7.3	Low	0.15	5	2
Au Gres	13-21	6.0-20	0.06-0.09	4.5-7.3	Low	0.15		
	21-60	>20	0.05-0.07	5.1-6.0	Low	0.15		
Br	0-8	6.0-20	0.07-0.12	5.6-7.8	Low	0.17	5	2
Brevort	8-31	6.0-20	0.06-0.11	6.1-7.8	Low	0.17		
	31-60	0.2-0.6	0.14-0.22	7.4-8.4	Moderate	0.43		
Co	0-17	2.0-6.0	0.13-0.18	6.6-8.4	Low	0.20	5	3
Colonville	17-60	2.0-20	0.02-0.12	7.9-8.4	Low	0.15		
CrB	0-7	6.0-20	0.07-0.09	4.5-6.0	Low	0.15	5	1
Croswell	7-29	6.0-20	0.06-0.08	5.1-6.5	Low	0.15		
	29-60	>20	0.05-0.07	5.6-7.3	Low	0.15		
GaA	0-11	6.0-20	0.06-0.12	6.1-7.8	Low	0.17	4	1
Gladwin	11-22	6.0-20	0.05-0.11	6.1-7.8	Low	0.17		
	22-29	2.0-6.0	0.05-0.13	6.1-7.8	Low	0.17		
	29-60	>20	0.02-0.04	7.9-8.4	Low	0.10		
GrB, GrC, GrD	0-3	6.0-20	0.04-0.10	4.5-6.5	Low	0.15	5	1
Graycalm	3-22	6.0-20	0.05-0.10	4.5-6.5	Low	0.15		
	22-60	6.0-20	0.04-0.09	4.5-6.5	Low	0.15		
GyB, GyC, GyD	0-19	>20	0.05-0.09	4.5-5.0	Low	0.15	5	1
Grayling	19-60	>20	0.04-0.06	5.1-6.5	Low	0.15		
Hs*.								
Histosols								
IkA*:								
Iosco	0-6	6.0-20	0.10-0.12	5.1-6.5	Low	0.17	5	2
	6-30	6.0-20	0.06-0.11	5.1-6.5	Low	0.17		
	30-60	0.2-0.6	0.14-0.20	6.1-7.8	Moderate	0.37		
Kawkawlin	0-21	2.0-6.0	0.12-0.15	5.1-7.3	Low	0.24	5	3
	21-31	0.2-0.6	0.10-0.20	5.1-7.8	Moderate	0.32		
	31-60	0.2-0.6	0.13-0.20	7.9-8.4	Moderate	0.32		
KwB	0-6	0.6-2.0	0.20-0.24	5.1-7.3	Low	0.32	5	6
Kawkawlin	6-24	0.2-0.6	0.10-0.20	5.1-7.8	Moderate	0.32		
	24-60	0.2-0.6	0.13-0.20	7.9-8.4	Moderate	0.32		
Lg*:								
Loxley	0-13	0.6-6.0	0.45-0.55	<5.5		---	---	3
	13-60	0.2-6.0	0.35-0.45	<5.5		---		
Greenwood	0-6	>6.0	0.55-0.65	3.6-4.4	High	---	---	3
	6-60	0.6-6.0	0.45-0.55	3.6-4.4	High	---		
Lu	0-60	0.2-6.0	0.35-0.45	6.6-7.8		---	---	3
Lupton								
MaB, MaC	0-5	2.0-6.0	0.10-0.12	5.6-6.5	Low	0.17	4	2
Mancelona	5-18	6.0-20	0.06-0.12	5.6-7.8	Low	0.17		
	18-27	2.0-6.0	0.06-0.16	6.1-7.8	Low	0.17		
	27-60	>20	0.02-0.04	7.4-8.4	Low	0.10		
Mb	0-32	0.2-6.0	0.35-0.45	5.6-7.8		---	---	3
Markey	32-60	6.0-20	0.03-0.08	6.1-8.4	Low	---		

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
						K	T	
	In	In/hr	In/in	pH				
McB, McC	0-15	2.0-6.0	0.10-0.15	4.5-7.3	Low	0.24	3	3
McBride	15-30	0.06-0.2	0.02-0.04	5.1-6.5	Low	0.24		
	30-38	0.06-0.2	0.02-0.04	5.1-6.5	Low	0.24		
	38-60	0.2-0.6	0.03-0.05	5.1-7.3	Low	0.24		
MeB	0-53	>20	0.04-0.08	5.1-7.3	Low	0.15	5	1
Melita	53-57	0.2-2.0	0.14-0.19	6.1-7.3	Low	0.32		
	57-60	0.2-0.6	0.13-0.18	7.4-8.4	Low	0.32		
MnB, MnC	0-11	6.0-20	0.08-0.12	5.1-6.5	Low	0.17	5	2
Menominee	11-23	6.0-20	0.04-0.10	5.1-6.5	Low	0.17		
	23-60	0.2-0.6	0.14-0.18	5.6-7.8	Moderate	0.32		
MoC*:								
Menominee	0-11	6.0-20	0.08-0.12	5.1-6.5	Low	0.17	5	2
	11-23	6.0-20	0.04-0.10	5.1-6.5	Low	0.17		
	23-60	0.2-0.6	0.14-0.18	5.6-7.8	Moderate	0.32		
Montcalm	0-7	6.0-20	0.10-0.12	5.1-6.5	Low	0.17	5	2
	7-21	6.0-20	0.06-0.10	5.1-6.5	Low	0.17		
	21-60	6.0-20	0.04-0.13	5.1-6.5	Low	0.17		
MtB, MtC, MtD, MtE	0-7	6.0-20	0.10-0.12	5.1-6.5	Low	0.17	5	2
Montcalm	7-21	6.0-20	0.06-0.10	5.1-6.5	Low	0.17		
	21-60	6.0-20	0.04-0.13	5.1-6.5	Low	0.17		
NeB, NeC, NeD	0-10	0.6-2.0	0.20-0.24	5.1-6.5	Low	0.32	5	6
Nester	10-38	0.2-0.6	0.10-0.20	5.1-7.9	Moderate	0.32		
	38-60	0.2-0.6	0.14-0.20	7.9-8.4	Moderate	0.32		
OtA	0-11	2.0-20	0.07-0.12	5.1-6.5	Very low	0.17	5	2
Otisco	11-28	2.0-20	0.06-0.11	5.1-6.5	Very low	0.17		
	28-50	2.0-20	0.05-0.17	6.1-7.8	Low	0.17		
	50-60	2.0-20	0.05-0.10	6.6-7.8	Very low	0.17		
Pt*.								
Pits								
Rn	0-30	0.2-6.0	0.35-0.48	7.4-7.8		---	---	8
Rondeau	30-60	<0.2	0.20-0.22	7.4-7.8		---		
Ro	0-10	6.0-20	0.07-0.20	6.1-7.8	Low	0.17	5	2
Roscommon	10-60	6.0-20	0.05-0.07	6.1-7.8	Low	0.17		
RuB, RuC	0-8	6.0-20	0.05-0.09	4.5-6.0	Low	0.15	5	1
Rubicon	8-22	6.0-20	0.04-0.08	4.5-6.0	Low	0.15		
	22-60	6.0-20	0.04-0.06	4.5-6.5	Low	0.15		
Sm	0-9	0.2-0.6	0.20-0.22	6.1-7.8	Moderate	0.32	5	6
Sims	9-28	0.06-0.2	0.12-0.18	6.1-7.8	Moderate	0.32		
	28-60	0.06-0.2	0.10-0.14	7.4-8.4	Moderate	0.32		
UbB	0-7	2.0-6.0	0.10-0.14	5.6-6.5	Low	0.24	5	3
Ubly	7-24	2.0-6.0	0.10-0.14	5.6-6.5	Low	0.24		
	24-31	0.2-0.6	0.14-0.18	6.1-7.8	Moderate	0.37		
	31-60	0.2-0.6	0.14-0.18	7.4-8.4	Moderate	0.37		
Wh	0-8	2.0-6.0	0.10-0.12	6.6-7.8	Low	0.15	2	2
Wheatley	8-40	6.0-20	0.06-0.08	6.6-7.8	Low	0.15		
	40-60	>20	0.02-0.04	7.4-8.4	Low	0.15		
Wn*:								
Winterfield	0-7	2.0-6.0	0.10-0.12	5.6-7.8	Low	0.17	5	2
	7-31	6.0-20	0.06-0.11	5.6-7.8	Low	0.17		
	31-60	6.0-20	0.04-0.10	5.6-8.4	Low	0.17		
Evart	0-8	0.6-2.0	0.16-0.19	6.1-7.8	Low	0.15	5	6
	8-60	6.0-20	0.05-0.10	6.1-8.4	Low	0.15		

* See map unit description for the composition and behavior of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

[Absence of an entry indicates the feature is not a concern. See text for descriptions of symbols and such terms as "rare," "brief," and "perched." The symbol > means greater than]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
AuA---------- Au Gres	B	None--------	---	---	0.5-1.5	Apparent	Nov-May	Moderate	Low-------	Moderate.
Br---------- Brevort	B/D	Frequent-----	Brief------	Mar-Apr	0-1.0	Apparent	Nov-May	High------	Low-------	Moderate.
Co---------- Colonville	C	Common-------	Brief------	Dec-May	1.0-2.0	Apparent	Sep-May	High------	Low-------	Low.
CrB---------- Croswell	A	None--------	---	---	2.0-3.0	Apparent	Nov-Apr	Low-------	Low-------	Moderate.
GaA---------- Gladwin	A	None--------	---	---	1.0-2.0	Apparent	Nov-May	Moderate	Low-------	Low.
GrB, GrC, GrD----- Graycalm	A	None--------	---	---	>6.0	---	---	Low-------	Low-------	Moderate.
GyB, GyC, GyD----- Grayling	A	None--------	---	---	>6.0	---	---	Low-------	Low-------	Moderate.
Hs*. Histosols										
IkA*: Iosco----------	B	None--------	---	---	1.0-2.0	Apparent	Nov-Jun	Moderate	Low-------	Moderate.
Kawkawlin--------	C	None--------	---	---	1.0-2.0	Apparent	Oct-May	High------	High------	Low.
KwB---------- Kawkawlin	C	None--------	---	---	1.0-2.0	Apparent	Oct-May	High------	High------	Low.
Lg*: Loxley----------	A/D	Frequent-----	Long-------	Nov-May	0-1.0	Apparent	Nov-May	High------	High------	High.
Greenwood--------	D	Frequent-----	Very long	Nov-May	0-1.0	Apparent	Sep-Jun	High------	High------	High.
Lu---------- Lupton	A/D	Frequent-----	Long-------	Nov-May	0-1.0	Apparent	Sep-May	High------	High------	Low.
MaB, MaC---------- Mancelona	A	None--------	---	---	>6.0	---	---	Low-------	Low-------	Low.
Mb---------- Markey	D	Frequent-----	Long-------	Nov-May	0-1.0	Apparent	Nov-Jun	High------	High------	Low.
McB, McC---------- McBride	B	None--------	---	---	1.0-2.0	Perched	Nov-Apr	Moderate	Low-------	Moderate.
MeB---------- Melita	B	None--------	---	---	>6.0	---	---	Low-------	Low-------	Moderate.
MnB---------- Menominee	A	None--------	---	---	3.0-6.0	Apparent	Dec-Apr	Low-------	Low-------	Moderate.
MnC---------- Menominee	A	None--------	---	---	>6.0	---	---	Low-------	Low-------	Moderate.
MoC*: Menominee--------	A	None--------	---	---	>6.0	---	---	Low-------	Low-------	Moderate.
Montcalm---------	A	None--------	---	---	>6.0	---	---	Low-------	Low-------	Moderate.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
MtB, MtC, MtD, MtE---------- Montcalm	A	None--------	---	---	>6.0	---	---	Low-------	Low-------	Moderate.
NeB, NeC, NeD----- Nester	C	None--------	---	---	>6.0	---	---	Moderate	High------	Low.
OtA---------- Otisco	A	None--------	---	---	0.5-1.5	Apparent	Nov-May	Moderate	Low-------	Moderate.
Pt*. Pits										
Rn---------- Rondeau	D	Frequent-----	Long-------	Nov-May	0-1.0	Apparent	Jan-Dec	High------	High------	Low.
Ro---------- Roscommon	A/D	Frequent-----	Brief------	Sep-May	0-1.0	Apparent	Sep-Jun	Moderate	High------	Low.
RuB, RuC---------- Rubicon	A	None--------	---	---	>6.0	---	---	Low-------	Low-------	High.
Sm---------- Sims	D	Frequent-----	Brief------	Mar-May	0-1.0	Apparent	Nov-May	High------	High------	Low.
UbB---------- Ubly	B	None--------	---	---	>6.0	---	---	Moderate	Low-------	Low.
Wh---------- Wheatley	A/D	Frequent-----	Long-------	Nov-Apr	0-1.0	Apparent	Oct-May	Moderate	High------	Low.
Wn*: Winterfield------	A/D	Frequent-----	Brief------	Nov-May	1.0-2.0	Apparent	Nov-May	Moderate	Low-------	Low.
Evart----------	D	Frequent-----	Long-------	Nov-Jun	0-1.0	Apparent	Nov-Jun	Moderate	High------	Low.

* See map unit description for the composition and behavior of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics of this taxadjunct that are outside the range of the series]

Soil name	Family or higher taxonomic class
Au Gres	Sandy, mixed, frigid Entic Haplaquods
Brevort	Sandy over loamy, mixed, nonacid, frigid Mollic Haplaquents
Colonville	Coarse-loamy, mixed (calcareous), frigid Fluvaquentic Haplaquolls
Croswell	Sandy, mixed, frigid Entic Haplorthods
*Evart	Sandy, mixed, frigid Fluvaquentic Haplaquolls
Gladwin	Sandy, mixed, frigid Alfic Haplaquods
Graycalm	Mixed, frigid Alfic Udipsamments
Grayling	Mixed, frigid Typic Udipsamments
Greenwood	Dysic Typic Borohemists
Iosco	Sandy over loamy, mixed, frigid Alfic Haplaquods
Kawkawlin	Fine, mixed Aquic Eutroboralfs
Loxley	Dysic Typic Borosaprists
Lupton	Euic Typic Borosaprists
Mancelona	Sandy, mixed, frigid Alfic Haplorthods
Markey	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
McBride	Coarse-loamy, mixed, frigid Alfic Fragiorthods
Melita	Sandy, mixed, frigid Alfic Haplorthods
*Menominee	Sandy over loamy, mixed, frigid Alfic Haplorthods
Montcalm	Sandy, mixed, frigid Alfic Haplorthods
Nester	Fine, mixed Typic Eutroboralfs
Otisco	Sandy, mixed, frigid Alfic Haplaquods
Rondeau	Marly, euic Limnic Borosaprists
Roscommon	Mixed, frigid Mollic Psammaquents
Rubicon	Sandy, mixed, frigid Entic Haplorthods
Sims	Fine, mixed, nonacid, frigid Mollic Haplaquepts
Ubly	Coarse-loamy, mixed, frigid Alfic Haplorthods
*Wheatley	Mixed, frigid Mollic Psammaquents
Winterfield	Mixed, frigid Aquic Udipsamments

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