United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with Michigan Department of Agriculture, Michigan Agricultural Experiment Station, Michigan State University Extension, and Michigan Technological University

# Soil Survey of Mackinac County, Michigan

# How To Use This Soil Survey

## General Soil Map

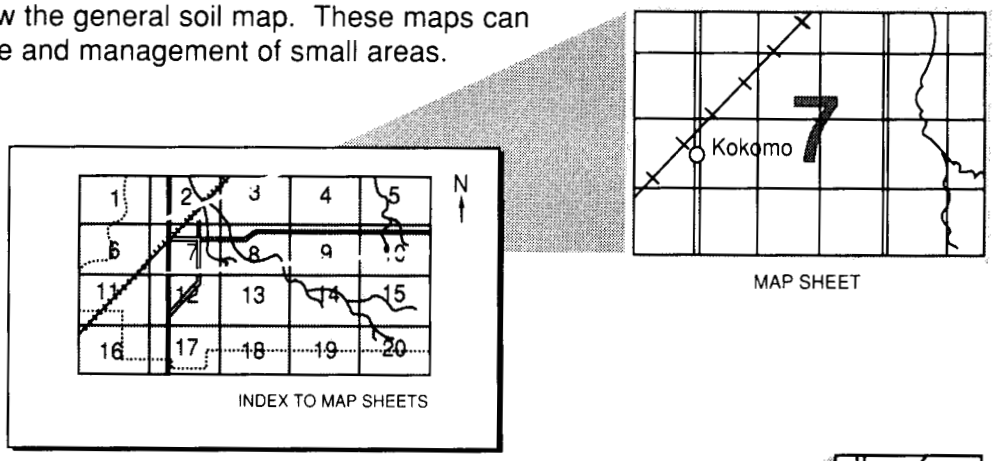
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

## Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

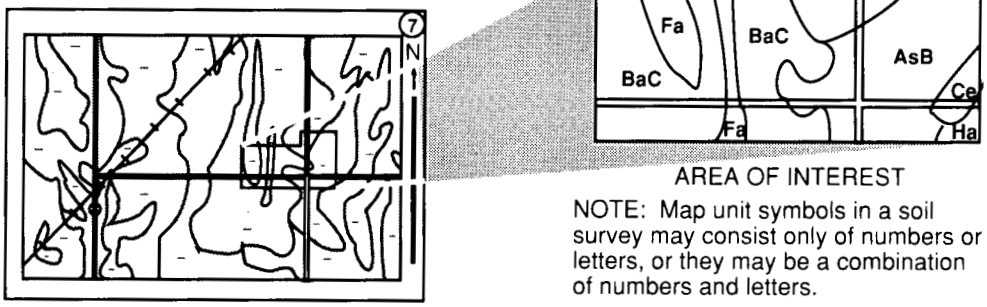
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1993. Soil names and descriptions were approved in 1994. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1993. This survey was made cooperatively by the Natural Resources Conservation Service and the Forest Service, the Michigan Department of Agriculture, the Michigan Agricultural Experiment Station, Michigan State University Extension, and Michigan Technological University. The survey is part of the technical assistance furnished to the Mackinac County Soil Conservation District and other agencies working within the county. Financial assistance was provided by the Mackinac County Board of Commissioners.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

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**Cover: A scenic overlook of Knob Lake and fall colors in Mackinac County. The view is from a hiking trail on Big Knob Hill.**

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# Summary of Tables

# Foreword

This soil survey contains information that affects land use planning in this survey area. It contains predictions of soil behavior for selected land uses. The survey also highlights soil limitations, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations that affect various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as 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 soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

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# Soil Survey of Mackinac County, Michigan

By Gregory Whitney, Natural Resources Conservation Service

Fieldwork by Stephen Rodock, William Anzalone, Martin Kroell III, and Gregory Whitney, Natural Resources Conservation Service; Craig Outwater and Larry Perreault, Michigan Department of Agriculture; and Randy Davis, Forest Service

United States Department of Agriculture, Natural Resources Conservation Service and Forest Service,
in cooperation with
the Michigan Department of Agriculture, the Michigan Agricultural Experiment Station, Michigan State University Extension, and Michigan Technological University

MACKINAC COUNTY is in the eastern part of the Upper Peninsula of Michigan (fig. 1). It has an area of 698,938 acres (including 42,624 acres of water), or about 1,014 square miles. The county is 85 miles in length and has more than 100 miles of Great Lakes shoreline along the mainland. There are 36 islands in the county. Bois Blanc is the largest at 25,000 acres. The extensive shoreline and the large number of islands make tourism of major economic importance. The county seat is St. Ignace, which is the first city reached when the Mackinac Bridge is crossed to the Upper Peninsula. The population of the county was 10,674 in 1990.

About 87 percent of the county, or about 570,000 acres, is forested. The remaining 13 percent is used for farming, for recreational uses, or as urban land. The county has about 151,000 acres of National forest land and about 200,000 acres of State forest land.

The survey area has about 63 different kinds of soil. The soils vary widely in texture, natural drainage, slope, and other characteristics. This survey is the first detailed soil survey completed in the county. A reconnaissance soil survey and land type map were made in 1950 (Schneider and Whiteside, 1950).

## General Nature of the County

This section provides general information concerning the county. It describes climate, physiography, lakes and streams, and history and development.

### Climate

Table 1 gives data on temperature and precipitation for the survey area as recorded at Newberry State Hospital in the period 1961 to 1990. 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.

The climate data are from Luce County, which adjoins Mackinac County on the north. There is no official weather data station in Mackinac County. The weather in Newberry is typical of that in the northern one-half of Mackinac County. The shoreline along Lake Michigan receives less snowfall. The date of the last freeze in spring is typically earlier in May the closer one gets to Lake Michigan. Conversely, the first freeze in fall is generally later in September.

In winter, the average temperature is 17.3 degrees F and the average daily minimum temperature is 9.4 degrees. The lowest temperature on record, which occurred on January 26, 1927, is -30 degrees. In summer, the average temperature is 62.2 degrees and the average daily maximum temperature is 73.7 degrees. The highest recorded temperature, which occurred on July 13, 1936, is 103 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base


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

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.

The total annual precipitation is 32.36 inches. Of this, 18.18 inches, or about 56 percent, usually falls in April through September. The growing season for most crops falls within this period. The heaviest 1-day rainfall on record was 4.10 inches on September 1, 1937. Thunderstorms occur on about 29 days each year, and most occur in June.

The average seasonal snowfall is about 112.6 inches. The greatest snow depth at any one time during the period of record was 43 inches. On the average, 125 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 67 percent. Humidity is higher at night, and the average at dawn is about 85 percent. The sun shines 59 percent of the time possible in summer and 37 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 10.4 miles per hour, in April.

## Physiography

The surface features of Mackinac County were formed by glaciers and the meltwaters that followed. The Nipissing glacial lake was the last major recessional lake. It occurred about 3,000 years ago (Smith, 1936). The elevation of the county ranges from 580 feet at the Lake Huron shoreline to 1,000 feet at Maple Hill in the north-central part of the county. Practically all of the survey area has been under water and has been worked by waves as lake levels dropped to the next lower stage. Soils that formed in this sequence typically have a lithologic discontinuity of some significance at some point in the profile.

The surface features of the county include several lakebed plains; gently rolling plateaus intersected and pitted by broad swamp valleys and lakes; isolated low rounded ridges or hills rising conspicuously above adjacent plains; and lakeshore features consisting of beach ridges, low sand dunes, marshes, and bluffs and escarpments (Larsen, 1987; Smith, 1936).

Mackinac County has limestone bedrock, limestone breccia, and soft shale bedrock. The Rexton area, the Engadine to Gould City area, the Cedarville area, and the East Lake to Hill Lake area have thin glacial till over limestone bedrock or have exposures of the bedrock. There are several limestone quarries in the county. They range in size from 20 acres to more than 500 acres. The St. Ignace peninsula and Mackinac Island have the limestone breccia outcropping or a thin mantle of glacial till over the bedrock. The St. Ignace breccia is broken and recemented salt beds that were dissolved during the Silurian Age Group (Vanlier and Deutsch, 1958). The Moran, St. Ignace, and Point Aux Chenes areas have red to green, soft shale bedrock. The glacial till in these areas is shallow to moderately deep over bedrock.

## Lakes and Streams

The county has more than 24,000 acres of lakes and ponds. These bodies of water range in size from 5 to 7,000 acres. Manistique Lake is the largest in the county at 7,000 acres. Other lakes in the county are Brevoort Lake, 4,230 acres; Millecoquins Lake, 1,000 acres; South Manistique Lake, 4,000 acres; Milakokia Lake, 1,956 acres; and East Lake, 995 acres.

The major rivers are the Black, Brevoort, Carp, Hendrie, Milakokia, Millecoquins, Munuscong, and Pine Rivers. The Carp and Pine Rivers flow into Lake Huron on the eastern side of the county. The Hendrie River in the north-central part of the county flows north into the Tahquamenon River. The other rivers flow into Lake Michigan on the western side of the county. Most of the

riverbeds are silts or sands and have a few rocky rapids. The Pine and Carp Rivers have clay or silt bottoms (Davis and Frey, 1984).

### History and Development

The survey area, or, more specifically, the Straits of Mackinac, was the cultural meeting place of early Indian tribes as far back as 2000 A.D. (Rosentreter, 1986). By 300 A.D., a large Indian fishing village had been established in the St. Ignace area. By the late 17th century, the Europeans were in the Great Lakes area exploring and trading furs. In the summer of 1671, French Jesuit missionary Father Marquette established an Indian mission at St. Ignace. The area was inhabited by the Ottawa and Huron Indians. The French, British, and Americans exchanged ownership of the area many times until 1815, when the area finally became United States territory. Fur trading and fishing made this area very important to the countries that controlled it. John Astor established the American Fur Company with its headquarters on Mackinac Island. The American Fur Company made Astor the country's first millionaire.

Mackinac County was organized in 1818. It included the northern two-thirds of the Lower Peninsula and the eastern half of the Upper Peninsula. Mackinac Island was the county seat until 1882, when railroads and a ferry service were established between the two peninsulas. St. Ignace became the county seat at that time. Lumbering flourished, and fishing was an important industry, especially on St. Helena Island, just west of St. Ignace.

By the late 1800's, Mackinac County was becoming a tourist area. Lake Michigan, Lake Huron, the Les Cheneaux islands, and Mackinac Island were the main attractions. In 1875, Congress created the Nation's second National park from the remains of Fort Michilimackinac on Mackinac Island. This park was Michigan's first State park.

Another important part of Mackinac County history was the construction of the Mackinac Bridge, which linked the two peninsulas. The Mackinac Bridge further increased the tourist trade for the county.

## How This Survey Was Made

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and

tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from Michigan State University records (Michigan State University, 1985).

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

The descriptions, names, and delineations of the soils in this survey area do not fully agree with those of the soils in adjacent survey areas. Differences are the result of a better knowledge of soils, modifications in series concepts, and the changing concepts of soil mapping and soil descriptions.

## Survey Procedures

The general procedures followed in making this survey are described in the National Soil Survey Handbook (USDA/NRCS) and the Soil Survey Manual (USDA, 1993) of the Natural Resources Conservation Service.

Before traversing the landscape, the soil scientists compared each map sheet to the U.S. Geological Survey topographic map for the area and stereoscopically plotted preliminary boundaries of slopes and landforms on leaf-off aerial photographs. Some traverses were made by truck using existing roads and trails, but most were made on foot. Most traverses were made at intervals of about one-fourth mile. Traverses or random observations were made at closer intervals in areas of high variability.

Soil examinations along the traverses were made wherever obvious soil boundaries were crossed. Observations of such features as landforms, water tables, vegetation, roadbanks, surface cobbles and stones, and rock outcrops were made.

Soil boundaries were determined on the basis of soil examinations, landscape interpretations, vegetation observations, and photo interpretations. The soil material was examined to a depth of 60 to 80 inches. The soil types described as typical were observed and studied in small excavations.

Samples for chemical and physical analyses were taken for the most common soil types in the survey area. The analyses were made by the Soil Research Laboratory, Michigan Technological University, Houghton, Michigan, and by the Soil Survey Laboratory, Natural Resources Conservation Service, Lincoln, Nebraska. The results of the analyses are stored in a computerized data file at the laboratories. The results and the laboratory procedures can be obtained on request from the laboratories.

# General Soil Map Units

The general soil map in this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, it consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The components of one map unit can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map 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 soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

## Soil Descriptions

### Nearly Level to Rolling, Very Deep Soils That Are Very Poorly Drained to Moderately Well Drained

These soils are generally used as woodland. A few small areas are used as cropland or pasture. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. If these soils are used for crops or pasture, removing excess water and minimizing surface compaction are management concerns.

#### 1. Pickford-Rudyard Association

*Very deep, nearly level, poorly drained and somewhat poorly drained, clayey soils on lake plains*

Areas of these soils are on lake plains. Slopes range from 0 to 3 percent.

This association makes up about 6 percent of the county. It is about 48 percent Pickford and similar soils, 20 percent Rudyard and similar soils, and 32 percent soils of minor extent (fig. 2).

Pickford soils are poorly drained. Typically, the surface layer is very dark grayish brown silty clay loam about 6 inches thick. The subsoil is reddish brown and dark gray, mottled, firm clay about 13 inches thick. The substratum to a depth of 60 inches or more is reddish brown, calcareous clay with olive gray streaks of lime.

Rudyard soils are somewhat poorly drained. Typically, the surface layer is dark grayish brown silty clay loam about 10 inches thick. The subsoil is reddish brown, mottled, firm clay about 9 inches thick. The substratum to a depth of 60 inches or more is reddish brown, calcareous clay.

Of minor extent are the very poorly drained Dorval, poorly drained Wakeley, somewhat poorly drained Allendale, and well drained Ontonagon soils. The organic Dorval soils are in depressions. Wakeley soils are in landscape positions similar to those of the Pickford soils. Allendale soils are in landscape positions similar to those of the Rudyard soils. They have sandy textures in the upper 30 inches. Ontonagon soils are along the side slopes of drainageways.

Most areas of this association are wooded. Some areas are used as cropland or pasture. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. If the soils are used for crops or pasture, removing excess water and minimizing surface compaction are management concerns.

#### 2. Markey-Finch Association

*Very deep, nearly level, very poorly drained and somewhat poorly drained, mucky and sandy soils on outwash plains and lake plains*

Areas of these soils are on outwash plains and lake plains. Slopes range from 0 to 3 percent.

This association makes up about 19 percent of the county. It is about 50 percent Markey and similar soils, 15 percent Finch and similar soils, and 35 percent soils of minor extent.

Markey soils are very poorly drained. Typically, the surface layer is black muck about 18 inches thick. The next layer is very dark brown mucky peat about 5 inches thick. Below this is about 4 inches of very dark grayish brown muck. The next layer to a depth of about

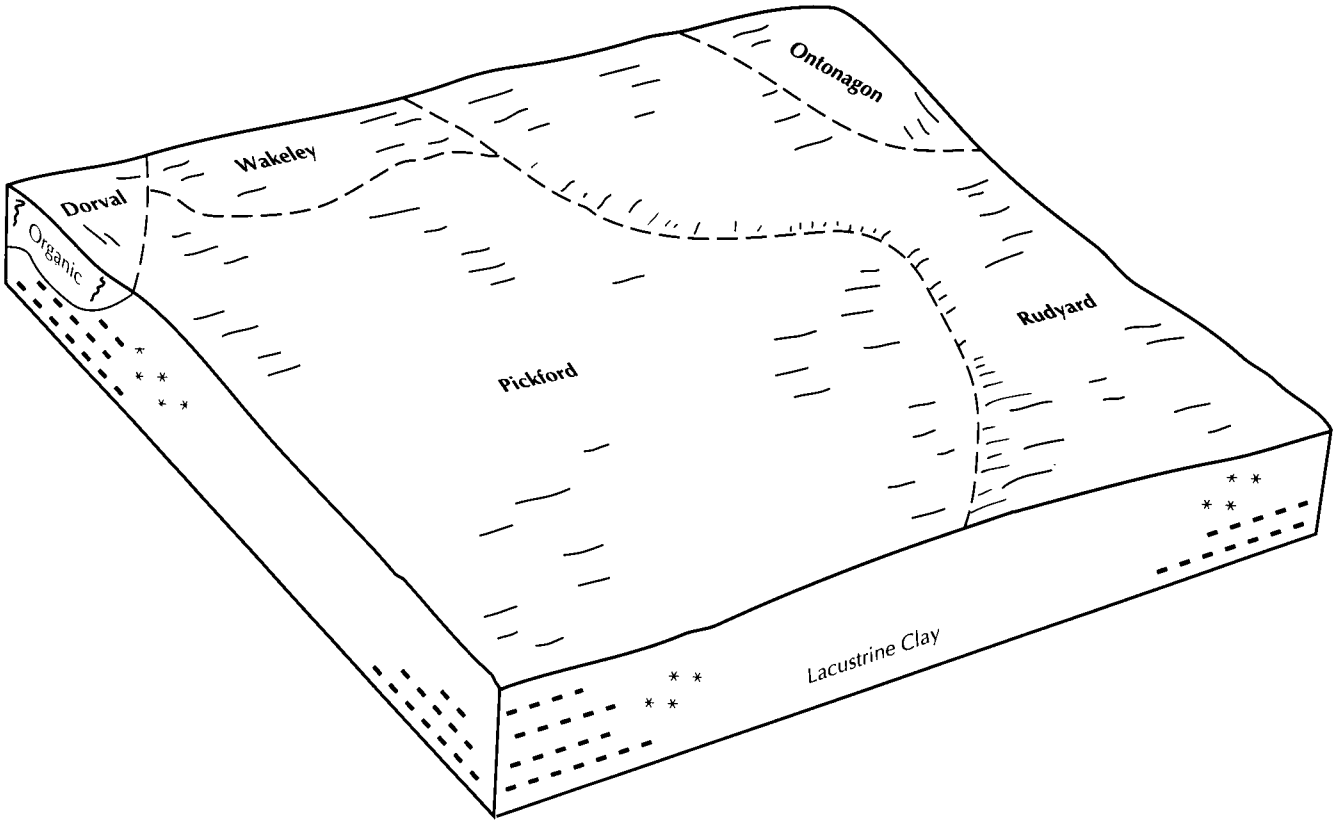


**Figure 2.—Typical pattern of soils and parent material in the Pickford-Rudyard association.**

60 inches is dark gray and dark grayish brown sand.

Finch soils are somewhat poorly drained. Typically, about 1 inch of partially decomposed leaf litter is at the surface. Below this is pinkish gray sand about 10 inches thick. The subsoil is brown to dark reddish brown, mottled, cemented sand about 31 inches thick. The substratum to a depth of 80 inches or more is yellowish brown fine sand.

Of minor extent are the somewhat excessively drained Pullup, well drained Wallace, moderately well drained Paquin, and poorly drained Spot soils. Pullup, Wallace, and Paquin soils are in the higher landscape positions. Spot soils have a subsoil of cemented sand. They are in landscape positions similar to those of the Markey soils.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality.

### 3. Angelica-Solona-Markey Association

*Very deep, nearly level, very poorly drained to somewhat poorly drained, mucky and loamy soils on ground moraines*

Areas of these soils are on ground moraines. Slopes range from 0 to 3 percent.

This association makes up about 3 percent of the county. It is about 35 percent Angelica and similar soils, 25 percent Solona and similar soils, 20 percent Markey and similar soils, and 20 percent soils of minor extent.

Angelica soils are poorly drained. Typically, the surface layer is about 2 inches of black muck over 2 inches of black loam. The subsoil is about 13 inches thick. The upper part is dark gray, mottled, friable loam. The lower part is brown and reddish brown, mottled, friable clay loam. The substratum to a depth of 60 inches or more is light reddish brown, calcareous loam that has light greenish gray coatings of silt.

Solona soils are somewhat poorly drained. Typically, the surface layer is very dark grayish brown loam about

3 inches thick. The subsurface layer is brown, mottled loam about 8 inches thick. The subsoil is brown and reddish brown, mottled, friable sandy loam about 16 inches thick. The substratum to a depth of 60 inches or more is light reddish brown, mottled, calcareous gravelly sandy loam.

Markey soils are very poorly drained. Typically, the surface layer is black muck about 18 inches thick. The next layer is very dark brown mucky peat about 5 inches thick. Below this is about 4 inches of very dark grayish brown muck. The next layer to a depth of about 60 inches is dark gray and dark grayish brown sand.

Of minor extent are the well drained Greylock and somewhat poorly drained Iosco soils. Greylock soils are in the higher landscape positions. Iosco soils are in landscape positions similar to those of the Solona soils. They have sandy textures in the upper part.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality.

### 4. Leafriver-Croswell-Wainola Association

*Very deep, nearly level to undulating, very poorly drained to moderately well drained, mucky and sandy soils on lake plains, on low dunes, and in swales*

Areas of these soils are on low ridges and in long narrow swales along Lake Michigan. Slopes range from 0 to 6 percent.

This association makes up about 3 percent of the county. It is about 40 percent Leafriver and similar soils, 25 percent Croswell and similar soils, 20 percent Wainola and similar soils, and 15 percent soils of minor extent (fig. 3).

Leafriver soils are very poorly drained. Typically, the surface layer is about 2 inches of black mucky peat over 6 inches of black muck. The next layer is black loamy fine sand about 2 inches thick. The substratum to a depth of 60 inches or more is grayish brown and dark grayish brown, mottled fine sand.

Croswell soils are moderately well drained. Typically, about 2 inches of partially decomposed leaf litter is at the surface. Below this is light brownish gray sand about 4 inches thick. The subsoil is about 16 inches thick. The upper part is strong brown, very friable sand, and the lower part is strong brown and brownish yellow, loose sand. The substratum to a depth of 80 inches or more is light yellowish brown, mottled sand.

Wainola soils are somewhat poorly drained. Typically, about 3 inches of partially decomposed leaf litter is at the surface. Below this is pinkish gray fine sand about 11 inches thick. The subsoil is about 16 inches thick. The upper part is dark brown and strong brown, very friable, mottled fine sand. The lower part is yellowish brown, loose fine sand. The substratum to a depth of about 80 inches is light yellowish brown fine sand.

Of minor extent are the excessively drained Eastport, somewhat poorly drained Esau, and very poorly drained Markey soils. Eastport soils are in the higher landscape positions. Esau soils are gravelly. They are on low beach ridges. Markey soils are in landscape positions similar to those of the Leafriver soils.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. Building site development along Lake Michigan is also a management concern. These soils are poorly suited or unsuited to building site development and to septic tank absorption fields because of the poor filtering capacity of the sandy material and the depth to the water table.

### 5. Markey-Mattix-Cozy Association

*Very deep, nearly level to undulating, very poorly drained to moderately well drained, mucky and loamy soils on outwash plains and ground moraines*

Areas of these soils are on outwash plains and ground moraines. Slopes range from 0 to 6 percent.

This association makes up about 1 percent of the county. It is about 40 percent Markey and similar soils, 20 percent Mattix and similar soils, 20 percent Cozy and similar soils, and 20 percent soils of minor extent.

Markey soils are very poorly drained. Typically, the surface layer is black muck about 18 inches thick. The next layer is very dark brown mucky peat about 5 inches thick. Below this is about 4 inches of very dark grayish brown muck. The next layer to a depth of about 60 inches is dark gray and dark grayish brown sand.

Mattix soils are somewhat poorly drained. Typically, about 3 inches of well decomposed leaf litter is at the surface. Below this is pinkish gray sandy loam about 2 inches thick. The subsoil is about 19 inches thick. The upper part is dark reddish brown, friable sandy loam, and the lower part is dark brown, very friable loamy sand. The substratum to a depth of 80 inches or more is light yellowish brown and brown gravelly sand and very gravelly sand.

Cozy soils are moderately well drained. Typically, about 5 inches of well decomposed leaf litter is at the surface. Below this is brown cobbly fine sandy loam about 1 inch thick. The subsoil is dark brown, friable

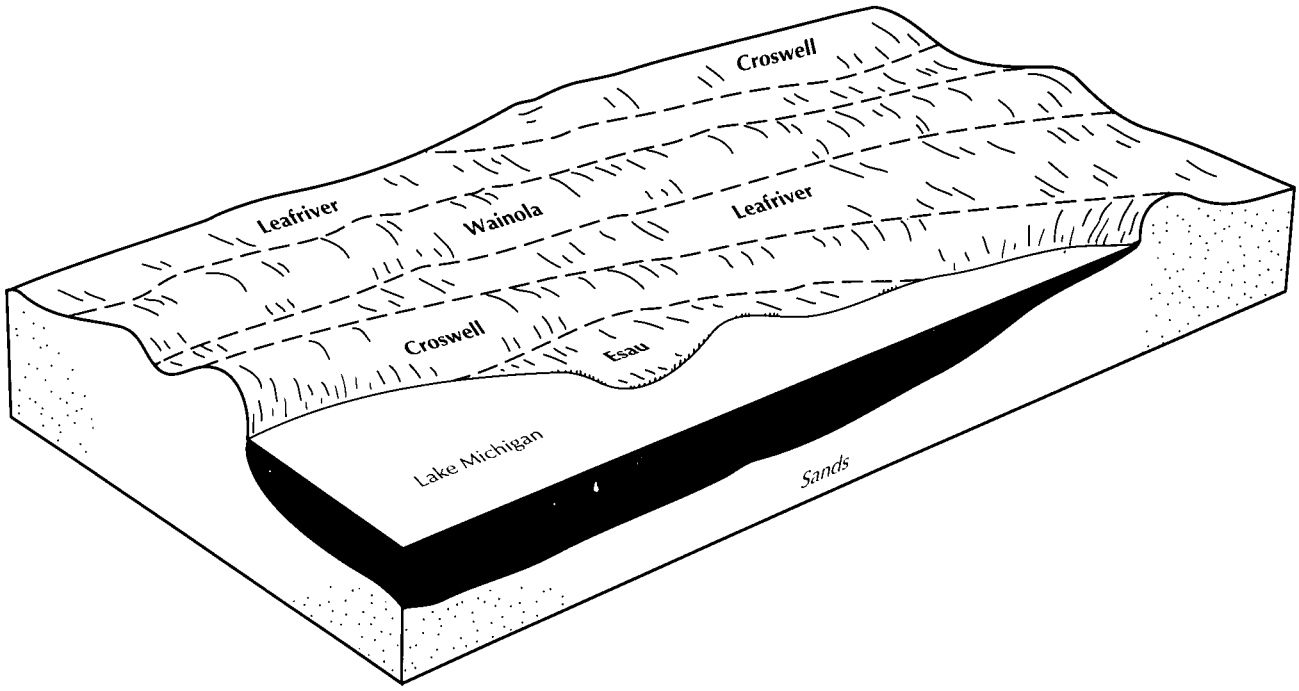


**Figure 3.—Typical pattern of soils and parent material in the Leafriver-Croswell-Wainola association.**

cobbly fine sandy loam about 8 inches thick. The substratum to a depth of 60 inches or more is light brown, dense very gravelly sandy loam.

Of minor extent are the well drained Guardlake, moderately well drained Heinz, and poorly drained Angelica soils. Guardlake soils are in landscape positions similar to those of the Cozy soils. Heinz soils are gravelly. They are on low ridges. Angelica soils are in landscape positions similar to those of the Markey soils.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality.

### 6. Markey-Solona-Graveraet Association

*Very deep, nearly level to rolling, very poorly drained to moderately well drained, mucky and loamy soils on ground moraines and outwash plains*

Areas of these soils are on ground moraines and outwash plains. Slopes range from 0 to 15 percent.

This association makes up about 5 percent of the county. It is about 40 percent Markey and similar soils, 20 percent Solona and similar soils, 15 percent Graveraet and similar soils, and 25 percent soils of minor extent.

Markey soils are very poorly drained. Typically, the surface layer is black muck about 18 inches thick. The next layer is very dark brown mucky peat about 5 inches thick. Below this is about 4 inches of very dark grayish brown muck. The next layer to a depth of about 60 inches is dark gray and dark grayish brown sand.

Solona soils are somewhat poorly drained. Typically, the surface layer is very dark grayish brown loam about 3 inches thick. The subsurface layer is brown, mottled loam about 8 inches thick. The subsoil is brown and reddish brown, mottled, friable sandy loam about 16 inches thick. The substratum to a depth of 60 inches or more is light reddish brown, mottled, calcareous gravelly sandy loam.

Graveraet soils are moderately well drained. Typically, about 1 inch of slightly decomposed leaf litter is at the surface. Below this is very dark gray fine sandy loam about 3 inches thick. The subsurface layer is brown fine sandy loam about 3 inches thick. The subsoil is about 61 inches thick. The upper part is dark reddish brown and reddish brown, friable fine sandy loam. The next part is mottled, brown loamy sand and reddish brown loam. It is firm in place and friable when disturbed. The lower part of the subsoil is reddish brown, friable sandy clay loam. The substratum to a depth of 80 inches or more is reddish brown sandy loam.

Of minor extent are the somewhat excessively drained Kalkaska and poorly drained Angelica soils. Kalkaska soils are sandy. They are in landscape positions similar to those of the Graveraet soils. Angelica soils are loamy. They are in landscape positions similar to those of the Markey soils.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality.

**Nearly Level to Very Steep, Very Deep Soils That Are Very Poorly Drained to Excessively Drained**

These soils are generally used as woodland. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. The hazard of erosion is an additional concern in the steeper areas.

### 7. Carbondale-Shelter-Alpena Association

*Very deep, nearly level to rolling, very poorly drained to excessively drained, mucky, gravelly, and loamy soils on ground moraines and gravelly beach ridges*

Areas of these soils are on ground moraines and beach ridges along Lake Huron. Slopes range from 0 to 15 percent.

This association makes up about 6 percent of the county. It is about 30 percent Carbondale and similar soils, 25 percent Shelter and similar soils, 15 percent Alpena and similar soils, and 30 percent soils of minor extent.

Carbondale soils are very poorly drained. Typically, the soils are black muck to a depth of about 65 inches.

Shelter soils are somewhat poorly drained. Typically, about 2 inches of well decomposed leaf litter is at the surface. Below this is black very cobbly loam and very dark grayish brown and dark yellowish brown very cobbly fine sandy loam about 6 inches thick. The subsoil is dark yellowish brown, friable very cobbly fine sandy loam about 4 inches thick. The substratum to a depth of 60 inches or more is light brown, mottled, dense, calcareous very gravelly fine sandy loam.

Alpena soils are excessively drained. Typically, the surface layer is very dark grayish brown gravelly loam about 5 inches thick. The subsoil is dark yellowish brown, friable extremely gravelly loam about 5 inches thick. The substratum to a depth of 60 inches or more is calcareous, light yellowish brown and very pale brown very gravelly coarse sand.

Of minor extent are the somewhat poorly drained Esau soils and the poorly drained Beavertail, Zela, and Ermatinger soils. Esau soils are on low beach ridges. Zela soils are near lake edges between the beach ridges. Beavertail and Ermatinger soils are on flats along the lake edges.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. Building site development along Lake Huron is also a management concern. These soils are poorly suited or unsuited to building site development and to septic tank absorption fields because of the dense glacial till and the poor filtering capacity of the gravelly material. The depth to the water table is also a concern in areas of the Shelter and Beavertail soils.

### 8. Eastport-Leafriver Association

*Very deep, nearly level to steep, excessively drained and very poorly drained, sandy and mucky soils on dunes, on beach ridges, and in swales*

Areas of these soils are on dunes and in the intervening swales along Lake Michigan. Slopes range from 0 to 35 percent.

This association makes up about 3 percent of the county. It is about 45 percent Eastport and similar soils, 35 percent Leafriver and similar soils, and 20 percent soils of minor extent.

Eastport soils are excessively drained. Typically, about 1 inch of slightly decomposed leaf litter is at the surface. Below this is dark gray sand about 3 inches thick. The subsurface layer is pale brown sand about 11 inches thick. The subsoil is strong brown and brownish yellow, loose sand about 24 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown sand.

Leafriver soils are very poorly drained. Typically, the surface layer is about 2 inches of black mucky peat over 6 inches of black muck. The next layer is black loamy fine sand about 2 inches thick. The substratum to a depth of 60 inches or more is grayish brown and dark grayish brown, mottled fine sand.

Of minor extent are the somewhat poorly drained Wainola soils and the very poorly drained Markey soils. Wainola soils are on low ridges. The organic Markey soils are deep. They are in landscape positions similar to those of the Leafriver soils.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. The hazard of erosion is an additional concern in the steeper areas of Eastport soils.

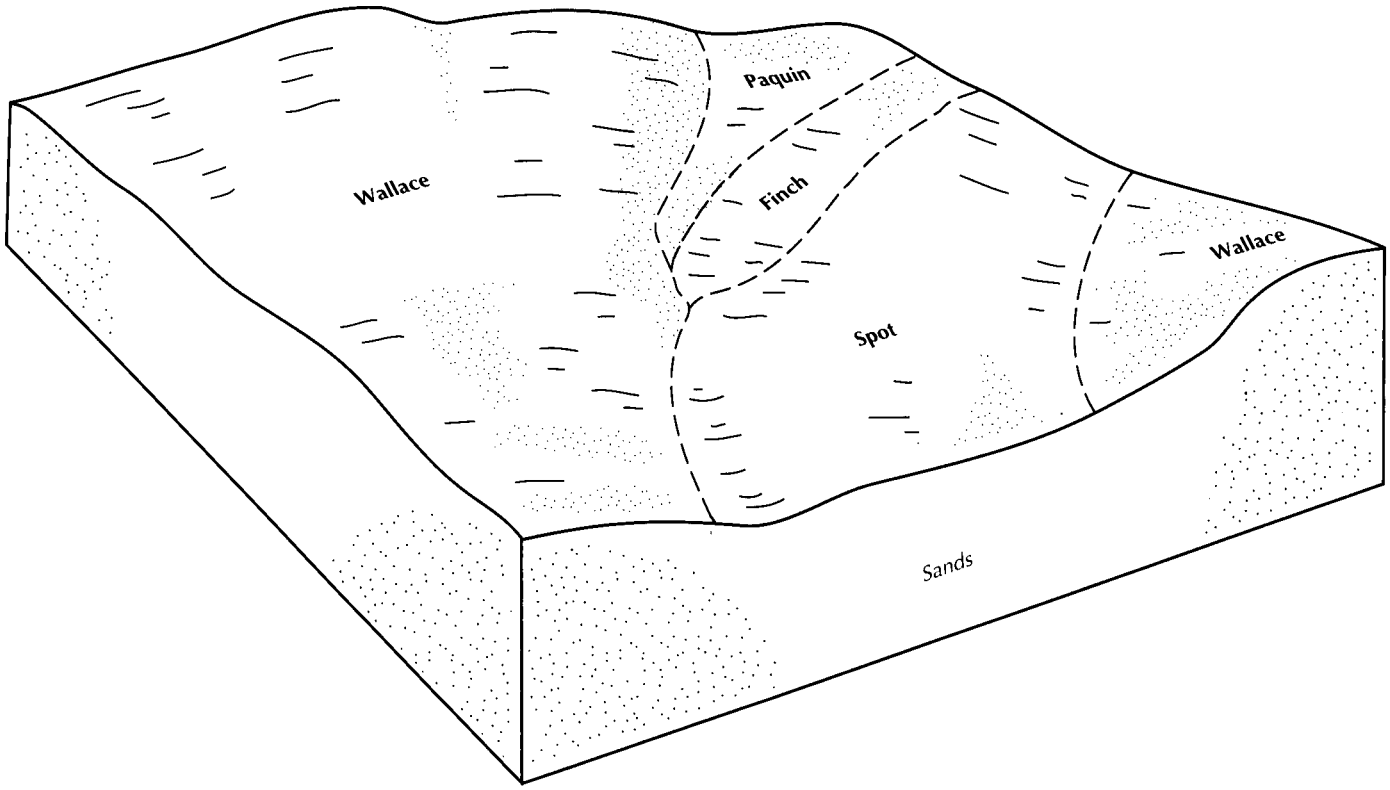


**Figure 4.—Typical pattern of soils and parent material in the Wallace-Spot association.**

## 9. Wallace-Spot Association

*Very deep, nearly level to very steep, well drained and poorly drained, sandy and mucky soils on lake plains and outwash plains*

Areas of these soils are on lake plains and outwash plains. Slopes range from 0 to 60 percent.

This association makes up about 11 percent of the county. It is about 45 percent Wallace and similar soils, 15 percent Spot and similar soils, and 40 percent soils of minor extent (fig. 4).

Wallace soils are well drained. Typically, about 2 inches of partially decomposed leaf litter is at the surface. Below this is light brownish gray sand about 2 inches thick. The subsoil is about 49 inches thick. The upper part is dark reddish brown and brown, cemented sand. The lower part is brownish yellow, loose sand. The substratum to a depth of 80 inches or more is light yellowish brown sand.

Spot soils are poorly drained. Typically, the surface layer is about 2 inches of slightly decomposed organic matter and black muck. The subsurface layer is light brownish gray, mottled sand about 6 inches thick. The subsoil is about 10 inches thick. The upper part is dark reddish brown and dark brown, cemented sand. The lower part is strong brown, friable sand. The substratum to a depth of 80 inches or more is light brown and light yellowish brown sand.

Of minor extent are the somewhat poorly drained Finch soils, the somewhat excessively drained Pullup soils, the moderately well drained Paquin soils, and the very poorly drained Loxley and Markey soils. Finch soils are in transitional areas between the Wallace and Spot soils. Pullup soils are in landscape positions similar to those of the Wallace soils. Paquin soils are slightly lower on the landscape than the Wallace soils. Loxley and Markey soils are in depressions.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations and seedling mortality. The hazard of erosion is an additional concern in the steeper areas.

### Nearly Level to Very Steep, Very Deep to Shallow Soils That Are Poorly Drained to Excessively Drained

Most areas of these soils are used as woodland. Some areas are used for building site development. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling

mortality. The hazard of erosion is an additional concern in the steeper areas.

### 10. St. Ignace-Alpena-Esau Association

*Shallow and very deep, nearly level to very steep, excessively drained to somewhat poorly drained, sandy and loamy soils on limestone bedrock benches and gravelly beach ridges*

Areas of these soils are on limestone bedrock benches and beach ridges along Lake Michigan and Lake Huron. Slopes range from 0 to 70 percent.

This association makes up about 2 percent of the county. It is about 40 percent St. Ignace and similar soils, 20 percent Alpena and similar soils, 15 percent Esau and similar soils, and 25 percent soils of minor extent.

St. Ignace soils are well drained. Typically, the surface layer is black silt loam about 5 inches thick. The subsoil is yellowish brown, friable gravelly silt loam about 10 inches thick. Fractured limestone breccia bedrock is at a depth of about 15 inches.

Alpena soils are excessively drained. Typically, the surface layer is very dark grayish brown gravelly loam about 5 inches thick. The subsoil is dark yellowish brown, friable extremely gravelly loam about 5 inches thick. The substratum to a depth of 60 inches or more is calcareous, light yellowish brown and very pale brown very gravelly coarse sand.

Esau soils are somewhat poorly drained. Typically, about 2 inches of partially decomposed leaf litter is at the surface. Below this is very dark gray extremely gravelly sandy loam about 4 inches thick. The subsoil is yellowish brown, loose extremely gravelly coarse sand about 4 inches thick. The substratum to a depth of 80 inches or more is calcareous, brown very gravelly coarse sand.

Of minor extent are the somewhat poorly drained Solona, poorly drained Beavertail, and very poorly drained Markey soils. Solona soils are loamy. They are in landscape positions similar to those of the Esau soils. Beavertail and Markey soils are in depressions and swales between beach ridges.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. Building site development along Lake Huron and Lake Michigan is also a management concern. These soils are poorly suited or unsuited to building site development and to septic tank absorption fields because of the depth to bedrock and the poor filtering capacity of the gravelly material and the fractured breccia bedrock. The depth to the water table is also a concern in areas of the Esau soils.

### 11. Angelica-Satago Association

*Moderately deep to very deep, nearly level to undulating, well drained and poorly drained, mucky and loamy soils on bedrock-controlled ground moraines*

Areas of these soils are on bedrock-controlled ground moraines. Slopes range from 0 to 6 percent.

This association makes up about 3 percent of the county. It is about 35 percent Angelica and similar soils, 30 percent Satago and similar soils, and 35 percent soils of minor extent.

Angelica soils are poorly drained. Typically, the surface layer is about 2 inches of black muck over 2 inches of black loam. The subsoil is about 13 inches thick. The upper part is dark gray, mottled, friable loam about 3 inches thick. The lower part is brown and reddish brown, mottled, friable clay loam. The substratum to a depth of 60 inches or more is light reddish brown, calcareous loam that has light greenish gray coatings of silt.

Satago soils are well drained. Typically, about 2 inches of slightly decomposed leaf litter is at the surface. Below this is dark brown silt loam about 4 inches thick. The subsoil is brown and reddish brown, friable silt loam about 8 inches thick. It is about 30 percent weathered shale fragments. The substratum is reddish brown, calcareous silt loam about 34 inches thick. Weathered, soft shale bedrock is at a depth of about 46 inches.

Of minor extent are the excessively drained Alpena soils and the somewhat poorly drained Esau, Search, and Solona soils. Alpena soils are on gravelly beach ridges. Esau soils are very gravelly sand. They are on low ridges. Search and Solona soils are very deep, loamy soils. They are in transitional areas between the Angelica and Satago soils.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality.

### 12. Amadon-Longrie-Battydoe Association

*Shallow to very deep, nearly level to very steep, well drained, loamy soils on bedrock-controlled ground moraines and bedrock benches*

Areas of these soils are on bedrock-controlled ground moraines and benches. Slopes range from 1 to 45 percent.

This association makes up about 9 percent of the county. It is about 30 percent Amadon and similar soils, 20 percent Longrie and similar soils, 15 percent

Battydoe and similar soils, and 35 percent soils of minor extent.

Amadon soils are well drained. Typically, about 2 inches of partially decomposed leaf litter is at the surface. Below this is about 6 inches of pinkish gray sandy loam. The subsoil is dark reddish brown and dark brown, friable fine sandy loam about 7 inches thick. Unweathered limestone bedrock is at a depth of about 15 inches.

Longrie soils are well drained. Typically, about 2 inches of partially decomposed and well decomposed leaf litter is at the surface. Below this is about 4 inches of reddish gray sandy loam. The subsoil is dark reddish brown and dark brown, friable fine sandy loam about 17 inches thick. The substratum is brown, calcareous sandy loam about 13 inches thick. Unweathered limestone bedrock is at a depth of about 36 inches.

Battydoe soils are well drained. Typically, about 1 inch of partially decomposed leaf litter is at the surface. Below this is about 2 inches of black fine sandy loam. The subsurface layer is reddish gray loamy sand about 2 inches thick. The subsoil is about 15 inches thick. The upper part is dark reddish brown, friable fine sandy loam that has pockets of weakly cemented material. The lower part is reddish brown, friable loamy sand and brown, friable gravelly fine sandy loam. The substratum to a depth of 60 inches or more is light brown, calcareous gravelly sandy loam.

Of minor extent are areas of exposed limestone bedrock, the well drained Furlong and Greylock soils, and the somewhat poorly drained Ensign soils. Furlong soils have sandy textures over bedrock. They are in landscape positions similar to those of the Amadon and Longrie soils. The very deep Greylock soils are less cobbly than the major soils. They are in landscape positions similar to those of the Battydoe soils. Ensign soils are in depressions.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality in areas of the shallower soils and the hazard of erosion in the steeper areas.

### Nearly Level to Steep, Very Deep Soils That Are Very Poorly Drained to Somewhat Excessively Drained

These soils are used mainly as woodland. A few small areas are used as cropland or pasture. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. If the soils are used for crops or pasture, removing excess water and minimizing surface compaction are management concerns.

#### 13. Wakeley-Allendale Association

*Very deep, nearly level, poorly drained and somewhat poorly drained, mucky and sandy soils on lake plains and outwash plains*

Areas of these soils are on lake plains and outwash plains. Slopes range from 0 to 31 percent.

This association makes up about 3 percent of the county. It is about 40 percent Wakeley and similar soils, 25 percent Allendale and similar soils, and 35 percent soils of minor extent.

Wakeley soils are poorly drained. Typically, the surface layer is about 4 inches of black muck over 1 inch of black loamy fine sand. The substratum extends to a depth of 60 inches or more. It is dark grayish brown, mottled loamy fine sand in the upper part; pale brown, mottled fine sand in the next part; and reddish brown, mottled, calcareous silty clay in the lower part.

Allendale soils are somewhat poorly drained. Typically, about 2 inches of partially decomposed leaf litter is at the surface. Below this is about 1 inch of black fine sand. The subsurface layer is brown fine sand about 4 inches thick. The subsoil is about 30 inches thick. The upper part is dark reddish brown, yellowish brown, and pale brown, mottled, loose fine sand. The lower part is light reddish brown, mottled, firm silty clay loam. The substratum to a depth of 80 inches or more is light reddish brown, calcareous silty clay.

Of minor extent are the poorly drained Angelica and Pickford soils, the very poorly drained Leafriver soils, and the moderately well drained Croswell soils. Pickford and Angelica soils are in landscape positions similar to those of the Wakeley soils. Pickford soils are clayey throughout, and Angelica soils are loamy throughout. Croswell soils are in the slightly higher landscape positions.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality.

#### 14. Caffey-Iosco-Pullup Association

*Very deep, nearly level to steep, poorly drained to somewhat excessively drained, mucky and sandy soils on lake plains, outwash plains, and ground moraines*

Areas of these soils are on lake plains, outwash plains, and ground moraines. Slopes range from 0 to 35 percent.

This association makes up about 1 percent of the county. It is about 35 percent Caffey and similar soils, 20 percent Iosco and similar soils, 20 percent Pullup and similar soils, and 25 percent soils of minor extent.

Caffey soils are poorly drained. Typically, the surface

layer is black muck about 6 inches thick. The substratum extends to a depth of 80 inches or more. It is brown and yellowish brown, stratified sand and fine sand in the upper part and grayish brown very fine sandy loam in the lower part.

Iosco soils are somewhat poorly drained. Typically, about 6 inches of partially decomposed leaf litter and black, well decomposed leaf litter is at the surface. Below this is about 5 inches of dark grayish brown and brown, mottled sand. The subsoil is about 27 inches thick. The upper part is dark brown and yellowish brown, mottled, friable sand and loamy sand. The lower part is reddish brown, mottled, friable loam. The substratum to a depth of 60 inches or more is light brown loam.

Pullup soils are somewhat excessively drained. Typically, about 1 inch of slightly decomposed leaf litter is at the surface. Below this is about 8 inches of light brownish gray fine sand. The subsoil is about 14 inches thick. It is dark brown, very friable fine sand in the upper part and strong brown and pinkish gray, cemented fine sand in the lower part. The substratum to a depth of 80 inches or more is very pale brown fine sand.

Of minor extent are the moderately well drained Paquin, somewhat poorly drained Finch, and very poorly drained Markey soils. Paquin and Finch soils are sandy throughout. They are in landscape positions similar to those of the Iosco soils. The organic Markey soils are in landscape positions similar to those of the Caffey soils.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, seedling mortality, and the windthrow hazard. The hazard of erosion is an additional concern in the steeper areas.

### 15. Pickford-Battydoe-Gogomain Association

*Very deep, nearly level to steep, poorly drained to well drained, clayey and loamy soils on ground moraines and lake plains*

Areas of these soils are on ground moraines and lake plains. Slopes range from 0 to 35 percent.

This association makes up about 3 percent of the county. It is about 25 percent Pickford and similar soils, 25 percent Battydoe and similar soils, 15 percent Gogomain and similar soils, and 35 percent soils of minor extent.

Pickford soils are poorly drained. Typically, the surface layer is very dark grayish brown silty clay loam about 6 inches thick. The subsoil is reddish brown and dark gray, mottled, firm clay about 13 inches thick. The substratum to a depth of 60 inches or more is reddish brown, calcareous clay that has olive gray streaks of lime.

Battydoe soils are well drained. Typically, about 1 inch of partially decomposed leaf litter is at the surface. Below this is about 2 inches of black fine sandy loam. The subsurface layer is reddish gray loamy sand about 2 inches thick. The subsoil is about 15 inches thick. The upper part is dark reddish brown, friable fine sandy loam that has pockets of weakly cemented material. The lower part is reddish brown, friable loamy sand and brown, friable gravelly fine sandy loam. The substratum to a depth of 60 inches or more is light brown, calcareous gravelly fine sandy loam.

Gogomain soils are poorly drained. Typically, the surface layer is very dark gray very fine sandy loam about 10 inches thick. The subsoil is grayish brown and brown, stratified, mottled, friable loamy very fine sand, very fine sandy loam, and fine sandy loam about 8 inches thick. The substratum to a depth of 80 inches or more is reddish brown, calcareous clay.

Of minor extent are the well drained Superior soils, the somewhat poorly drained Engadine and Moltke soils, and the very poorly drained Markey soils. Superior soils are loamy and are underlain by clayey deposits. They are in landscape positions similar to those of the Battydoe soils. Engadine and Moltke soils are in slightly higher positions on the landscape than the Pickford and Gogomain soils. The organic Markey soils are in depressions.

Most areas of this association are wooded. Some areas are used as cropland or pasture. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. The hazard of erosion is an additional concern in the steeper areas of the Battydoe soils. If the soils are used for crops or pasture, removing excess water, minimizing surface compaction, and controlling erosion are management concerns.

### 16. Dawson-Spot-Pullup Association

*Very deep, nearly level to steep, very poorly drained to somewhat excessively drained, mucky and sandy soils on lake plains and outwash plains*

Areas of these soils are on lake plains and outwash plains. Slopes range from 0 to 35 percent.

This association makes up about 3 percent of the county. It is about 33 percent Dawson and similar soils, 32 percent Spot and similar soils, 15 percent Pullup and similar soils, and 20 percent soils of minor extent.

Dawson soils are very poorly drained. Typically, the surface layer is yellowish brown and dark yellowish brown peat about 5 inches thick. The next layer is black muck about 27 inches thick. The substratum to a depth

of 60 inches or more is grayish brown or yellowish brown sand.

Spot soils are poorly drained. Typically, the surface layer is about 2 inches of slightly decomposed organic material and black muck. The subsurface layer is light brownish gray, mottled sand about 6 inches thick. The subsoil is about 10 inches thick. The upper part is dark reddish brown and dark brown, cemented sand. The lower part is strong brown, friable sand. The substratum to a depth of 80 inches or more is light brown and light yellowish brown sand.

Pullup soils are somewhat excessively drained. Typically, about 1 inch of slightly decomposed leaf litter is at the surface. Below this is about 8 inches of light brownish gray fine sand. The subsoil is about 14 inches thick. It is dark brown, very friable fine sand in the upper part and strong brown and pinkish gray, cemented fine sand in the lower part. The substratum to a depth of 80 inches or more is very pale brown fine sand.

Of minor extent are the moderately well drained Paquin, well drained Wallace, and poorly drained Finch soils. Paquin soils are in slightly lower positions on the landscape than the Pullup soils. Wallace soils are in landscape positions similar to those of the Pullup soils. Finch soils are in slightly higher positions on the landscape than the Spot soils.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations and seedling mortality. The hazard of erosion is an additional concern in the steeper areas.

### 17. Markey-Battydoe-Shelter Association

*Very deep, nearly level to steep, well drained to very poorly drained, mucky and loamy soils on ground moraines*

Areas of these soils are on ground moraines. Slopes range from 0 to 35 percent.

This association makes up about 4 percent of the county. It is about 25 percent Markey and similar soils, 25 percent Battydoe and similar soils, 15 percent Shelter and similar soils, and 35 percent soils of minor extent.

Markey soils are very poorly drained. Typically, the surface layer is black muck about 18 inches thick. The next layer is very dark brown mucky peat about 5 inches thick. Below this is about 4 inches of very dark grayish brown muck. The next layer to a depth of about 60 inches is dark gray and dark grayish brown sand.

Battydoe soils are well drained. Typically, about 1 inch of partially decomposed leaf litter is at the surface. Below this is about 2 inches of black fine sandy loam. The subsurface layer is reddish gray loamy sand about 2 inches thick. The subsoil is about 15 inches thick. The upper part is dark reddish brown, friable fine sandy loam that has pockets of weakly cemented material. The lower part is reddish brown, friable loamy sand and brown, friable gravelly fine sandy loam. The substratum to a depth of 60 inches or more is light brown, calcareous gravelly fine sandy loam.

Shelter soils are somewhat poorly drained. Typically, about 2 inches of well decomposed leaf litter is at the surface. Below this is about 6 inches of black very cobbly loam and very dark grayish brown and dark yellowish brown very cobbly fine sandy loam. The subsoil is dark yellowish brown, friable very cobbly fine sandy loam about 4 inches thick. The substratum to a depth of 60 inches or more is light brown, mottled, dense, calcareous very gravelly fine sandy loam.

Of minor extent are the well drained Guardlake soils and the poorly drained Beavertail and Pickford soils. Guardlake soils are sand in the upper part and have a substratum of gravel. They are in landscape positions similar to those of the Battydoe soils. Beavertail and Pickford soils are in depressions.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. The hazard of erosion is an additional concern in the steeper areas of the Battydoe soils.

#### Nearly Level to Very Steep, Very Deep Soils That Are Well Drained to Excessively Drained

These soils are generally used as woodland. A few small areas are used as cropland or pasture. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. The hazard of erosion is an additional concern in the steeper areas. If the soils are used for crops or pasture, droughtiness and the hazard of erosion are management concerns.

### 18. Springlake-Kalkaska Association

*Very deep, nearly level to very steep, somewhat excessively drained, sandy soils on outwash plains and ground moraines*

Areas of these soils are on outwash plains and ground moraines. Slopes range from 0 to 60 percent.

This association makes up about 4 percent of the county. It is about 50 percent Springlake soils, 25 percent Kalkaska and similar soils, and 25 percent soils of minor extent.

Springlake soils are somewhat excessively drained. Typically, about 1 inch of slightly decomposed leaf litter is at the surface. Below this is about 6 inches of very dark grayish brown loamy coarse sand. The subsurface

layer is grayish brown loamy coarse sand about 2 inches thick. The subsoil is about 17 inches thick. The upper part is dark brown, very friable loamy coarse sand and strong brown, loose loamy coarse sand. The lower part is strong brown, loose gravelly coarse sand. The substratum to a depth of 80 inches or more is yellowish brown gravelly coarse sand.

Kalkaska soils are somewhat excessively drained. Typically, about 1 inch of partially decomposed leaf litter is at the surface. Below this is about 5 inches of brown sand. The subsoil is dark reddish brown, dark brown, and dark yellowish brown, very friable sand about 32 inches thick. The substratum to a depth of 80 inches or more is yellowish brown sand.

Of minor extent are the well drained Guardlake and Wallace soils and the moderately well drained Paquin soils. Guardlake and Wallace soils are in landscape positions similar to those of the Springlake and Kalkaska soils. Paquin soils are in the slightly lower landscape positions.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations and seedling mortality. The hazard of erosion is an additional concern in the steeper areas.

### 19. Greylock-Adams-Kalkaska Association

*Very deep, nearly level to very steep, well drained and somewhat excessively drained, sandy and loamy soils on outwash plains and ground moraines*

Areas of these soils are on outwash plains and ground moraines. Slopes range from 0 to 60 percent.

This association makes up about 1 percent of the county. It is about 35 percent Greylock and similar soils, 25 percent Adams and similar soils, 20 percent Kalkaska and similar soils, and 20 percent soils of minor extent.

Greylock soils are well drained. Typically, about 1 inch of partially decomposed leaf litter is at the surface. Below this is about 5 inches of black fine sandy loam. The subsurface layer is reddish gray sandy loam about 1 inch thick. The subsoil is about 27 inches thick. The upper part is dark reddish brown and dark brown, friable fine sandy loam and sandy loam. The lower part is brown and reddish brown, firm loamy sand and sandy loam. The substratum to a depth of 80 inches or more is brown, calcareous sandy loam.

Adams soils are somewhat excessively drained. Typically, about 1 inch of slightly decomposed leaf litter is at the surface. Below this is about 4 inches of very dark gray sandy loam. The subsurface layer is reddish gray sandy loam about 1 inch thick. The subsoil is about 21 inches thick. The upper part is dark reddish brown, friable sandy loam. The next part is reddish brown, friable loamy sand. The lower part is strong brown and brownish yellow, very friable sand. The substratum to a depth of 80 inches or more is light yellowish brown sand that has a few thin strata of yellowish brown loamy sand.

Kalkaska soils are somewhat excessively drained. Typically, about 1 inch of partially decomposed leaf litter is at the surface. Below this is about 5 inches of brown sand. The subsoil is dark reddish brown, dark brown, and dark yellowish brown, very friable sand about 32 inches thick. The substratum to a depth of 80 inches or more is yellowish brown sand.

Of minor extent are the moderately well drained Graveraet, somewhat poorly drained Solona, and very poorly drained Markey soils. Graveraet soils are in landscape positions similar to those of the Greylock soils. Solona soils are in the lower landscape positions. The organic Markey soils are in depressions.

Most areas of this association are wooded. A few small areas are used as cropland or pasture. The major concerns affecting woodland are equipment limitations and seedling mortality. The hazard of erosion is an additional concern in areas of the Greylock soils. If the soils are used for crops or pasture, the hazard of erosion is a management concern.

### 20. Guardlake-Wallace-Greylock Association

*Very deep, nearly level to very steep, well drained, sandy and loamy soils on outwash plains and ground moraines*

Areas of these soils are on outwash plains and ground moraines. Slopes range from 0 to 60 percent.

This association makes up about 7 percent of the county. It is about 30 percent Guardlake and similar soils, 25 percent Wallace and similar soils, 20 percent Greylock and similar soils, and 25 percent soils of minor extent.

Guardlake soils are well drained. Typically, about 1 inch of slightly decomposed leaf litter is at the surface. Below this is about 1 inch of black fine sandy loam. The subsurface layer is brown fine sandy loam about 2 inches thick. The subsoil is dark reddish brown, very friable fine sandy loam about 9 inches thick. The substratum to a depth of 60 inches or more is calcareous, light yellowish brown and yellow very gravelly sand.

Wallace soils are well drained. Typically, about 2 inches of partially decomposed leaf litter is at the surface. Below this is about 2 inches of light brownish gray sand. The subsoil is about 49 inches thick. The upper part is very friable, dark reddish brown sand. The next part is dark brown, cemented sand. The lower part

is brownish yellow, loose sand. The substratum to a depth of 80 inches or more is light yellowish brown sand.

Greylock soils are well drained. Typically, about 1 inch of partially decomposed leaf litter is at the surface. Below this is about 5 inches of black fine sandy loam. The subsurface layer is reddish gray sandy loam about 1 inch thick. The subsoil is about 27 inches thick. The upper part is dark reddish brown and dark brown, friable fine sandy loam and sandy loam. The lower part is brown and reddish brown, firm loamy sand and sandy loam. The substratum to a depth of 80 inches or more is brown, calcareous sandy loam.

Of minor extent are the somewhat poorly drained Solona, well drained Battydoe, and somewhat excessively drained Springlake soils. Solona soils are in the lower landscape positions. Battydoe soils have more coarse fragments throughout than the major soils. They are in landscape positions similar to those of the Greylock soils. Springlake soils are in landscape positions similar to those of the Guardlake soils.

Most areas of this association are wooded. A few small areas are used as cropland or pasture. The major concerns affecting woodland are equipment limitations, the windthrow hazard, and seedling mortality. The hazard of erosion is an additional concern in the steeper areas. If the soils are used for crops or pasture, droughtiness and the hazard of erosion are management concerns.

### 21. Rubicon-Kalkaska Association

*Very deep, nearly level to very steep, excessively drained and somewhat excessively drained, sandy soils on outwash plains and ground moraines*

Areas of these soils are on outwash plains and ground moraines. Slopes range from 0 to 60 percent.

This association makes up about 3 percent of the county. It is about 45 percent Rubicon and similar soils, 30 percent Kalkaska and similar soils, and 25 percent soils of minor extent.

Rubicon soils are excessively drained. Typically, about 2 inches of partially decomposed leaf litter is at the surface. Below this is about 2 inches of grayish brown sand. The subsoil is about 28 inches thick. The upper part is dark brown and strong brown, very friable sand. The lower part is reddish yellow, loose sand. The substratum to a depth of 80 inches or more is brownish yellow and light yellowish brown sand.

Kalkaska soils are somewhat excessively drained. Typically, about 1 inch of partially decomposed leaf litter is at the surface. Below this is about 5 inches of brown sand. The subsoil is dark reddish brown, dark brown, and dark yellowish brown, very friable sand about 32 inches thick. The substratum to a depth of 80 inches or more is yellowish brown sand.

Of minor extent are the moderately well drained Croswell, somewhat poorly drained Finch, and very poorly drained Markey soils. Croswell and Finch soils are in the lower landscape positions. The organic Markey soils are in depressions.

Most areas of this association are wooded. The major concerns affecting woodland are equipment limitations and seedling mortality. The hazard of erosion is an additional concern in the steeper areas.

# Detailed Soil Map Units

The map units delineated on the detailed maps in this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses. More information about each map unit is given under the heading "Use and Management of the Soils."

A map unit delineation on a map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some "included" areas that belong to other taxonomic classes.

Most included soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included areas of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans, but if intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Kalkaska sand, 0 to 6 percent slopes, is a phase of the Kalkaska series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Finch-Dawson-Pullup complex, 0 to 35 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. The map unit Markey and Carbondale mucks is an undifferentiated group in this survey area.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. The map unit Pits, sand and gravel, is an example.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

## Soil Descriptions

## 10D—Ontonagon silt loam, 6 to 15 percent slopes

### *Setting*

*Landform:* Gently rolling and rolling areas on lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 80 acres

### *Typical Profile*

*Surface layer:*
0 to 7 inches—dark reddish brown silt loam

*Subsoil:*
7 to 10 inches—reddish brown, firm clay and reddish gray, firm silty clay
10 to 21 inches—reddish brown, firm clay

*Substratum:*
21 to 80 inches—reddish brown clay

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Very slow
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Rapid
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Slight
*Potential for frost action:* Moderate
*Shrink-swell potential:* High

### *Composition*

Ontonagon soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### *Inclusions*

*Contrasting inclusions:*
• The somewhat poorly drained Rudyard soils in nearly level areas

*Similar inclusions:*
• Soils that have a surface layer of sand

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations, windthrow hazard
*Management measures:*
• Because of the very slow permeability and the sticky and plastic subsoil, logging roads should be graveled and, in some areas, landings should be stabilized.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

**Cropland**
*Major management concerns:* Water erosion, low organic matter content, tilth of the surface layer
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.
• Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.

**Pasture**
*Major management concerns:* Wetness, compaction
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.
• The only hay and pasture plants that should be seeded are those that can withstand periodic inundation and seasonal wetness.

### *Interpretive Groups*

*Land capability classification:* IIIe
*Woodland ordination symbol:* 2C
*Michigan soil management group:* Oa
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 10F—Ontonagon silt loam, 25 to 50 percent slopes

### Setting

*Landform:* Rolling to very steep areas on lake plains
*Shape of areas:* Irregular or elongated
*Size of areas:* 5 to 120 acres

### Typical Profile

*Surface layer:*
0 to 7 inches—dark reddish brown silt loam
*Subsoil:*
7 to 10 inches—reddish brown, firm clay and reddish gray, firm silty clay
10 to 21 inches—reddish brown, firm clay
*Substratum:*
21 to 80 inches—reddish brown clay

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Very slow
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Rapid
*Flooding:* None
*Hazard of water erosion:* Severe
*Hazard of soil blowing:* Slight
*Potential for frost action:* Moderate
*Shrink-swell potential:* High

### Composition

Ontonagon soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Pickford soils in depressions
*Similar inclusions:*
• Soils that have a surface layer of sand

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, windthrow hazard
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• Because of the erosion hazard, skid roads and skid trails should be established on the contour and water should be removed by water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures.
• Log landings should be located in included level areas or adjacent level areas.
• Cable yarding systems are generally safer than other logging methods and result in less surface disturbance.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIIe
*Woodland ordination symbol:* 2R
*Michigan soil management group:* Oa
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 11A—Rudyard silty clay loam, 0 to 3 percent slopes

### Setting

*Landform:* Nearly level areas on lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 750 acres

### Typical Profile

*Surface layer:*
0 to 10 inches—dark grayish brown silty clay loam
*Subsoil:*
10 to 19 inches—reddish brown, firm, mottled clay
*Substratum:*
19 to 60 inches—reddish brown, mottled clay

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Very slow
*Available water capacity:* Moderate
*Drainage class:* Somewhat poorly drained
*Seasonal high water table:* Perched at a depth of 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* High

### Composition

Rudyard soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Pickford soils in depressions

*Similar inclusions:*
- Soils that have a surface layer of silt loam
- Soils that have a surface layer of sand

### *Use and Management*

**Land use:** Dominant use—cropland; other uses—woodland and pasture

**Cropland**

*Major management concerns:* Seasonal wetness, tilth of the surface layer, low organic matter content, soil compaction

*Management measures:*
- Shallow surface ditches help to remove surface water after heavy rains.
- Subsurface drains can reduce the wetness if a suitable outlet is available.
- Minimizing tillage and tilling and harvesting at the proper soil moisture content help to prevent excessive compaction and maintain tilth.
- Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

**Pasture**

*Major management concerns:* Seasonal wetness, compaction

*Management measures:*
- Proper stocking rates and a planned grazing system help to keep the pasture in good condition.
- The only hay and pasture plants that should be seeded are those that can withstand periodic inundation and seasonal wetness.

**Woodland**

*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard

*Management measures:*
- Because of the very slow permeability and the sticky and plastic subsoil, logging roads should be graveled and, in some areas, landings should be stabilized.
- Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
- Landing sites generally can be used only during the driest time of the year.
- Trees that can withstand seasonal wetness should be selected for planting.
- Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### *Interpretive Groups*

*Land capability classification:* IIIw
*Woodland ordination symbol:* 6W
*Michigan soil management group:* Ob
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 12—Pickford silty clay loam

### *Setting*

*Landform:* Depressions on lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 1,200 acres

### *Typical Profile*

*Surface layer:*
0 to 6 inches—very dark grayish brown silty clay loam

*Subsoil:*
6 to 9 inches—dark gray, firm, mottled clay
9 to 19 inches—reddish brown, firm, mottled clay

*Substratum:*
19 to 60 inches—reddish brown clay

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Very slow
*Available water capacity:* Moderate
*Drainage class:* Poorly drained
*Seasonal high water table:* Perched 1 foot above to 1 foot below the surface at times from November through June
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* Moderate
*Shrink-swell potential:* High

### *Composition*

Pickford soil and similar soils: 80 to 95 percent
Contrasting inclusions: 5 to 20 percent

### *Inclusions*

*Contrasting inclusions:*
- The very poorly drained Dorval soils in shallow depressions
- The somewhat poorly drained Rudyard soils in the slightly higher landscape positions

*Similar inclusions:*
- Soils that have a sandy surface layer

### *Use and Management*

**Land use:** Dominant use—cropland; other uses—pasture and woodland

**Cropland**

*Major management concerns:* Ponding, tilth of the surface layer, soil compaction

*Management measures:*
• Shallow surface ditches help to remove surface water after heavy rains.
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Water-tolerant species should be selected for planting.
• Minimizing tillage and tilling and harvesting at the proper soil moisture content help to prevent excessive compaction and maintain tilth.

**Pasture**
*Major management concerns:* Ponding, soil compaction
*Management measures:*
• Proper stocking rates and a planned grazing system help to keep the pasture in good condition.
• The only hay and pasture plants that should be seeded are those that can withstand periodic inundation and seasonal wetness.

**Woodland**
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Because of wetness, seedling mortality, and plant competition, trees are generally not planted on this soil.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Site preparation methods, such as bedding, trenching, or mounding, can maximize seedling survival and growth in new plantations.

### *Interpretive Groups*

*Land capability classification:* IIIw
*Woodland ordination symbol:* 6W
*Michigan soil management group:* 1c
*Primary habitat type:* TTP
*Secondary habitat type:* None assigned

## 13B—Alcona fine sandy loam, 0 to 6 percent slopes

### *Setting*

*Landform:* Nearly level and undulating areas on lake plains and ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 175 acres

### *Typical Profile*

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 3 inches—pinkish gray fine sandy loam
*Subsoil:*
3 to 17 inches—dark yellowish brown and strong brown, friable fine sandy loam
17 to 23 inches—reddish brown and light pinkish gray, firm very fine sandy loam
23 to 54 inches—light reddish brown, friable loamy fine sand and reddish brown, friable sandy loam
*Substratum:*
54 to 80 inches—light brown and brown, stratified loamy very fine sand, fine sandy loam, and very fine sandy loam

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### *Composition*

Alcona soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### *Inclusions*

*Contrasting inclusions:*
• The somewhat poorly drained Moltke soils in the slightly lower landscape positions
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Alcona soil
• The well drained Wallace soils in landscape positions similar to those of the Alcona soil

*Similar inclusions:*
• Soils that have clayey layers at a depth of 40 to 60 inches
• Soils that have a thin sandy cap

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations
*Management measures:*
• Because of low strength, suitable surfacing material is

needed on year-round logging roads and landings.
• Equipment use should be limited to logging roads during spring snowmelt when the soil is wet and ruts form easily.

**Cropland**
*Major management concerns:* Water erosion, soil blowing
*Management measures:*
• Crop rotations that include close-growing crops, conservation tillage, grassed waterways, cover crops, and crop residue management help to control runoff and water erosion.
• Conservation tillage, crop residue management, vegetative barriers, cover crops, and crop rotations that include small grain and hay help to control soil blowing.

**Pasture**
*Major management concerns:* Overgrazing, seasonal droughtiness
*Management measures:*
• Proper stocking rates and short-duration grazing during the summer help to control soil blowing and water erosion, maintain plant density and hardiness, and keep the pasture in good condition.
• Applying lime and fertilizer according to soil tests ensures maximum growth of plants.

### *Interpretive Groups*

*Land capability classification:* IIe
*Woodland ordination symbol:* 3L
*Michigan soil management group:* 3a-s
*Primary habitat type:* ATD
*Secondary habitat type:* None assigned

## 13D—Alcona fine sandy loam, 6 to 15 percent slopes

### *Setting*

*Landform:* Gently rolling and rolling areas on lake plains and ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 125 acres

### *Typical Profile*

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 3 inches—pinkish gray fine sandy loam
*Subsoil:*
3 to 17 inches—dark brown, dark yellowish brown, and strong brown, friable fine sandy loam
17 to 23 inches—reddish brown and light pinkish gray, firm very fine sandy loam
23 to 54 inches—light reddish brown, friable loamy fine sand and reddish brown, friable sandy loam
*Substratum:*
54 to 80 inches—light brown and brown, stratified loamy very fine sand, fine sandy loam, and very fine sandy loam

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### *Composition*

Alcona soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### *Inclusions*

*Contrasting inclusions:*
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Alcona soil
• The well drained Battydoe soils, which have more rock fragments than the Alcona soil; in landscape positions similar to those of the Alcona soil
• The somewhat poorly drained Moltke soils in the lower landscape positions and in drainageways

*Similar inclusions:*
• Soils that have clayey layers at a depth of 40 to 60 inches

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations
*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• Equipment use should be limited to logging roads during spring snowmelt when the soil is wet and ruts form easily.

**Cropland**
*Major management concerns:* Water erosion, soil blowing
*Management measures:*
• Crop rotations that include close-growing crops, conservation tillage, grassed waterways, cover crops,

and crop residue management help to control runoff and water erosion.
• Conservation tillage, crop residue management, vegetative barriers, cover crops, and crop rotations that include small grain and hay help to control soil blowing.

**Pasture**
*Major management concerns:* Erosion hazard, overgrazing, seasonal wetness, seasonal droughtiness
*Management measures:*
• Proper stocking rates and short-duration grazing during the summer help to control soil blowing and water erosion, maintain plant density and hardiness, and keep the pasture in good condition.
• Applying lime and fertilizer according to soil tests ensures maximum growth of plants.

### *Interpretive Groups*

*Land capability classification:* IIIe
*Woodland ordination symbol:* 3L
*Michigan soil management group:* 3a-s
*Primary habitat type:* ATD
*Secondary habitat type:* None assigned

## 16B—Graveraet fine sandy loam, 1 to 6 percent slopes

### *Setting*

*Landform:* Nearly level and undulating areas on drumlins and ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 160 acres

### *Typical Profile*

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter
*Surface layer:*
0 to 3 inches—very dark gray fine sandy loam
*Subsurface layer:*
3 to 6 inches—brown fine sandy loam
*Subsoil:*
6 to 9 inches—dark reddish brown, friable fine sandy loam
9 to 16 inches—dark brown, firm fine sandy loam
16 to 32 inches—a fragipan of mottled, brown, firm loamy sand and reddish brown, firm loam
32 to 67 inches—reddish brown, firm sandy clay loam and brown loamy sand
*Substratum:*
67 to 80 inches—reddish brown sandy loam

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Very slow in the fragipan, slow in the lower part of the subsoil, and moderate throughout the rest of the profile
*Available water capacity:* Moderate
*Drainage class:* Moderately well drained
*Seasonal high water table:* Perched at a depth of 1.0 to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### *Composition*

Graveraet soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### *Inclusions*

*Contrasting inclusions:*
• The somewhat poorly drained Solona soils in the slightly lower landscape positions
*Similar inclusions:*
• Soils that have a sandy surface layer
• Soils having sandy layers below a depth of 40 inches

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• If trees are planted, site preparation by mechanical or chemical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

### *Interpretive Groups*

*Land capability classification:* IIe
*Woodland ordination symbol:* 3W
*Michigan soil management group:* 3a
*Primary habitat type:* AVO
*Secondary habitat type:* AVO-A

## 16D—Graveraet fine sandy loam, 6 to 15 percent slopes

### *Setting*

*Landform:* Gently rolling and rolling areas on drumlins

*Shape of areas:* Elongated or irregular
*Size of areas:* 10 to 95 acres

### Typical Profile

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 3 inches—very dark gray fine sandy loam

*Subsurface layer:*
3 to 6 inches—brown fine sandy loam

*Subsoil:*
6 to 9 inches—dark reddish brown, friable fine sandy loam
9 to 16 inches—dark brown, firm fine sandy loam
16 to 32 inches—a fragipan of mottled, brown, firm loamy sand and reddish brown, firm loam
32 to 67 inches—reddish brown, firm sandy clay loam and brown loamy sand

*Substratum:*
67 to 80 inches—reddish brown sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Very slow in the fragipan, slow in the lower part of the subsoil, and moderate throughout the rest of the profile
*Available water capacity:* Moderate
*Drainage class:* Moderately well drained
*Seasonal high water table:* Perched at a depth of 1.0 to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Graveraet soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Solona soils in the lower landscape positions

*Similar inclusions:*
• Soils that have a sandy surface layer
• Soils having sandy layers below a depth of 40 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard

*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• If trees are planted, site preparation by mechanical or chemical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting or strip cutting.

### Interpretive Groups

*Land capability classification:* IIIe
*Woodland ordination symbol:* 3W
*Michigan soil management group:* 3a
*Primary habitat type:* AVO
*Secondary habitat type:* AVO-A

## 17D—Eastport sand, 0 to 15 percent slopes

### Setting

*Landform:* Nearly level to rolling areas on dunes and beach ridges
*Shape of areas:* Elongated or irregular
*Size of areas:* 5 to 90 acres

### Typical Profile

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 3 inches—dark gray sand

*Subsurface layer:*
3 to 14 inches—pale brown sand

*Subsoil:*
14 to 38 inches—strong brown and brownish yellow, loose sand

*Substratum:*
38 to 60 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Eastport soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the lower landscape positions
• The poorly drained Leafriver soils in swales
*Similar inclusions:*
• Soils that have a water table between depths of 40 and 60 inches
• Soils that have gravel layers in the substratum

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* 5S
*Michigan soil management group:* 5.3a
*Primary habitat type:* AQVac
*Secondary habitat type:* TMV

## 17E—Eastport sand, 15 to 35 percent slopes

### Setting

*Landform:* Rolling to very steep areas on dunes and beach ridges
*Shape of areas:* Elongated or irregular
*Size of areas:* 5 to 1,500 acres

### Typical Profile

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter
*Surface layer:*
0 to 3 inches—dark gray sand
*Subsurface layer:*
3 to 14 inches—pale brown sand
*Subsoil:*
14 to 38 inches—strong brown and brownish yellow, loose sand
*Substratum:*
38 to 60 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Eastport soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the lower landscape positions
• The poorly drained Leafriver soils in swales
*Similar inclusions:*
• Soils that have gravel layers in the substratum

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Log landings should be located in included level areas or adjacent level areas.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* 5R
*Michigan soil management group:* 5.3a
*Primary habitat type:* AQVac
*Secondary habitat type:* TMV

## 18B—Rubicon sand, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 3,000 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 4 inches—grayish brown sand
*Subsoil:*
4 to 17 inches—dark brown and strong brown, very friable sand
17 to 32 inches—reddish yellow, loose sand
*Substratum:*
32 to 80 inches—brownish yellow and light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Rubicon soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the slightly lower landscape positions
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Rubicon soil
*Similar inclusions:*
• Soils that have a water table between depths of 40 and 60 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* 4S
*Michigan soil management group:* 5.3a
*Primary habitat type:* AQVac
*Secondary habitat type:* QAE

## 18D—Rubicon sand, 6 to 15 percent slopes

### Setting

*Landform:* Gently rolling and rolling areas on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 275 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 4 inches—grayish brown sand
*Subsoil:*
4 to 17 inches—dark brown and strong brown, very friable sand
17 to 32 inches—reddish yellow, loose sand
*Substratum:*
32 to 80 inches—brownish yellow and light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Rubicon soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the lower landscape positions
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Rubicon soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of

wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* 4S
*Michigan soil management group:* 5.3a
*Primary habitat type:* AQVac
*Secondary habitat type:* QAE

## 18E—Rubicon sand, 15 to 35 percent slopes

### Setting

*Landform:* Rolling to steep areas on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 65 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 4 inches—grayish brown sand
*Subsoil:*
4 to 17 inches—dark brown and strong brown, very friable sand
17 to 32 inches—reddish yellow, loose sand
*Substratum:*
32 to 80 inches—brownish yellow and light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Rubicon soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the lower landscape positions
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Rubicon soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• Building logging roads and skid trails on the contour helps to control erosion.
• Log landings should be located in included level areas or adjacent level areas.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* 4R
*Michigan soil management group:* 5.3a
*Primary habitat type:* AQVac
*Secondary habitat type:* QAE

## 18F—Rubicon sand, 35 to 60 percent slopes

### Setting

*Landform:* Very steep areas on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 65 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 4 inches—grayish brown sand
*Subsoil:*
4 to 17 inches—dark brown and strong brown, very friable sand
17 to 32 inches—reddish yellow, loose sand
*Substratum:*
32 to 80 inches—brownish yellow and light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Excessively drained

*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Rubicon soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Rubicon soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• Cable yarding systems are generally safer than other logging methods and result in less surface disturbance.
• Because of the erosion hazard, skid roads and skid trails should be established on the contour and water should be removed by water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures.
• Log landings should be located in included level areas or adjacent level areas.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* 4R
*Michigan soil management group:* 5.3a
*Primary habitat type:* AQVac
*Secondary habitat type:* QAE

## 19B—Kalkaska sand, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on outwash plains and ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 3,500 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 6 inches—brown sand
*Subsoil:*
6 to 18 inches—dark reddish brown and dark brown, very friable sand
18 to 38 inches—dark yellowish brown, loose sand
*Substratum:*
38 to 80 inches—yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Kalkaska soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the slightly lower landscape positions
*Similar inclusions:*
• Soils that have a water table between depths of 40 and 60 inches
• Soils that have calcareous sand and gravel below a depth of 40 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* IVs
*Woodland ordination symbol:* 3S
*Michigan soil management group:* 5a
*Primary habitat type:* ATD

*Secondary habitat type:* TM

## 19D—Kalkaska sand, 6 to 15 percent slopes

### Setting

*Landform:* Gently rolling and rolling areas on outwash plains and ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 325 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 6 inches—brown sand
*Subsoil:*
6 to 18 inches—dark reddish brown and dark brown, very friable sand
18 to 38 inches—dark yellowish brown, loose sand
*Substratum:*
38 to 80 inches—yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Kalkaska soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the lower landscape positions
*Similar inclusions:*
• Soils that have layers of fine sand
• Soils that have calcareous sand and gravel below a depth of 40 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* 3S
*Michigan soil management group:* 5a
*Primary habitat type:* ATD
*Secondary habitat type:* TM

## 19E—Kalkaska sand, 15 to 35 percent slopes

### Setting

*Landform:* Rolling to steep areas on outwash plains and ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 200 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 6 inches—brown sand
*Subsoil:*
6 to 18 inches—dark reddish brown and dark brown, very friable sand
18 to 38 inches—dark yellowish brown, loose sand
*Substratum:*
38 to 80 inches—yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Kalkaska soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the lower landscape positions

*Similar inclusions:*
• Soils that have layers of fine sand
• Soils that have calcareous sand and gravel below a depth of 40 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• Log landings should be located in included level areas or adjacent level areas.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* 3R
*Michigan soil management group:* 5a
*Primary habitat type:* ATD
*Secondary habitat type:* TM

## 19F—Kalkaska sand, 35 to 60 percent slopes

### Setting

*Landform:* Very steep areas on outwash plains and ground moraines
*Shape of areas:* Irregular or elongated
*Size of areas:* 5 to 200 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 6 inches—brown sand
*Subsoil:*
6 to 18 inches—dark reddish brown and dark brown, very friable sand
18 to 38 inches—dark yellowish brown, loose sand
*Substratum:*
38 to 80 inches—yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Severe
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Kalkaska soil and similar soils: 100 percent

### Inclusions

*Similar inclusions:*
• Soils that have layers of fine sand
• Soils that have calcareous sand and gravel below a depth of 40 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• Cable yarding systems are generally safer than other logging methods and result in less surface disturbance.
• Log landings should be located in included level areas or adjacent level areas.
• Because of the erosion hazard, skid roads and skid trails should be established on the contour and water should be removed by water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* 3R
*Michigan soil management group:* 5a
*Primary habitat type:* ATD
*Secondary habitat type:* TM

## 20B—Croswell sand, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 10 to 200 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter

*Surface layer:*
2 to 6 inches—light brownish gray sand

*Subsoil:*
6 to 8 inches—strong brown, loose sand
8 to 15 inches—strong brown, loose sand
15 to 22 inches—brownish yellow sand

*Substratum:*
22 to 80 inches—light yellowish brown, mottled sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Moderately well drained
*Depth to seasonal high water table:* 2.0 to 3.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Croswell soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The excessively drained Eastport soils in the higher landscape positions
• The somewhat poorly drained Finch and Wainola soils in the slightly lower landscape positions

*Similar inclusions:*
• Soils that have gravelly layers below a depth of 30 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

### Interpretive Groups

*Land capability classification:* IVs
*Woodland ordination symbol:* 5S
*Michigan soil management group:* 5a
*Primary habitat type:* AQVac
*Secondary habitat type:* None assigned

## 21A—Finch sand, 0 to 3 percent slopes

### Setting

*Landform:* Nearly level areas on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 325 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 11 inches—pinkish gray sand

*Subsoil:*
11 to 42 inches—dark brown, dark reddish brown, and brown, mottled, cemented sand

*Substratum:*
42 to 80 inches—yellowish brown fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layer and rapid in the rest of the profile
*Available water capacity:* Very low
*Drainage class:* Somewhat poorly drained
*Depth to seasonal high water table:* 0.5 foot to 1.5 feet at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Finch soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Spot soils in depressions
• The excessively drained Rubicon and well drained Wallace soils in the higher landscape positions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations,

seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Trees that can withstand seasonal wetness should be selected for planting.

### *Interpretive Groups*

*Land capability classification:* IVw
*Woodland ordination symbol:* 4W
*Michigan soil management group:* 5b-h
*Primary habitat type:* TMC
*Secondary habitat type:* TMC-V

## 22—Spot muck

### *Setting*

*Landform:* Depressions on outwash plains, ground moraines, and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 250 acres

### *Typical Profile*

*Surface layer:*
0 to 1 inch—slightly decomposed organic matter
1 to 2 inches—black muck
*Subsurface layer:*
2 to 8 inches—light brownish gray, mottled sand
*Subsoil:*
8 to 12 inches—dark reddish brown and dark brown, cemented sand
12 to 18 inches—strong brown, friable sand
*Substratum:*
18 to 80 inches—light brown and light yellowish brown sand

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layer and rapid in the rest of the profile
*Available water capacity:* Low
*Drainage class:* Poorly drained
*Seasonal high water table:* 1 foot above to 1 foot below the surface at times from September through June
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### *Composition*

Spot soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### *Inclusions*

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the slightly higher landscape positions
• The very poorly drained Markey and Dawson soils in landscape positions similar to those of the Spot soil

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Site preparation methods, such as bedding, trenching, or mounding, can maximize seedling survival and growth in new plantations.

### *Interpretive Groups*

*Land capability classification:* Vw
*Woodland ordination symbol:* 2W
*Michigan soil management group:* 5c-h
*Primary habitat type:* TTS
*Secondary habitat type:* None assigned

## 23—Leafriver mucky peat

### *Setting*

*Landform:* Depressions on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 340 acres

### *Typical Profile*

*Surface layer:*
0 to 8 inches—black mucky peat and muck

8 to 10 inches—black, mottled loamy fine sand

*Substratum:*

10 to 60 inches—grayish brown and dark grayish brown, mottled fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderately rapid in the upper part and rapid in the lower part
*Available water capacity:* Moderate
*Drainage class:* Very poorly drained
*Seasonal high water table:* 1 foot above to 1 foot below the surface at times from October through June
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

Leafriver soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*

• The somewhat poorly drained Finch soils in the slightly higher landscape positions
• The very poorly drained, organic Markey soils in landscape positions similar to those of the Leafriver soil
• The poorly drained Wakeley soils in landscape positions similar to those of the Leafriver soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*

• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Site preparation methods, such as bedding, trenching, or mounding, can maximize seedling survival and growth in new plantations.

### Interpretive Groups

*Land capability classification:* VIw
*Woodland ordination symbol:* 2W
*Michigan soil management group:* 5c
*Primary habitat type:* FMC
*Secondary habitat type:* None assigned

## 24B—Springlake loamy coarse sand, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on outwash plains, ground moraines, and beach ridges
*Shape of areas:* Irregular
*Size of areas:* 5 to 2,500 acres

### Typical Profile

*Organic mat:*

1 inch to 0—slightly decomposed leaf litter

*Surface layer:*

0 to 6 inches—very dark grayish brown loamy coarse sand

*Subsurface layer:*

6 to 8 inches—grayish brown loamy coarse sand

*Subsoil:*

8 to 13 inches—dark brown, very friable loamy coarse sand
13 to 25 inches—strong brown, loose coarse sand and gravelly coarse sand

*Substratum:*

25 to 80 inches—light yellowish brown gravelly coarse sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Very rapid
*Available water capacity:* Low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Springlake soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*

• The well drained Guardlake and Wallace soils in landscape positions similar to those of the Springlake soil

### Use and Management

**Land use:** Dominant uses—woodland (fig. 5); other uses—cropland and pasture

**Woodland**

*Major management concerns:* Equipment limitations, seedling mortality

*Management measures:*

• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.

• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

**Cropland**

*Major management concerns:* Droughtiness, low organic matter content

*Management measures:*

• A system of conservation tillage that leaves crop residue on the surface is effective in conserving moisture and in reducing the hazard of soil blowing.

• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

**Pasture**

*Major management concerns:* Droughtiness

*Management measures:*

• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### Interpretive Groups

*Land capability classification:* IVs
*Woodland ordination symbol:* 3S
*Michigan soil management group:* 5a
*Primary habitat type:* AVO
*Secondary habitat type:* ATD

## 24D—Springlake loamy coarse sand, 6 to 15 percent slopes

### Setting

*Landform:* Gently rolling and rolling areas on outwash plains, ground moraines, and beach ridges
*Shape of areas:* Irregular or elongated
*Size of areas:* 5 to 110 acres

### Typical Profile

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 6 inches—very dark grayish brown loamy coarse sand

*Subsurface layer:*
6 to 8 inches—grayish brown loamy coarse sand

*Subsoil:*
8 to 13 inches—dark brown loamy coarse sand
13 to 25 inches—strong brown, loose coarse sand and gravelly coarse sand

*Substratum:*
25 to 80 inches—light yellowish brown gravelly coarse sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Springlake soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*

• The well drained Guardlake and Wallace soils in landscape positions similar to those of the Springlake soil

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**

*Major management concerns:* Equipment limitations, seedling mortality

*Management measures:*

• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.

• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

**Cropland**

*Major management concerns:* Droughtiness, low organic matter content

*Management measures:*

• A system of conservation tillage that leaves crop residue on the surface is effective in conserving moisture and in reducing the hazard of soil blowing.

• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

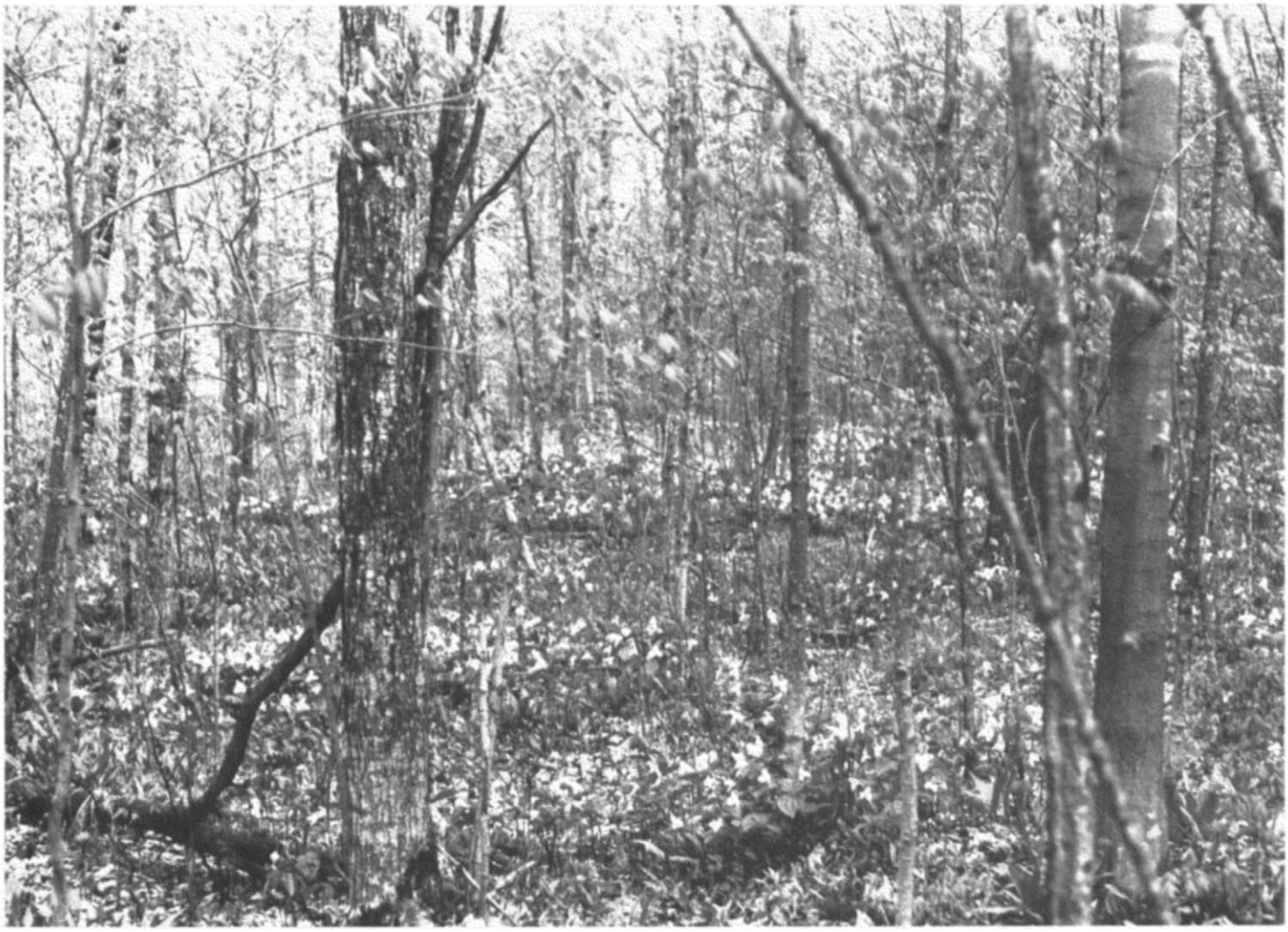

**Figure 5.—Northern hardwoods and spring wildflowers in an area of Springlake loamy coarse sand, 0 to 6 percent slopes. This soil is one of the most productive woodland soils in the county.**

**Pasture**
*Major management concerns:* Droughtiness
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### *Interpretive Groups*

*Land capability classification:* VIs
*Woodland ordination symbol:* 3S
*Michigan soil management group:* 5a
*Primary habitat type:* AVO
*Secondary habitat type:* ATD

## 24E—Springlake loamy coarse sand, 15 to 35 percent slopes

### *Setting*

*Landform:* Rolling to steep areas on outwash plains, ground moraines, and beach ridges
*Shape of areas:* Irregular or elongated
*Size of areas:* 5 to 100 acres

### *Typical Profile*

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 6 inches—very dark grayish brown loamy coarse sand

*Subsurface layer:*
6 to 8 inches—grayish brown loamy coarse sand

*Subsoil:*
8 to 13 inches—dark brown loamy coarse sand
13 to 25 inches—strong brown, loose coarse sand and gravelly coarse sand

*Substratum:*
25 to 80 inches—light yellowish brown gravelly coarse sand

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### *Composition*

Springlake soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### *Inclusions*

*Contrasting inclusions:*
• The well drained Wallace soils in landscape positions similar to those of the Springlake soil

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• Building logging roads and skid trails on the contour helps to control erosion.
• The included level areas or nearby nearly level areas should be selected as sites for log landings.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### *Interpretive Groups*

*Land capability classification:* VIIs
*Woodland ordination symbol:* 3R
*Michigan soil management group:* 5a
*Primary habitat type:* AVO
*Secondary habitat type:* ATD

## 25B—Guardlake fine sandy loam, 0 to 6 percent slopes

### *Setting*

*Landform:* Nearly level and undulating areas on outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 2,650 acres

### *Typical Profile*

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 1 inch—black fine sandy loam

*Subsurface layer:*
1 to 3 inches—brown fine sandy loam

*Subsoil:*
3 to 12 inches—dark reddish brown, very friable fine sandy loam

*Substratum:*
12 to 60 inches—light yellowish brown and yellow very gravelly sand

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate in the upper part and very rapid in the lower part
*Available water capacity:* Low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### *Composition*

Guardlake soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### *Inclusions*

*Contrasting inclusions:*
• The well drained Greylock and Wallace soils in landscape positions similar to those of the Guardlake soil
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Guardlake soil

*Similar inclusions:*
• Soils that have limestone bedrock between depths of 40 and 60 inches

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* None

**Cropland**
*Major management concerns:* Seasonal droughtiness
*Management measures:*
• A system of conservation tillage that leaves crop residue on the surface is effective in conserving moisture and in reducing the hazard of soil blowing.

**Pasture**
*Major management concerns:* Seasonal droughtiness
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### *Interpretive Groups*

*Land capability classification:* IVs
*Woodland ordination symbol:* 3A
*Michigan soil management group:* Ga
*Primary habitat type:* AVO
*Secondary habitat type:* AVO-A

## 25D—Guardlake fine sandy loam, 6 to 15 percent slopes

### *Setting*

*Landform:* Gently rolling and rolling areas on outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 75 acres

### *Typical Profile*

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 1 inch—black fine sandy loam

*Subsurface layer:*
1 to 3 inches—brown fine sandy loam

*Subsoil:*
3 to 12 inches—dark reddish brown, very friable fine sandy loam

*Substratum:*
12 to 60 inches—dark yellowish brown and yellow very gravelly sand

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate in the upper part and very rapid in the lower part
*Available water capacity:* Low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### *Composition*

Guardlake soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### *Inclusions*

*Contrasting inclusions:*
• The well drained Greylock and Wallace soils in landscape positions similar to those of the Guardlake soil
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Guardlake soil

*Similar inclusions:*
• Soils that have limestone bedrock between depths of 40 and 60 inches

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* None

### *Interpretive Groups*

*Land capability classification:* VIs
*Woodland ordination symbol:* 3A
*Michigan soil management group:* Ga
*Primary habitat type:* AVO
*Secondary habitat type:* AVO-A

## 25E—Guardlake fine sandy loam, 15 to 35 percent slopes

### *Setting*

*Landform:* Rolling to steep areas on outwash plains
*Shape of areas:* Irregular
*Size of areas:* 10 to 60 acres

### *Typical Profile*

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 1 inch—black fine sandy loam

*Subsurface layer:*
1 to 3 inches—brown fine sandy loam
*Subsoil:*
3 to 12 inches—dark reddish brown, very friable fine sandy loam
*Substratum:*
12 to 60 inches—dark yellowish brown and yellow very gravelly sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate in the upper part and very rapid in the lower part
*Available water capacity:* Low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Medium
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Guardlake soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Wallace soils in landscape positions similar to those of the Guardlake soil
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Guardlake soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• Building logging roads and skid trails on the contour helps to control erosion.
• The included level areas or nearby nearly level areas should be selected as sites for log landings.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* 3R
*Michigan soil management group:* Ga
*Primary habitat type:* AVO
*Secondary habitat type:* AVO-A

## 27B—Greylock fine sandy loam, 1 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on ground moraines, end moraines, and drumlins
*Shape of areas:* Irregular
*Size of areas:* 5 to 400 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 6 inches—black fine sandy loam
*Subsurface layer:*
6 to 7 inches—reddish gray sandy loam
*Subsoil:*
7 to 19 inches—dark reddish brown and dark brown, friable fine sandy loam and sandy loam
19 to 26 inches—brown and reddish brown, firm loamy sand and sandy loam
26 to 34 inches—reddish brown, friable sandy loam and loamy sand
*Substratum:*
34 to 80 inches—brown sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Greylock soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Solona soils in the slightly lower landscape positions
• The well drained Longrie soils in landscape positions similar to those of the Greylock soil and near slope breaks

• The somewhat excessively drained Springlake soils in landscape positions similar to those of the Greylock soil

*Similar inclusions:*
• Soils that have a water table between depths of 40 and 60 inches
• Soils that have a sandy surface layer
• Soils that have a stony surface layer

### *Use and Management*

**Land use:** Dominant uses—woodland; other uses—cropland and pasture (fig. 6)

**Woodland**

*Major management concerns:* Equipment limitations, seedling mortality

*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• If trees are planted, site preparation by mechanical or chemical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

**Cropland**

*Major management concerns:* Water erosion, tilth of the surface layer, low organic matter content

*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

**Pasture**

*Major management concerns:* Compaction, overgrazing

*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### *Interpretive Groups*

*Land capability classification:* IIe
*Woodland ordination symbol:* 3L
*Michigan soil management group:* 3a
*Primary habitat type:* AVO-A
*Secondary habitat type:* None assigned

## 27D—Greylock fine sandy loam, 6 to 15 percent slopes

### *Setting*

*Landform:* Gently rolling and rolling areas on ground moraines, end moraines, and drumlins
*Shape of areas:* Irregular
*Size of areas:* 5 to 250 acres

### *Typical Profile*

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 6 inches—black fine sandy loam

*Subsurface layer:*
6 to 7 inches—reddish gray sandy loam

*Subsoil:*
7 to 19 inches—dark reddish brown and dark brown, friable fine sandy loam and sandy loam
19 to 26 inches—brown and reddish brown, firm loamy sand and sandy loam
26 to 34 inches—reddish brown, friable sandy loam and loamy sand

*Substratum:*
34 to 80 inches—brown sandy loam

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### *Composition*

Greylock soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### *Inclusions*

*Contrasting inclusions:*
• The somewhat poorly drained Solona soils in the lower landscape positions
• The well drained Longrie soils in landscape positions similar to those of the Greylock soil and near slope breaks
• The somewhat excessively drained Springlake soils in landscape positions similar to those of the Greylock soil

*Similar inclusions:*
• Soils that have a sandy surface layer
• Soils that have a stony surface layer

### *Use and Management*

**Land use:** Dominant uses—woodland; other uses—cropland and pasture

**Figure 6.—A second cutting of clover in an area of Greylock fine sandy loam, 1 to 6 percent slopes. This soil is prime farmland and is well suited to agriculture.**

**Woodland**

*Major management concerns:* Equipment limitations, seedling mortality

*Management measures:*

• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.

• If trees are planted, site preparation by mechanical or chemical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

**Cropland**

*Major management concerns:* Water erosion, tilth of the surface layer, low organic matter content

*Management measures:*

• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.

• Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.

• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

**Pasture**

*Major management concerns:* Compaction, overgrazing

*Management measures:*

• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### *Interpretive Groups*

*Land capability classification:* IIIe
*Woodland ordination symbol:* 3L
*Michigan soil management group:* 3a
*Primary habitat type:* AVO-A
*Secondary habitat type:* None assigned

## 27F—Greylock fine sandy loam, 35 to 60 percent slopes

### Setting

*Landform:* Very steep areas on ground moraines, end moraines, and drumlins
*Shape of areas:* Irregular
*Size of areas:* 5 to 300 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 6 inches—black fine sandy loam
*Subsurface layer:*
6 to 7 inches—reddish gray sandy loam
*Subsoil:*
7 to 19 inches—dark reddish brown and dark brown, friable fine sandy loam and sandy loam
19 to 26 inches—brown and reddish brown, firm loamy sand and sandy loam
26 to 34 inches—reddish brown, friable sandy loam and loamy sand
*Substratum:*
34 to 80 inches—brown sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Rapid
*Flooding:* None
*Hazard of water erosion:* Severe
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Greylock soil and similar soils: 90 to 100 percent
Contrasting inclusions: 0 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat excessively drained Springlake soils in landscape positions similar to those of the Greylock soil
*Similar inclusions:*
• Soils that have a sandy surface layer
• Soils that have a stony surface layer

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• Because of the erosion hazard, skid roads and skid trails should be established on the contour and water should be removed by water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures.
• Cable yarding systems are generally safer than other logging methods and result in less surface disturbance.
• If trees are planted, site preparation by mechanical or chemical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

### Interpretive Groups

*Land capability classification:* VIIe
*Woodland ordination symbol:* 3R
*Michigan soil management group:* 3a
*Primary habitat type:* AVO-A
*Secondary habitat type:* None assigned

## 28B—Longrie sandy loam, 1 to 6 percent slopes, rocky

### Setting

*Landform:* Nearly level and undulating areas on bedrock-controlled ground moraines and lake benches
*Shape of areas:* Irregular
*Size of areas:* 5 to 235 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
1 to 2 inches—well decomposed leaf litter
*Surface layer:*
2 to 6 inches—reddish gray sandy loam
*Subsoil:*
6 to 23 inches—dark reddish brown and dark brown, friable fine sandy loam
*Substratum:*
23 to 36 inches—brown sandy loam
*Bedrock:*
36 inches—fractured limestone

### Soil Properties and Qualities

*Depth class:* Moderately deep
*Permeability:* Moderate
*Available water capacity:* Low
*Drainage class:* Well drained

*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Longrie soil and similar soils: 85 to 90 percent
Rock outcrop: 1 to 10 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Battydoe, Greylock, and Guardlake soils in landscape positions similar to those of the Longrie soil

*Similar inclusions:*
• Soils that are less than 20 inches deep over bedrock
• Soils that have stones on the surface; in the northern part of Brevort Township

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations, windthrow hazard
*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

**Cropland**
*Major management concerns:* Water erosion, tilth of the surface layer, low organic matter content
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

**Pasture**
*Major management concerns:* Compaction, overgrazing
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### Interpretive Groups

*Land capability classification:* IIe
*Woodland ordination symbol:* 3D
*Michigan soil management group:* 3/Ra
*Primary habitat type:* AVO
*Secondary habitat type:* AVO-A

## 28D—Longrie sandy loam, 6 to 15 percent slopes, rocky

### Setting

*Landform:* Gently rolling and rolling areas on bedrock-controlled ground moraines and lake benches
*Shape of areas:* Irregular
*Size of areas:* 10 to 50 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
1 to 2 inches—well decomposed leaf litter

*Surface layer:*
2 to 6 inches—reddish gray sandy loam

*Subsoil:*
6 to 23 inches—dark reddish brown and dark brown, friable fine sandy loam

*Substratum:*
23 to 36 inches—brown sandy loam

*Bedrock:*
36 inches—fractured limestone

### Soil Properties and Qualities

*Depth class:* Moderately deep
*Permeability:* Moderate
*Available water capacity:* Low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Longrie soil and similar soils: 85 to 90 percent
Rock outcrop: 1 to 10 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Battydoe, Greylock, and Guardlake soils, which are very deep over bedrock; in landscape positions similar to those of the Longrie soil

*Similar inclusions:*
• Soils that are less than 20 inches deep over bedrock
• Soils that have stones on the surface; in the northern part of Brevort Township

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations, windthrow hazard
*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

**Cropland**
*Major management concerns:* Water erosion, tilth of the surface layer, low organic matter content
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

**Pasture**
*Major management concerns:* Compaction, overgrazing
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### *Interpretive Groups*

*Land capability classification:* IIIe
*Woodland ordination symbol:* 3D
*Michigan soil management group:* 3/Ra
*Primary habitat type:* AVO
*Secondary habitat type:* AVO-A

## 29A—Solona loam, 0 to 3 percent slopes

### *Setting*

*Landform:* Nearly level areas on ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 400 acres

### *Typical Profile*

*Surface layer:*
0 to 3 inches—very dark grayish brown loam

*Subsurface layer:*
3 to 11 inches—brown, mottled loam

*Subsoil:*
11 to 27 inches—brown and reddish brown, mottled, friable sandy loam

*Substratum:*
27 to 60 inches—light reddish brown, mottled gravelly sandy loam

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate
*Available water capacity:* Moderate
*Drainage class:* Somewhat poorly drained
*Depth to seasonal high water table:* 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Low
*Potential for frost action:* High
*Shrink-swell potential:* Low

### *Composition*

Solona soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

### *Inclusions*

*Contrasting inclusions:*
• The well drained Greylock soils in the higher landscape positions
• The poorly drained Angelica soils in depressions

*Similar inclusions:*
• Soils that have a sandy surface layer

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

• Trees that can withstand seasonal wetness should be selected for planting.

**Cropland**

*Major management concerns:* Seasonal wetness
*Management measures:*
• A subsurface drainage system can lower the water table.
• In some areas, improving drainage is difficult because adequate subsurface outlets are not available.

**Pasture**

*Major management concerns:* Seasonal wetness, overgrazing
*Management measures:*
• Proper stocking rates, a planned grazing system, and deferred grazing during wet periods help to keep the pasture in good condition.

### *Interpretive Groups*

*Land capability classification:* IIw
*Woodland ordination symbol:* 3W
*Michigan soil management group:* 3b
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 32A—Allendale fine sand, 0 to 3 percent slopes

### *Setting*

*Landform:* Nearly level areas on lake plains, outwash plains, and ground moraines
*Shape of areas:* Irregular
*Size of areas:* 10 to 300 acres

### *Typical Profile*

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 3 inches—black fine sand
*Subsurface layer:*
3 to 7 inches—brown fine sand
*Subsoil:*
7 to 23 inches—dark reddish brown and yellowish brown, loose, mottled fine sand
23 to 29 inches—pale brown, loose, mottled fine sand
29 to 37 inches—light reddish brown, firm, mottled silty clay
*Substratum:*
37 to 80 inches—light reddish brown silty clay

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Rapid in the upper part and very slow in the lower part
*Available water capacity:* Low
*Drainage class:* Somewhat poorly drained
*Seasonal high water table:* Perched at a depth of 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Moderate
*Shrink-swell potential:* High

### *Composition*

Allendale soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### *Inclusions*

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in landscape positions similar to those of the Allendale soil
• The poorly drained Wakeley soils in depressions
• The somewhat poorly drained Rudyard soils in landscape positions similar to those of the Allendale soil

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**

*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Trees that can withstand seasonal wetness should be selected for planting.

**Cropland**

*Major management concerns:* Seasonal wetness, soil blowing, nutrient loss, low organic matter content
*Management measures:*
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Conservation tillage, crop residue management, vegetative barriers, cover crops, and crop rotations that include small grain and hay help to control soil blowing.
• Ensuring that the nutrients in manure and fertilizer applications do not exceed the plant nutrient

requirements helps to protect ground water.
• A cropping sequence that includes green manure crops, no-till planting, and crop residue management increase the organic matter content.

**Pasture**

*Major management concerns:* Overgrazing, seasonal wetness
*Management measures:*
• Proper stocking rates, a planned grazing system, and deferred grazing during wet periods help to keep the pasture in good condition.
• Applying lime and fertilizer according to soil tests ensures maximum growth of plants.

### *Interpretive Groups*

*Land capability classification:* IIIw
*Woodland ordination symbol:* 4W
*Michigan soil management group:* 4/1b
*Primary habitat type:* TMC-D
*Secondary habitat type:* None assigned

## 33—Pits, sand and gravel

### *Setting*

*Shape of areas:* Irregular
*Size of areas:* 5 to 120 acres

### *Composition*

Pits: 100 percent

### *Use and Management*

**Land use:** Source of sand and gravel
*Management measures:*
• Onsite investigation is needed to determine the suitability for specific uses.

### *Interpretive Groups*

*Land capability classification:* None assigned
*Woodland ordination symbol:* None assigned
*Michigan soil management group:* None assigned
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 34—Entisols, frequently flooded

### *Setting*

*Landform:* River bottoms
*Shape of areas:* Elongated or irregular
*Size of areas:* 5 to 200 acres

### *Soil Properties and Qualities*

*Texture:* Sandy or loamy
*Depth class:* Very deep
*Permeability:* Variable
*Available water capacity:* High
*Drainage class:* Very poorly drained to somewhat poorly drained
*Seasonal high water table:* 3.0 feet above to 1.5 feet below the surface at times from October through June
*Surface runoff:* Ponded
*Flooding:* Frequent

### *Composition*

Entisols and similar soils: 90 to 100 percent
Contrasting inclusions: 0 to 10 percent

### *Inclusions*

*Contrasting inclusions:*
• Small areas of well drained soils on ridges and knolls

### *Use and Management*

**Land use:** Wetland wildlife habitat
*Management measures:*
• Onsite investigation is needed to determine the suitability for specific uses.

### *Interpretive Groups*

*Land capability classification:* None assigned
*Woodland ordination symbol:* None assigned
*Michigan soil management group:* None assigned
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 35—Histosols and Aquents, ponded

### *Setting*

*Landform:* Depressions, beaver dam areas, and marshes
*Shape of areas:* Elongated or irregular
*Size of areas:* 5 to 1,000 acres

### *Soil Properties and Qualities*

*Texture:* Mineral or organic
*Depth class:* Very deep
*Permeability:* Very slow to rapid
*Available water capacity:* Variable
*Drainage class:* Very poorly drained and poorly drained
*Seasonal high water table:* At the surface to 3 feet above the surface during most of the year
*Surface runoff:* Ponded
*Flooding:* Frequent

### *Composition*

Histosols and Aquents: 90 to 100 percent
Contrasting inclusions: 0 to 10 percent

### *Inclusions*

• Small areas of the excessively drained Rubicon soils in the higher landscape positions

• Small areas of the somewhat poorly drained Finch soils in the slightly higher landscape positions

### Use and Management

**Land use:** Wetland wildlife habitat
*Management measures:*
• Onsite investigation is needed to determine the suitability for specific uses.

### Interpretive Groups

*Land capability classification:* None assigned
*Woodland ordination symbol:* None assigned
*Michigan soil management group:* None assigned
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 36—Markey and Carbondale mucks

### Setting

*Landform:* Depressions on ground moraines, lake plains, and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 3,900 acres

### Typical Profile

**Markey**

*Surface layer:*
0 to 18 inches—black muck
18 to 27 inches—very dark brown and very dark grayish brown muck

*Substratum:*
27 to 60 inches—dark gray and dark grayish brown sand

**Carbondale**

0 to 4 inches—black muck
4 to 18 inches—black muck
18 to 65 inches—black muck

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Markey—moderately slow to moderately rapid in the muck and rapid in the sand; Carbondale—moderately slow to moderately rapid
*Available water capacity:* Very high
*Drainage class:* Very poorly drained
*Seasonal high water table:* 1 foot above to 1 foot below the surface at times from September through June
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

• Areas of this unit can be made up of one of these soils, or they can be made up of both soils. Contrasting inclusions make up 5 to 15 percent of the unit.

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the slightly higher landscape positions
• The poorly drained Angelica soils in landscape positions similar to those of the major soils

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Wetness and the instability of the muck limit these soils to winter logging when roads can be frozen.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Because of wetness and severe seedling mortality, trees are not planted on these soils.

### Interpretive Groups

*Land capability classification:* Vw
*Woodland ordination symbol:* Markey—7W; Carbondale—5W
*Michigan soil management group:* Markey—M/4c; Carbondale—Mc
*Primary habitat type:* TTM
*Secondary habitat type:* TTS

## 37—Dawson and Loxley peats

### Setting

*Landform:* Closed depressions on ground moraines, lake plains, and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 2,300 acres

### Typical Profile

**Dawson**

*Surface layer:*
0 to 5 inches—yellowish brown peat
5 to 32 inches—black muck

*Substratum:*
32 to 60 inches—grayish brown to yellowish brown sand

**Loxley**

0 to 8 inches—dark yellowish brown peat
8 to 60 inches—black and dark reddish brown muck

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Dawson—moderately slow to moderately rapid in the muck and rapid in the sand; Loxley—moderately slow to moderately rapid
*Available water capacity:* Very high
*Drainage class:* Very poorly drained
*Seasonal high water table:* 1 foot above to 1 foot below the surface at times from September through June
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

• Areas of this unit can be made up of one of these soils, or they can be made up of both of them. Contrasting inclusions make up 5 to 15 percent of the unit.

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the slightly lower landscape positions
• The somewhat excessively drained Springlake soils in the higher landscape positions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Opportunities for logging are limited because the soils support very few trees and because of the low strength of the muck.
• Wetness and instability of the muck limit these soils to winter logging when roads can be frozen.

### Interpretive Groups

*Land capability classification:* VIIw
*Woodland ordination symbol:* 2W
*Michigan soil management group:* Dawson—M/4c-a; Loxley—Mc-a
*Primary habitat type:* PCS
*Secondary habitat type:* None assigned

## 38E—Eastport-Leafriver complex, 0 to 35 percent slopes

### Setting

*Landform:* Dune-swale complex; Eastport—on dunes with slopes of 2 to 35 percent; Leafriver—in swales with slopes of 0 to 2 percent
*Shape of areas:* Elongated
*Size of areas:* 15 to 400 acres

### Typical Profile

**Eastport**

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 3 inches—dark gray sand

*Subsurface layer:*
3 to 14 inches—pale brown sand

*Subsoil:*
14 to 38 inches—strong brown and brownish yellow, loose sand

*Substratum:*
38 to 60 inches—light yellowish brown sand

**Leafriver**

*Surface layer:*
0 to 8 inches—black mucky peat and muck
8 to 10 inches—black, mottled loamy fine sand

*Substratum:*
10 to 60 inches—grayish brown and dark grayish brown, mottled fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Eastport—low; Leafriver—moderate
*Drainage class:* Eastport—excessively drained; Leafriver—very poorly drained
*Seasonal high water table:* Eastport—at a depth of more than 60 inches; Leafriver—1 foot above to 1 foot below the surface at times from October through June
*Surface runoff:* Eastport—slow; Leafriver—very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Eastport—high; Leafriver—low
*Potential for frost action:* Eastport—low; Leafriver—high
*Shrink-swell potential:* Low

### Composition

Eastport soil and similar soils: 40 to 60 percent
Leafriver soil and similar soils: 30 to 45 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Wainola soils in the

slightly lower landscape positions
• The very poorly drained Markey soils in swales
*Similar inclusions:*
• Small marshy areas

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Logging roads and log landings should be located on the ridges.
• In areas of the Leafriver soil, windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• In areas of the Eastport soil, planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
• In areas of the Leafriver soil, site preparation methods, such as bedding, trenching, or mounding, can maximize seedling survival and growth in new plantations.

### *Interpretive Groups*

*Land capability classification:* VIIs
*Woodland ordination symbol:* Eastport—5S; Leafriver—2W
*Michigan soil management group:* Eastport—5.3a; Leafriver—5c
*Primary habitat type:* AQVac
*Secondary habitat type:* FMC

## 39E—Finch-Dawson-Pullup complex, 0 to 35 percent slopes

### *Setting*

*Landform:* Finch—low ridges on lake terraces with slopes of 0 to 3 percent; Dawson—closed depressions on lake terraces with slopes of 0 to 2 percent; Pullup—dunes on lake terraces with slopes of 6 to 35 percent
*Shape of areas:* Irregular
*Size of areas:* 25 to 450 acres

### *Typical Profile*

**Finch**
*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 11 inches—pinkish gray sand
*Subsoil:*
11 to 42 inches—dark brown, dark reddish brown, and brown, mottled, cemented sand
*Substratum:*
42 to 80 inches—yellowish brown fine sand

**Dawson**
*Surface layer:*
0 to 5 inches—yellowish brown peat
5 to 32 inches—black muck
*Substratum:*
32 to 60 inches—grayish brown to yellowish brown sand

**Pullup**
*Organic mat:*
2 inches to 0—slightly decomposed leaf litter
*Surface layer:*
0 to 8 inches—light brownish gray fine sand
*Subsoil:*
8 to 12 inches—dark brown, very friable fine sand
12 to 22 inches—dark brown and pinkish gray, cemented fine sand
*Substratum:*
22 to 80 inches—very pale brown fine sand

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Finch and Pullup—moderate or moderately rapid in the cemented layer and rapid in the rest of the profile; Dawson—moderately slow to moderately rapid in the muck and rapid in the sand
*Available water capacity:* Finch—very low; Dawson—high; Pullup—low
*Drainage class:* Finch—somewhat poorly drained; Dawson—very poorly drained; Pullup—somewhat excessively drained
*Seasonal high water table:* Finch—at a depth of 0.5 foot to 1.5 feet at times from October through May; Dawson—1 foot above to 1 foot below the surface at times from September through June; Pullup—at a depth of more than 60 inches
*Surface runoff:* Finch and Pullup—slow; Dawson—very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Finch and Pullup—high; Dawson—moderate
*Potential for frost action:* Finch and Pullup—low; Dawson—high
*Shrink-swell potential:* Finch and Pullup—low; Dawson—high

### *Composition*

Finch soil and similar soils: 20 to 40 percent

Dawson soil and similar soils: 20 to 40 percent
Pullup soil and similar soils: 10 to 30 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Spot soils in swales
• The very poorly drained Markey soils in depressions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Logging roads and log landings should be located on the ridges.
• In areas of the Pullup soil, planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
• In areas of the Finch soil, windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* IVw
*Woodland ordination symbol:* Finch—4W; Dawson—2W; Pullup—4R
*Michigan soil management group:* Finch—5b; Dawson—M/4c-a; Pullup—5.3a-h
*Primary habitat type:* TMC
*Secondary habitat type:* PCS

## 40A—Rudyard-Allendale complex, 0 to 3 percent slopes

### Setting

*Landform:* Nearly level areas on lake plains and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 10 to 145 acres

### Typical Profile

**Rudyard**

*Surface layer:*
0 to 10 inches—dark grayish brown silty clay loam
*Subsoil:*
10 to 19 inches—reddish brown, firm, mottled clay
*Substratum:*
19 to 60 inches—reddish brown, mottled clay

**Allendale**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 3 inches—black fine sand
*Subsurface layer:*
3 to 7 inches—pinkish gray fine sand
*Subsoil:*
7 to 23 inches—dark reddish brown and yellowish brown, loose, mottled fine sand
23 to 29 inches—pale brown, loose, mottled fine sand
29 to 37 inches—reddish brown, firm, mottled silty clay
*Substratum:*
37 to 80 inches—reddish brown silty clay

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rudyard—very slow; Allendale—rapid in the upper part and very slow in the lower part
*Available water capacity:* Rudyard—moderate; Allendale—low
*Drainage class:* Somewhat poorly drained
*Seasonal high water table:* Perched at a depth of 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Rudyard—moderate; Allendale—high
*Potential for frost action:* Moderate
*Shrink-swell potential:* Rudyard—high; Allendale—low

### Composition

Rudyard soil and similar soils: 50 to 70 percent
Allendale soil and similar soils: 20 to 40 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Pickford and Wakeley soils in depressions
*Similar inclusions:*
• Soils that have a surface layer of silt loam

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**

*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Because of the very slow permeability and the sticky and plastic subsoil, logging roads should be graveled

and, in some areas, landings should be stabilized.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Soils that can withstand seasonal wetness should be selected for planting.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

**Cropland**

*Major management concerns:* Seasonal wetness, tilth of the surface layer, low organic matter content, compaction, soil blowing

*Management measures:*
• Shallow surface ditches help to remove surface water after heavy rains.
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Minimizing tillage and tilling and harvesting at the proper soil moisture content help to prevent excessive compaction and maintain tilth in areas of the Rudyard soil.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.
• Conservation tillage, crop residue management, vegetative barriers, cover crops, and crop rotations that include small grain and hay help to control soil blowing in areas of the Allendale soil.

**Pasture**

*Major management concerns:* Seasonal wetness, compaction, overgrazing

*Management measures:*
• Proper stocking rates and a planned grazing system help to keep the pasture in good condition.
• The only hay and pasture plants that should be seeded are those that can withstand periodic inundation and seasonal wetness.
• Applying lime and fertilizer according to soil tests ensures maximum growth of plants.

### *Interpretive Groups*

*Land capability classification:* IIIw
*Woodland ordination symbol:* Rudyard—6W; Allendale—4W
*Michigan soil management group:* Rudyard—Ob; Allendale—4/1b
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 41D—Amadon-Rock outcrop complex, 1 to 15 percent slopes

### *Setting*

*Landform:* Nearly level to rolling areas on bedrock-controlled ground moraines
*Shape of areas:* Irregular
*Size of areas:* 10 to 400 acres

### *Typical Profile*

**Amadon**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 8 inches—pinkish gray sandy loam
*Subsoil:*
8 to 15 inches—dark reddish brown and dark brown, friable fine sandy loam
*Bedrock:*
15 inches—limestone

### *Soil Properties and Qualities*

**Amadon**

*Depth class:* Shallow
*Permeability:* Moderate
*Available water capacity:* Very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### *Composition*

Amadon soil and similar soils: 30 to 70 percent
Rock outcrop: 20 to 70 percent
Contrasting inclusions: 10 to 15 percent

### *Inclusions*

*Contrasting inclusions:*
• The somewhat poorly drained Ensign and Shelter soils in the slightly lower landscape positions
• The well drained Battydoe soils in landscape positions similar to those of the Amadon soil

*Similar inclusions:*
• Soils that have a sandy surface layer
• Soils that have stones on the surface; in the northern part of Brevort Township

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations,

seedling mortality, windthrow hazard
*Management measures:*
• Rock outcrops and the shallow depth to bedrock should be considered when road locations and landing sites are planned. Equipment maneuverability is limited by the exposed bedrock.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.
• Seedling survival rates can be low during dry periods because of the very low available water capacity.

### *Interpretive Groups*

*Land capability classification:* IVe
*Woodland ordination symbol:* Amadon—2D; Rock outcrop—none assigned
*Michigan soil management group:* Amadon—Ra; Rock outcrop—none assigned
*Primary habitat type:* TM
*Secondary habitat type:* AVO

## 41F—Amadon-Rock outcrop complex, 15 to 45 percent slopes

### *Setting*

*Landform:* Rolling to very steep areas on bedrock-controlled ground moraines
*Shape of areas:* Irregular or elongated
*Size of areas:* 10 to 65 acres

### *Typical Profile*

**Amadon**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 8 inches—pinkish gray sandy loam
*Subsoil:*
8 to 15 inches—dark reddish brown and dark brown, friable fine sandy loam
*Bedrock:*
15 inches—limestone

### *Soil Properties and Qualities*

**Amadon**

*Depth class:* Shallow
*Permeability:* Moderate
*Available water capacity:* Very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Medium
*Flooding:* None
*Hazard of water erosion:* Severe
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### *Composition*

Amadon soil and similar soils: 30 to 60 percent
Rock outcrop: 30 to 70 percent
Contrasting inclusions: 5 to 10 percent

### *Inclusions*

*Contrasting inclusions:*
• The well drained Battydoe soils in landscape positions similar to those of the Amadon soil
*Similar inclusions:*
• Soils that have a sandy surface layer

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality, windthrow hazard
*Management measures:*
• Caution is needed in operating logging equipment because of the rock outcrop and the slope.
• Because of the erosion hazard, skid roads and skid trails should be established on the contour and water should be removed by water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.
• Seedling survival rates can be low during dry periods because of the very low available water capacity.

### *Interpretive Groups*

*Land capability classification:* VIIe
*Woodland ordination symbol:* Amadon—2R; Rock outcrop—none assigned
*Michigan soil management group:* Amadon—Ra; Rock outcrop—none assigned
*Primary habitat type:* TM
*Secondary habitat type:* AVO

## 43—Angelica muck

### *Setting*

*Landform:* Depressions on ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 625 acres

### *Typical Profile*

*Surface layer:*
0 to 2 inches—black muck
2 to 4 inches—black loam

*Subsoil:*
4 to 7 inches—dark gray, mottled, friable loam
7 to 17 inches—brown and reddish brown, mottled, friable clay loam

*Substratum:*
17 to 60 inches—light reddish brown loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderately slow
*Available water capacity:* High
*Drainage class:* Poorly drained
*Seasonal high water table:* 1 foot above to 1 foot below the surface at times from October through June
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* High
*Shrink-swell potential:* Moderate

### Composition

Angelica soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Solona and Search soils in the slightly higher landscape positions
• The very poorly drained Markey soils in landscape positions similar to those of the Angelica soil

*Similar inclusions:*
• Soils that have a sandy surface layer

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen (fig. 7).
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Because of wetness, seedling mortality, and plant competition, trees are generally not planted on this soil.

### Interpretive Groups

*Land capability classification:* Vw
*Woodland ordination symbol:* 7W
*Michigan soil management group:* 2c
*Primary habitat type:* TTP
*Secondary habitat type:* None assigned

## 44B—Battydoe fine sandy loam, 1 to 6 percent slopes, stony

### Setting

*Landform:* Nearly level and undulating areas on ground moraines and drumlins
*Shape of areas:* Irregular
*Size of areas:* 5 to 3,600 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 3 inches—black fine sandy loam

*Subsurface layer:*
3 to 5 inches—reddish gray loamy sand

*Subsoil:*
5 to 20 inches—dark reddish brown and reddish brown, friable fine sandy loam and loamy sand
20 to 28 inches—brown, friable gravelly fine sandy loam

*Substratum:*
28 to 80 inches—light brown gravelly fine sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Rock fragments on the surface:* Kind—stones; percentage of the surface covered—0.01 to 0.1 percent
*Permeability:* Moderate
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slight
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Battydoe soil and similar soils: 75 to 85 percent
Contrasting inclusions: 15 to 25 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Longrie and Amadon soils in landscape positions similar to those of the Battydoe soil
• The somewhat poorly drained Shelter soils in the

**Figure 7.—Logging in an area of Angelica muck. Because of wetness, equipment use is limited to winter or to dry periods in the summer.**

slightly lower landscape positions
• The well drained Guardlake soils in landscape positions similar to those of the Battydoe soil

*Similar inclusions:*
• Soils that have a sandy surface layer

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**

*Major management concerns:* Equipment limitations
*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.

**Cropland**

*Major management concerns:* Water erosion, low organic matter content
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.
• The stones on the surface may interfere with the use of tillage and planting equipment and some harvesting equipment. Removing the stones minimizes wear on equipment.

**Pasture**
*Major management concerns:* Compaction, overgrazing
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### *Interpretive Groups*

*Land capability classification:* IIIe
*Woodland ordination symbol:* 3L
*Michigan soil management group:* 3a
*Primary habitat type:* AVO
*Secondary habitat type:* AVO-A

## 44D—Battydoe fine sandy loam, 6 to 15 percent slopes, stony

### *Setting*

*Landform:* Gently rolling and rolling areas on ground moraines and drumlins
*Shape of areas:* Irregular
*Size of areas:* 5 to 120 acres

### *Typical Profile*

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 3 inches—black fine sandy loam

*Subsurface layer:*
3 to 5 inches—reddish gray loamy sand

*Subsoil:*
5 to 20 inches—dark reddish brown and reddish brown, friable fine sandy loam and loamy sand
20 to 28 inches—brown, friable gravelly fine sandy loam

*Substratum:*
28 to 80 inches—light brown gravelly fine sandy loam

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Rock fragments on the surface:* Kind—stones; percentage of the surface covered—0.01 to 0.1 percent
*Permeability:* Moderate
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### *Composition*

Battydoe soil and similar soils: 75 to 85 percent
Contrasting inclusions: 15 to 25 percent

### *Inclusions*

*Contrasting inclusions:*
• The well drained Longrie and Amadon soils in landscape positions similar to those of the Battydoe soil
• The well drained Guardlake soils in landscape positions similar to those of the Battydoe soil

*Similar inclusions:*
• Soils that have a sandy surface layer

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations
*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.

**Cropland**
*Major management concerns:* Water erosion, low organic matter content
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.
• The stones on the surface may interfere with the use of tillage and planting equipment and some harvesting equipment. Removing the stones minimizes wear on equipment.

**Pasture**
*Major management concerns:* Compaction, overgrazing
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### *Interpretive Groups*

*Land capability classification:* IVe
*Woodland ordination symbol:* 3L
*Michigan soil management group:* 3a
*Primary habitat type:* AVO
*Secondary habitat type:* AVO-A

## 44E—Battydoe fine sandy loam, 15 to 35 percent slopes, stony

### Setting

*Landform:* Rolling to steep areas on ground moraines and drumlins
*Shape of areas:* Elongated or irregular
*Size of areas:* 10 to 145 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 3 inches—black fine sandy loam
*Subsurface layer:*
3 to 5 inches—reddish gray loamy sand
*Subsoil:*
5 to 20 inches—dark reddish brown and reddish brown, friable fine sandy loam and loamy sand
20 to 28 inches—brown, friable gravelly fine sandy loam
*Substratum:*
28 to 80 inches—light brown gravelly fine sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Rock fragments on the surface:* Kind—stones; percentage of the surface covered—0.01 to 0.1 percent
*Permeability:* Moderate
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Medium
*Flooding:* None
*Hazard of water erosion:* Severe
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Battydoe soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Guardlake soils in landscape positions similar to those of the Battydoe soil
• The well drained Amadon soils in landscape positions similar to those of the Battydoe soil
*Similar inclusions:*
• Soils that have a sandy surface layer

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• The risk of erosion can be reduced by seeding logging roads, landings, and areas that have been cut and filled and by installing water bars and culverts.

### Interpretive Groups

*Land capability classification:* VIe
*Woodland ordination symbol:* 3R
*Michigan soil management group:* 3a
*Primary habitat type:* AVO
*Secondary habitat type:* AVO-A

## 46B—Adams sandy loam, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on outwash plains and ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 2,000 acres

### Typical Profile

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter
*Surface layer:*
0 to 4 inches—very dark gray sandy loam
*Subsurface layer:*
4 to 5 inches—reddish gray sandy loam
*Subsoil:*
5 to 7 inches—dark reddish brown, friable sandy loam
7 to 12 inches—reddish brown, friable loamy sand
12 to 26 inches—strong brown and brownish yellow, very friable sand
*Substratum:*
26 to 80 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderately rapid in the upper part and rapid or very rapid in the lower part
*Available water capacity:* Low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate

*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Adams soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the slightly lower landscape positions
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Adams soil

*Similar inclusions:*
• Areas that have a water table between depths of 40 and 60 inches
• Soils that have calcareous sand and gravel below a depth of 40 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* None

### Interpretive Groups

*Land capability classification:* IIIs
*Woodland ordination symbol:* 3S
*Michigan soil management group:* 5a
*Primary habitat type:* ATD
*Secondary habitat type:* AVO

## 48E—Wainola-Leafriver-Pullup complex, 0 to 35 percent slopes

### Setting

*Landform:* Dune-swale complex on lake plains; Wainola—on low ridges with slopes of 0 to 3 percent; Leafriver—in swales with slopes of 0 to 2 percent; Pullup—on dunes with slopes of 6 to 35 percent
*Shape of areas:* Irregular
*Size of areas:* 25 to 450 acres

### Typical Profile

**Wainola**

*Organic mat:*
0 to 3 inches—partially decomposed leaf litter

*Surface layer:*
3 to 14 inches—pinkish gray fine sand

*Subsoil:*
14 to 17 inches—dark brown and dark reddish brown, mottled, very friable fine sand
17 to 26 inches—strong brown, mottled, very friable fine sand
26 to 30 inches—yellowish brown, loose fine sand

*Substratum:*
30 to 80 inches—light yellowish brown fine sand

**Leafriver**

*Surface layer:*
0 to 8 inches—black mucky peat and muck
8 to 10 inches—black, mottled loamy fine sand

*Substratum:*
10 to 60 inches—grayish brown and dark grayish brown, mottled fine sand

**Pullup**

*Organic mat:*
2 inches to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 8 inches—light brownish gray fine sand

*Subsoil:*
8 to 12 inches—dark brown, very friable fine sand
12 to 22 inches—dark brown and pinkish gray, cemented fine sand

*Substratum:*
22 to 80 inches—very pale brown fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Wainola and Leafriver—rapid; Pullup—moderate or moderately rapid in the cemented layer and rapid in the rest of the profile
*Available water capacity:* Wainola and Pullup—low; Leafriver—moderate
*Drainage class:* Wainola—somewhat poorly drained; Leafriver—very poorly drained; Pullup—excessively drained
*Seasonal high water table:* Wainola—at a depth of 0.5 foot to 1.5 feet at times from November through May; Leafriver—1 foot above to 1 foot below the surface at times from October through June; Pullup—at a depth of more than 60 inches
*Surface runoff:* Wainola and Pullup—slow; Leafriver—very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Wainola and Leafriver—slight; Pullup—moderate
*Hazard of soil blowing:* Wainola and Pullup—severe; Leafriver—slight
*Potential for frost action:* Wainola—moderate; Leafriver—high; Pullup—low
*Shrink-swell potential:* Low

### Composition

Wainola soil and similar soils: 30 to 50 percent
Leafriver soil and similar soils: 20 to 40 percent
Pullup soil and similar soils: 15 to 25 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
- The poorly drained Spot soils in swales
- The very poorly drained Markey soils in depressions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
- Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
- Logging roads and log landings should be located on the ridges.
- In areas of the Pullup soil, planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
- In areas of the Wainola soil, windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* IVw
*Woodland ordination symbol:* Wainola—6W; Leafriver—2W; Pullup—7R
*Michigan soil management group:* Wainola—5b; Leafriver—5c; Pullup—5.3a-h
*Primary habitat type:* TMC-V
*Secondary habitat type:* FMC

## 49A—Wainola fine sand, 0 to 3 percent slopes

### Setting

*Landform:* Nearly level areas on lake plains and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 300 acres

### Typical Profile

*Organic mat:*
0 to 3 inches—partially decomposed leaf litter
*Surface layer:*
3 to 14 inches—pinkish gray fine sand
*Subsoil:*
14 to 17 inches—dark brown and dark reddish brown, mottled, very friable fine sand
17 to 26 inches—strong brown, mottled, very friable fine sand
26 to 30 inches—yellowish brown, loose fine sand
*Substratum:*
30 to 80 inches—light yellowish brown fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Somewhat poorly drained
*Depth to seasonal high water table:* 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Wainola soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
- The poorly drained Spot soils in depressions
- The excessively drained Pullup soils in the higher landscape positions
- The somewhat poorly drained Finch soils in landscape positions similar to those of the Wainola soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
- Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
- Landing sites generally can be used only during the driest time of the year.
- Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
- Trees that can withstand seasonal wetness should be selected for planting.

### Interpretive Groups

*Land capability classification:* IIIw
*Woodland ordination symbol:* 6W
*Michigan soil management group:* 5b
*Primary habitat type:* TMC-V
*Secondary habitat type:* None assigned

## 52A—Ingalls fine sand, 0 to 3 percent slopes

### Setting

*Landform:* Nearly level areas on lake plains and outwash plains

*Shape of areas:* Irregular
*Size of areas:* 5 to 115 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—well decomposed leaf litter
*Surface layer:*
2 to 8 inches—grayish brown fine sand
*Subsoil:*
8 to 20 inches—dark brown, mottled, very friable fine sand
*Substratum:*
20 to 27 inches—light yellowish brown, mottled, stratified loamy very fine sand, very fine sand, and silt loam
27 to 60 inches—pale brown and light brown, mottled, stratified silt loam, loamy very fine sand, and very fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid in the upper part and moderately slow in the lower part
*Available water capacity:* Moderate
*Drainage class:* Somewhat poorly drained
*Depth to seasonal high water table:* 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Ingalls soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Caffey soils in depressions
• The moderately well drained Borgstrom soils in the slightly higher landscape positions
• The somewhat poorly drained Wainola soils in landscape positions similar to those of the Ingalls soil
*Similar inclusions:*
• Soils that have gravelly glacial till below a depth of 40 inches

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Trees that can withstand seasonal wetness should be selected for planting.

**Cropland**
*Major management concerns:* Seasonal wetness, soil blowing, nutrient loss, low organic matter content
*Management measures:*
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Conservation tillage, crop residue management, vegetative barriers, cover crops, and crop rotations that include small grain and hay help to control soil blowing.
• Ensuring that the nutrients in applications of manure and fertilizer applications do not exceed the nutrient requirements of the plants helps to prevent the pollution of ground water.
• Including green manure crops in the cropping sequence, no-till planting, and managing crop residue increase the organic matter content.

**Pasture**
*Major management concerns:* Overgrazing, seasonal wetness
*Management measures:*
• Proper stocking rates, a planned grazing system, and deferred grazing during wet periods help to keep the pasture in good condition.
• Applying lime and fertilizer according to soil tests ensures maximum growth of plants.

### Interpretive Groups

*Land capability classification:* IIIw
*Woodland ordination symbol:* 4W
*Michigan soil management group:* 4/2b
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 53B—Menominee loamy sand, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on ground

moraines and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 80 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—well decomposed leaf litter
*Surface layer:*
2 to 7 inches—reddish gray loamy sand
*Subsoil:*
7 to 28 inches—dark reddish brown and dark brown, friable loamy sand
28 to 38 inches—brown and brownish gray, friable loamy sand and sandy loam
38 to 45 inches—dark reddish brown and reddish gray, friable sandy clay loam and sandy loam
*Substratum:*
45 to 80 inches—reddish brown loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid in the upper part and moderate in the lower part
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Low
*Shrink-swell potential:* Moderate

### Composition

Menominee soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Greylock soils in landscape positions similar to those of the Menominee soil
• The well drained Wallace soils in landscape positions similar to those of the Menominee soil
• The somewhat poorly drained Iosco soils in depressions

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* None

**Cropland**
*Major management concerns:* Soil blowing, nutrient loss, low organic matter content
*Management measures:*
• Conservation tillage, vegetative barriers, and cover crops help to control soil blowing.
• Timing fertilizer applications according to crop nutrient needs, using split fertilizer applications, and applying fertilizer in bands may reduce the risk of nutrient leaching.
• Increasing the organic matter content in the root zone may increase the ability of the soil to hold water, nutrients, and pesticides and reduce the risk of groundwater pollution.
• Including green manure crops in the cropping sequence, no-till planting, and managing crop residue increase the organic matter content.

**Pasture**
*Major management concerns:* Overgrazing
*Management measures:*
• Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.
• Applying lime and fertilizer according to soil tests ensures maximum growth of plants.

### Interpretive Groups

*Land capability classification:* IIIe
*Woodland ordination symbol:* 5A
*Michigan soil management group:* 4/2a
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 53D—Menominee loamy sand, 6 to 15 percent slopes

### Setting

*Landform:* Gently rolling and rolling areas on ground moraines and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 40 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—well decomposed leaf litter
*Surface layer:*
2 to 7 inches—reddish gray loamy sand
*Subsoil:*
7 to 28 inches—dark reddish brown and dark brown, friable loamy sand
28 to 38 inches—brown and brownish gray, friable loamy sand and sandy loam
38 to 45 inches—dark reddish brown and reddish gray, friable sandy clay loam and sandy loam
*Substratum:*
45 to 80 inches—reddish brown loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid in the upper part and moderate in the lower part
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Low
*Shrink-swell potential:* Moderate

### Composition

Menominee soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Greylock soils in landscape positions similar to those of the Menominee soil
• The well drained Wallace soils in landscape positions similar to those of the Menominee soil
• The somewhat poorly drained Iosco soils in depressions

### Use and Management

**Land use:** Woodland
*Major management concerns:* None

### Interpretive Groups

*Land capability classification:* IVe
*Woodland ordination symbol:* 5A
*Michigan soil management group:* 4/2a
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 56A—Ensign fine sandy loam, 0 to 3 percent slopes, rocky

### Setting

*Landform:* Nearly level areas on bedrock-controlled ground moraines and glacial lake benches
*Shape of areas:* Irregular
*Size of areas:* 5 to 160 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 5 inches—very dark grayish brown fine sandy loam
*Subsoil:*
5 to 8 inches—dark yellowish brown and very dark grayish brown, mottled, friable fine sandy loam
8 to 15 inches—brown, mottled, friable sandy loam
*Bedrock:*
15 inches—limestone

### Soil Properties and Qualities

*Depth class:* Shallow
*Permeability:* Moderate
*Available water capacity:* Very low
*Drainage class:* Somewhat poorly drained
*Depth to seasonal high water table:* 0.5 foot to 1.5 feet at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

Ensign soil and similar soils: 75 to 85 percent
Rock outcrop: 1 to 10 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Amadon soils in the higher landscape positions
*Similar inclusions:*
• Soils that have a sandy surface layer

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Rock outcrops and the shallow depth to bedrock should be considered when road locations and landing sites are planned.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Trees that can withstand seasonal wetness should be selected for planting.

### Interpretive Groups

*Land capability classification:* IIIw

*Woodland ordination symbol:* 3W
*Michigan soil management group:* Rbc
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 57B—Amadon-Longrie sandy loams, 1 to 6 percent slopes, rocky

### Setting

*Landform:* Nearly level areas and undulating areas on bedrock-controlled ground moraines and benches
*Shape of areas:* Irregular
*Size of areas:* 15 to 1,200 acres

### Typical Profile

**Amadon**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 8 inches—pinkish gray sandy loam
*Subsoil:*
8 to 15 inches—dark brown and dark reddish brown, friable fine sandy loam
*Bedrock:*
15 inches—limestone

**Longrie**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
1 to 2 inches—well decomposed leaf litter
*Surface layer:*
2 to 6 inches—reddish gray sandy loam
*Subsoil:*
6 to 23 inches—dark reddish brown and dark brown, friable fine sandy loam
*Substratum:*
23 to 36 inches—brown sandy loam
*Bedrock:*
36 inches—fractured limestone

### Soil Properties and Qualities

*Depth class:* Amadon—shallow; Longrie—moderately deep
*Permeability:* Moderate
*Available water capacity:* Amadon—very low; Longrie—moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Amadon soil and similar soils: 30 to 60 percent
Longrie soil and similar soils: 30 to 60 percent
Rock outcrop: 1 to 10 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Guardlake and Battydoe soils in landscape positions similar to those of the major soils
*Similar inclusions:*
• Soils that have a sandy surface layer
• Areas that have stones on the surface; in the northern part of Brevort Township

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**

*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Rock outcrops and the shallow depth to bedrock should be considered when road locations and landing sites are planned. Equipment maneuverability is limited by the exposed bedrock.
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• Seedling survival rates can be low during dry periods because of the low available water capacity, especially in areas of the Amadon soil.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

**Cropland**

*Major management concerns:* Water erosion, tilth of the surface layer, low organic matter content
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

**Pasture**

*Major management concerns:* Compaction, overgrazing
*Management measures:*
• Proper stocking rates, controlled grazing, and

restricted use during dry periods help to keep the pasture in good condition.

### Interpretive Groups

*Land capability classification:* IIIs
*Woodland ordination symbol:* Amadon—2D; Longrie—3D
*Michigan soil management group:* Amadon—Ra; Longrie—3/Ra
*Primary habitat type:* TM
*Secondary habitat type:* AVO

## 57D—Amadon-Longrie sandy loams, 6 to 15 percent slopes, rocky

### Setting

*Landform:* Gently rolling and rolling areas on bedrock-controlled ground moraines and lake beaches
*Shape of areas:* Irregular
*Size of areas:* 15 to 220 acres

### Typical Profile

**Amadon**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 8 inches—pinkish gray sandy loam
*Subsoil:*
8 to 15 inches—dark brown and dark reddish brown, friable fine sandy loam
*Bedrock:*
15 inches—limestone

**Longrie**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
1 to 2 inches—well decomposed leaf litter
*Surface layer:*
2 to 6 inches—reddish gray sandy loam
*Subsoil:*
6 to 23 inches—dark reddish brown and dark brown, friable fine sandy loam
*Substratum:*
23 to 36 inches—brown sandy loam
*Bedrock:*
36 inches—fractured limestone

### Soil Properties and Qualities

*Depth class:* Amadon—shallow; Longrie—moderately deep
*Permeability:* Moderate
*Available water capacity:* Amadon—very low; Longrie—moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* Greater than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Amadon soil and similar soils: 30 to 60 percent
Longrie soil and similar soils: 30 to 60 percent
Rock outcrop: 1 to 10 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Guardlake and Battydoe soils in landscape positions similar to those of the major soils
*Similar inclusions:*
• Soils that have a sandy surface layer
• Areas that have stones on the surface; in the northern part of Brevort Township

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Rock outcrops and the shallow depth to bedrock should be considered when road locations and landing sites are planned. Equipment maneuverability is limited by the exposed bedrock.
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• Seedling survival rates can be low during dry periods because of the low available water capacity, especially in areas of the Amadon soil.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

### Interpretive Groups

*Land capability classification:* IVe
*Woodland ordination symbol:* Amadon—2D; Longrie—3D
*Michigan soil management group:* Amadon—Ra; Longrie—3/Ra
*Primary habitat type:* TM
*Secondary habitat type:* AVO

## 61B—Paquin sand, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on

outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 100 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter

*Surface layer:*
2 to 12 inches—brown sand

*Subsoil:*
12 to 14 inches—very dark brown, very friable sand
14 to 27 inches—very dark brown and dark brown, cemented sand
27 to 34 inches—strong brown, mottled, loose sand

*Substratum:*
34 to 80 inches—yellowish brown, mottled sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layer and rapid in the rest of the profile
*Available water capacity:* Low
*Drainage class:* Moderately well drained
*Depth to seasonal high water table:* 2.0 to 3.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Paquin soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in depressions

*Similar inclusions:*
• Soils that have a water table below a depth of 60 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* 3S
*Michigan soil management group:* 5a-h
*Primary habitat type:* ATD
*Secondary habitat type:* None assigned

## 62A—Iosco sand, 0 to 3 percent slopes

### Setting

*Landform:* Nearly level areas on ground moraines and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 30 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
2 to 6 inches—well decomposed leaf litter

*Surface layer:*
6 to 9 inches—dark grayish brown, mottled sand

*Subsurface layer:*
9 to 11 inches—brown, mottled sand

*Subsoil:*
11 to 27 inches—dark brown and yellowish brown, mottled, friable and loose sand
27 to 38 inches—reddish brown, mottled, friable loam

*Substratum:*
38 to 60 inches—light brown loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid in the upper sandy material and moderate in the lower loamy material
*Available water capacity:* Moderate
*Drainage class:* Somewhat poorly drained
*Depth to seasonal high water table:* 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

Iosco soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Solona soils in landscape positions similar to those of the Iosco soil

• The well drained Battydoe soils in the higher landscape positions

*Similar inclusions:*
• Soils that have stones on the surface

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**

*Major management concerns:* Equipment limitations, windthrow hazard

*Management measures:*
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

**Cropland**

*Major management concerns:* Seasonal wetness, soil blowing, nutrient loss, low organic matter content

*Management measures:*
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Conservation tillage, crop residue management, vegetative barriers, cover crops, and crop rotations that include small grain and hay help to control soil blowing.
• Ensuring that the nutrients in applications of manure and fertilizer applications do not exceed the nutrient requirements of the plants helps to prevent the pollution of ground water.
• Including green manure crops in the cropping sequence, no-till planting, and managing crop residue increase the organic matter content.

**Pasture**

*Major management concerns:* Overgrazing, seasonal wetness

*Management measures:*
• Proper stocking rates, a planned grazing system, and deferred grazing during wet periods help to keep the pasture in good condition.
• Applying lime and fertilizer according to soil tests ensures maximum growth of plants.

### Interpretive Groups

*Land capability classification:* IIIw
*Woodland ordination symbol:* 4W
*Michigan soil management group:* 4/2b
*Primary habitat type:* TMC
*Secondary habitat type:* None assigned

## 64A—Search very fine sandy loam, 0 to 3 percent slopes

### Setting

*Landform:* Nearly level areas on ground moraines and end moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 365 acres

### Typical Profile

*Surface layer:*
0 to 8 inches—black very fine sandy loam

*Subsoil:*
8 to 10 inches—yellowish brown and very dark grayish brown, mottled, friable very fine sandy loam

*Substratum:*
10 to 24 inches—light yellowish brown and light brown, mottled gravelly and very gravelly very fine sandy loam

*Bedrock:*
24 to 60 inches—weak red and pale olive, soft shale

### Soil Properties and Qualities

*Depth class:* Moderately deep
*Permeability:* Moderately slow
*Available water capacity:* Low
*Drainage class:* Somewhat poorly drained
*Depth to seasonal high water table:* 0.5 to 1.0 foot at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

Search soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Satago soils in the higher landscape positions
• The poorly drained Angelica soils in depressions

*Similar inclusions:*
• Soils that have bedrock above a depth of 20 inches

### Use and Management

**Land use:** Woodland

*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard

*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow

cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Trees that can withstand seasonal wetness should be selected for planting.

### Interpretive Groups

*Land capability classification:* IIIw
*Woodland ordination symbol:* 2W
*Michigan soil management group:* 3/Rbc
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 67B—Furlong sand, 0 to 6 percent slopes, rocky

### Setting

*Landform:* Nearly level and undulating areas on outwash plains and ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 110 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 2 inches—black sand
*Subsurface layer:*
2 to 5 inches—pinkish gray sand
*Subsoil:*
5 to 19 inches—dark reddish brown and dark brown, loose sand
*Substratum:*
19 to 22 inches—brown sand
*Bedrock:*
22 inches—fractured limestone

### Soil Properties and Qualities

*Depth class:* Moderately deep
*Permeability:* Rapid
*Available water capacity:* Very low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* High
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Furlong soil and similar soils: 70 to 80 percent
Rock outcrop: 1 to 10 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Wallace soils in landscape positions similar to those of the Furlong soil
• The well drained Amadon soils in landscape positions similar to those of the Furlong soil

*Similar inclusions:*
• Soils that are less than 20 inches deep over limestone bedrock

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Rock outcrops and the shallow depth to bedrock should be considered when road locations and landing sites are planned. Equipment maneuverability is limited by the exposed bedrock.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* IVs
*Woodland ordination symbol:* 3D
*Michigan soil management group:* 4/Ra
*Primary habitat type:* ATD
*Secondary habitat type:* None assigned

## 68—Wakeley muck

### Setting

*Landform:* Depressions on lake plains and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 645 acres

### Typical Profile

*Surface layer:*
0 to 4 inches—black muck
4 to 5 inches—black loamy fine sand
*Substratum:*
5 to 24 inches—dark grayish brown and pale brown, mottled loamy fine sand and fine sand

24 to 60 inches—reddish brown, mottled silty clay

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid in the upper part and very slow in the lower part
*Available water capacity:* Moderate
*Drainage class:* Poorly drained
*Seasonal high water table:* Perched 1 foot above to 1 foot below the surface at times from October through May
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* High

### Composition

Wakeley soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Allendale soils in the slightly higher landscape positions
• The very poorly drained Markey soils in landscape positions similar to those of the Wakeley soil

*Similar inclusions:*
• Soils that have sand in the lower part of the profile

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Because of wetness and severe seedling mortality, trees are not planted on this soil.

### Interpretive Groups

*Land capability classification:* Vw
*Woodland ordination symbol:* 3W
*Michigan soil management group:* 4/1c
*Primary habitat type:* TTP
*Secondary habitat type:* None assigned

## 69B—Satago silt loam, 1 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on bedrock-controlled ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 1,000 acres

### Typical Profile

*Organic mat:*
2 inches to 0—slightly decomposed leaf litter
*Surface layer:*
0 to 4 inches—dark brown silt loam
*Subsoil:*
4 to 12 inches—brown and reddish brown, friable silt loam
*Substratum:*
12 to 46 inches—reddish brown silt loam
*Bedrock:*
46 to 60 inches—grayish brown, soft shale

### Soil Properties and Qualities

*Depth class:* Deep
*Permeability:* Moderate
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

Satago soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Search soils in the slightly lower landscape positions
• The excessively drained Alpena soils in landscape positions similar to those of the Satago soil

*Similar inclusions:*
• Soils that have shale bedrock below a depth of 60 inches or above a depth of 40 inches

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* None
*Management measures:*
• Equipment use should be limited to logging roads during spring snowmelt when the soil is wet and ruts form easily.

**Cropland**
*Major management concerns:* Water erosion, tilth of the surface layer, low organic matter content
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

**Pasture**
*Major management concerns:* Compaction, overgrazing
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### *Interpretive Groups*

*Land capability classification:* IIe
*Woodland ordination symbol:* 3A
*Michigan soil management group:* 3/Rbc
*Primary habitat type:* AVO-A
*Secondary habitat type:* None assigned

## 70B—St. Ignace silt loam, 0 to 6 percent slopes

### *Setting*

*Landform:* Nearly level and undulating areas on bedrock-controlled ground moraines and lake benches
*Shape of areas:* Irregular
*Size of areas:* 5 to 225 acres

### *Typical Profile*

*Surface layer:*
0 to 5 inches—black silt loam
*Subsoil:*
5 to 15 inches—yellowish brown, friable gravelly silt loam
*Bedrock:*
15 inches—fractured limestone breccia

### *Soil Properties and Qualities*

*Depth class:* Shallow
*Permeability:* Moderate
*Available water capacity:* Very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### *Composition*

St. Ignace soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### *Inclusions*

*Contrasting inclusions:*
• The excessively drained Alpena soils in the slightly higher landscape positions

*Similar inclusions:*
• Soils that have stones and boulders on the surface
• Soils that have a seasonal high water table between depths of 12 and 20 inches

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
• The shallow depth to bedrock should be considered when road locations and landing sites are planned.
• Because of the shallow depth to bedrock, planting may not be practical.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

### *Interpretive Groups*

*Land capability classification:* VIIs
*Woodland ordination symbol:* 4D
*Michigan soil management group:* Ra
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 70D—St. Ignace silt loam, 6 to 15 percent slopes, rocky

### *Setting*

*Landform:* Gently rolling and rolling areas on bedrock-controlled ground moraines and lake benches
*Shape of areas:* Irregular
*Size of areas:* 5 to 65 acres

### Typical Profile

*Surface layer:*
0 to 5 inches—black silt loam
*Subsoil:*
5 to 15 inches—yellowish brown, friable gravelly silt loam
*Bedrock:*
15 inches—fractured limestone breccia

### Soil Properties and Qualities

*Depth class:* Shallow
*Permeability:* Moderate
*Available water capacity:* Very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

St. Ignace soil and similar soils: 85 to 90 percent
Rock outcrop: 1 to 10 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The excessively drained Alpena soils in the slightly higher landscape positions
*Similar inclusions:*
• Soils that have stones and boulders on the surface

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
• Rock outcrops and the shallow depth to bedrock should be considered when road locations and landing sites are planned. Equipment maneuverability is limited by the exposed bedrock.
• Because of the shallow depth to bedrock, planting may not be practical.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* 4D
*Michigan soil management group:* Ra
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 70F—St. Ignace-Rock outcrop complex, 35 to 70 percent slopes

### Setting

*Landform:* Very steep areas on bedrock-controlled ground moraines and lake beaches
*Shape of areas:* Elongated
*Size of areas:* 5 to 65 acres

### Typical Profile

**St. Ignace**

*Surface layer:*
0 to 5 inches—black silt loam
*Subsoil:*
5 to 15 inches—yellowish brown, friable gravelly silt loam
*Bedrock:*
15 inches—fractured limestone breccia

### Soil Properties and Qualities

**St. Ignace**

*Depth class:* Shallow
*Permeability:* Moderate
*Available water capacity:* Very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Rapid
*Flooding:* None
*Hazard of water erosion:* Severe
*Hazard of soil blowing:* Slight
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

St. Ignace soil and similar soils: 45 to 70 percent
Rock outcrop: 20 to 40 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The excessively drained Alpena soils in landscape positions similar to those of the St. Ignace soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality, windthrow hazard
• Onsite investigation is needed to determine the feasibility of logging in areas of this unit without causing severe erosion of side slopes and deposition of sediments into streams and lakes.
• Cable yarding systems are generally safer than other logging methods and result in less surface disturbance.

• Loose rock is a hazard on sites for logging or road construction.
• Because of the shallow depth to bedrock, planting may not be practical.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* St. Ignace—4R; Rock outcrop—none assigned
*Michigan soil management group:* St. Ignace—Ra; Rock outcrop—none assigned
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 71B—Johnswood cobbly silt loam, 2 to 6 percent slopes

### Setting

*Landform:* Undulating areas on ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 200 acres

### Typical Profile

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter
*Surface layer:*
0 to 3 inches—black cobbly silt loam
3 to 7 inches—dark brown cobbly silt loam
*Subsoil:*
7 to 13 inches—brown, friable very cobbly silt loam
*Substratum:*
13 to 60 inches—pale brown, firm very gravelly loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Slow
*Available water capacity:* Low
*Drainage class:* Well drained
*Seasonal high water table:* Perched at a depth of 1 to 2 feet at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Johnswood soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Shelter soils in the slightly lower landscape positions
• The well drained Battydoe soils in landscape positions similar to those of the Johnswood soil
*Similar inclusions:*
• Soils that have limestone bedrock above a depth of 60 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Large stones on the surface can hinder harvesting and damage equipment.
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• Planting when the soil is moist can reduce the seedling mortality rate.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

### Interpretive Groups

*Land capability classification:* IVs
*Woodland ordination symbol:* 3F
*Michigan soil management group:* 3a
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 84B—Wallace-Alcona complex, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on lake plains and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 165 acres

### Typical Profile

**Wallace**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 10 inches—light brownish gray sand
*Subsoil:*
10 to 11 inches—dark reddish brown, very friable sand
11 to 26 inches—dark brown, cemented sand
26 to 59 inches—brownish yellow, loose sand

*Substratum:*
59 to 80 inches—light yellowish brown sand

**Alcona**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 3 inches—pinkish gray fine sandy loam

*Subsoil:*
3 to 17 inches—dark brown, dark yellowish brown, and strong brown, friable fine sandy loam
17 to 23 inches—reddish brown and light pinkish gray, firm very fine sandy loam
23 to 54 inches—light reddish brown, friable loamy fine sand and reddish brown, friable sandy loam

*Substratum:*
54 to 80 inches—light brown and brown, stratified loamy very fine sand, fine sandy loam, and very fine sandy loam

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Wallace—moderate or moderately rapid in the cemented layer and rapid in the rest of the profile; Alcona—moderate
*Available water capacity:* Wallace—very low; Alcona—high
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Wallace—severe; Alcona—moderate
*Potential for frost action:* Wallace—low; Alcona—moderate
*Shrink-swell potential:* Low

### *Composition*

Wallace soil and similar soils: 40 to 50 percent
Alcona soil and similar soils: 35 to 45 percent
Contrasting inclusions: 15 to 20 percent

### *Inclusions*

*Contrasting inclusions:*
• The somewhat poorly drained Finch and Ingalls soils in the lower landscape positions
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the major soils
• The moderately well drained Borgstrom soils in the slightly lower landscape positions

*Similar inclusions:*
• Alcona soils that have a water table between depths of 40 and 60 inches

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Loose sand on the Wallace soil can interfere with the traction of wheeled equipment. Logging roads should be stabilized.
• Because of low strength in areas of the Alcona soil, suitable surfacing material is needed on year-round logging roads and landings.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate in areas of the Wallace soil.

### *Interpretive Groups*

*Land capability classification:* VIs
*Woodland ordination symbol:* Wallace—7D; Alcona—3L
*Michigan soil management group:* Wallace—5a-h; Alcona—3a-s
*Primary habitat type:* ATD
*Secondary habitat type:* None assigned

## 84D—Wallace-Alcona complex, 6 to 15 percent slopes

### *Setting*

*Landform:* Gently rolling and rolling areas on lake plains and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 225 acres

### *Typical Profile*

**Wallace**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter

*Surface layer:*
2 to 10 inches—light brownish gray sand

*Subsoil:*
10 to 11 inches—dark reddish brown, very friable sand
11 to 26 inches—dark brown, cemented sand
26 to 59 inches—brownish yellow, loose sand

*Substratum:*
59 to 80 inches—light yellowish brown sand

**Alcona**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 3 inches—pinkish gray fine sandy loam

*Subsoil:*
3 to 17 inches—dark brown, dark yellowish brown, and strong brown, friable fine sandy loam

17 to 23 inches—reddish brown and light pinkish gray, firm very fine sandy loam
23 to 54 inches—light reddish brown, friable loamy fine sand and reddish brown, friable sandy loam

*Substratum:*
54 to 80 inches—light brown and brown, stratified loamy very fine sand, fine sandy loam, and very fine sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Wallace—moderate or moderately rapid in the cemented layer and rapid in the rest of the profile; Alcona—moderate
*Available water capacity:* Wallace—very low; Alcona—high
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Wallace—severe; Alcona—moderate
*Potential for frost action:* Wallace—low; Alcona—moderate
*Shrink-swell potential:* Low

### Composition

Wallace soil and similar soils: 40 to 50 percent
Alcona soil and similar soils: 35 to 45 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch and Ingalls soils in the lower landscape positions
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the major soils
• The moderately well drained Borgstrom soils in the slightly lower landscape positions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Loose sand on the Wallace soil can interfere with the traction of wheeled equipment. Logging roads should be stabilized.
• Because of low strength in areas of the Alcona soil, suitable surfacing material is needed on year-round logging roads and landings.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate in areas of the Wallace soil.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* Wallace—7D; Alcona—3L
*Michigan soil management group:* Wallace—5a-h; Alcona—3a-s
*Primary habitat type:* ATD
*Secondary habitat type:* None assigned

## 84F—Wallace-Alcona complex, 35 to 60 percent slopes

### Setting

*Landform:* Rolling to very steep areas on lake plains and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 65 acres

### Typical Profile

**Wallace**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter

*Surface layer:*
2 to 10 inches—light brownish gray sand

*Subsoil:*
10 to 11 inches—dark reddish brown, very friable sand
11 to 26 inches—dark brown, cemented sand
26 to 59 inches—brownish yellow, loose sand

*Substratum:*
59 to 80 inches—light yellowish brown sand

**Alcona**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 3 inches—pinkish gray fine sandy loam

*Subsoil:*
3 to 17 inches—dark brown, dark yellowish brown, and strong brown, friable fine sandy loam
17 to 23 inches—reddish brown and light pinkish gray, firm very fine sandy loam
23 to 54 inches—light reddish brown, friable loamy fine sand and reddish brown, friable sandy loam

*Substratum:*
54 to 80 inches—light brown and brown, stratified loamy very fine sand, fine sandy loam, and very fine sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Wallace—moderate or moderately rapid in the cemented layer and rapid in the rest of the profile; Alcona—moderate

*Available water capacity:* Wallace—very low; Alcona—high
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Severe
*Hazard of soil blowing:* Wallace—severe; Alcona—moderate
*Potential for frost action:* Wallace—low; Alcona—moderate
*Shrink-swell potential:* Low

### Composition

Wallace soil and similar soils: 40 to 50 percent
Alcona soil and similar soils: 35 to 45 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the major soils

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• Cable yarding systems are generally safer than other logging methods and result in less surface disturbance.
• Log landings should be located in included level areas or adjacent level areas.
• Because of the erosion hazard, skid roads and skid trails should be established on the contour and water should be removed by water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures.
• Loose sand on the Wallace soil can interfere with the traction of wheeled equipment. Logging roads should be stabilized.
• Because of low strength in areas of the Alcona soil, suitable surfacing material is needed on year-round logging roads and landings.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate in areas of the Wallace soil.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* Wallace—7R; Alcona—3R
*Michigan soil management group:* Wallace—5a-h; Alcona—3a-s
*Primary habitat type:* ATD
*Secondary habitat type:* None assigned

## 86B—Ingalls-Paquin complex, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 25 acres

### Typical Profile

**Ingalls**

*Organic mat:*
0 to 2 inches—well decomposed leaf litter
*Surface layer:*
2 to 8 inches—grayish brown fine sand
*Subsoil:*
8 to 20 inches—dark brown, mottled, very friable fine sand
*Substratum:*
20 to 27 inches—light yellowish brown, mottled, stratified loamy very fine sand, very fine sand, and silt loam
27 to 60 inches—pale brown and light brown, mottled, stratified silt loam, loamy very fine sand, and very fine sand

**Paquin**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 12 inches—brown sand
*Subsoil:*
12 to 14 inches—very dark brown, very friable sand
14 to 27 inches—very dark brown and dark brown, cemented sand
27 to 34 inches—strong brown, mottled, loose sand
*Substratum:*
34 to 80 inches—yellowish brown, mottled sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Ingalls—rapid in the upper part and moderately slow in the lower part; Paquin—moderate or moderately rapid in the cemented layer and rapid in the rest of the profile
*Available water capacity:* Ingalls—moderate; Paquin—low
*Drainage class:* Ingalls—somewhat poorly drained; Paquin—moderately well drained
*Depth to seasonal high water table:* Ingalls—0.5 foot to

1.5 feet at times from November through May; Paquin—2.0 to 3.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Ingalls—moderate; Paquin—low
*Shrink-swell potential:* Low

### Composition

Ingalls soil and similar soils: 45 to 55 percent
Paquin soil and similar soils: 40 to 50 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in landscape positions similar to those of the Ingalls soil
• The well drained Wallace soils in the higher landscape positions
• The moderately well drained Borgstrom soils in landscape positions similar to those of the Paquin soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Trees that can withstand seasonal wetness should be selected for planting.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* IIIw
*Woodland ordination symbol:* Ingalls—4W; Paquin—3S
*Michigan soil management group:* Ingalls—4/2b; Paquin—5a-h
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 88B—Croswell-Wainola complex, 0 to 6 percent slopes

### Setting

*Landform:* Croswell—nearly level and undulating areas on lake plains; Wainola—nearly level areas on lake plains
*Shape of areas:* Irregular or elongated
*Size of areas:* 10 to 285 acres

### Typical Profile

**Croswell**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter

*Surface layer:*
2 to 6 inches—light brownish gray sand

*Subsoil:*
6 to 15 inches—strong brown, very friable sand
15 to 22 inches—brownish yellow, loose sand

*Substratum:*
22 to 80 inches—light yellowish brown, mottled sand

**Wainola**

*Organic mat:*
0 to 3 inches—partially decomposed leaf litter

*Surface layer:*
3 to 14 inches—pinkish gray fine sand

*Subsoil:*
14 to 17 inches—dark brown and dark reddish brown, mottled, very friable fine sand
17 to 26 inches—strong brown, mottled, very friable fine sand
26 to 30 inches—yellowish brown, loose fine sand

*Substratum:*
30 to 80 inches—light yellowish brown fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Low
*Drainage class:* Croswell—moderately well drained; Wainola—somewhat poorly drained
*Depth to seasonal high water table:* Croswell—2 to 3 feet at times from November through May; Wainola—0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Croswell—low; Wainola—moderate
*Shrink-swell potential:* Low

### Composition

Croswell soil and similar soils: 45 to 60 percent
Wainola soil and similar soils: 25 to 45 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The excessively drained Eastport soils in the higher landscape positions
• The poorly drained Spot and Leafriver soils in depressions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* IVs
*Woodland ordination symbol:* Croswell—5S; Wainola—6W
*Michigan soil management group:* Croswell—5a; Wainola—5b
*Primary habitat type:* AQVac
*Secondary habitat type:* TMC-V

## 89A—Spot-Finch complex, 0 to 3 percent slopes

### Setting

*Landform:* Spot—depressions on outwash plains and lake plains; Finch—nearly level areas on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 10 to 485 acres

### Typical Profile

**Spot**

*Surface layer:*
0 to 1 inch—slightly decomposed organic matter
1 to 2 inches—black muck

*Subsurface layer:*
2 to 8 inches—light brownish gray, mottled sand

*Subsoil:*
8 to 12 inches—dark reddish brown and dark brown, cemented sand
12 to 18 inches—strong brown, friable sand

*Substratum:*
18 to 80 inches—light brown and light yellowish brown sand

**Finch**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 11 inches—pinkish gray sand

*Subsoil:*
11 to 42 inches—dark brown, dark reddish brown, and brown, mottled, cemented sand

*Substratum:*
42 to 80 inches—yellowish brown fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layer and rapid in the rest of the profile
*Available water capacity:* Spot—low; Finch—very low
*Drainage class:* Spot—poorly drained; Finch—somewhat poorly drained
*Seasonal high water table:* Spot—1 foot above to 1 foot below the surface at times from September through June; Finch—at a depth of 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Spot—very slow or ponded; Finch—slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Spot soil and similar soils: 40 to 55 percent
Finch soil and similar soils: 25 to 60 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The moderately well drained Croswell soils in the slightly higher landscape positions
• The very poorly drained Dawson and Markey soils in landscape positions similar to those of the Spot soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer

months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Site preparation methods, such as bedding, trenching, or mounding, can maximize seedling survival and growth in new plantations.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### *Interpretive Groups*

*Land capability classification:* Vw
*Woodland ordination symbol:* Spot—2W; Finch—4W
*Michigan soil management group:* Spot—5c-h; Finch—5b-h
*Primary habitat type:* TTS
*Secondary habitat type:* TMC

## 92A—Engadine fine sandy loam, 0 to 3 percent slopes

### *Setting*

*Landform:* Depressions on lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 160 acres

### *Typical Profile*

*Surface layer:*
0 to 9 inches—very dark grayish brown fine sandy loam
*Subsurface layer*
9 to 10 inches—grayish brown, mottled fine sandy loam
*Subsoil:*
10 to 14 inches—dark brown and brown, friable, mottled fine sandy loam and sandy loam
14 to 18 inches—brown, firm, mottled silty clay loam and loamy fine sand
18 to 25 inches—reddish brown, firm, mottled clay
*Substratum:*
25 to 80 inches—brown, mottled clay

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate in the upper part and very slow in the lower part
*Available water capacity:* Moderate
*Drainage class:* Somewhat poorly drained
*Seasonal high water table:* Perched at a depth of 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* High
*Shrink-swell potential:* High

### *Composition*

Engadine soil and similar soils: 75 to 90 percent
Contrasting inclusions: 10 to 25 percent

### *Inclusions*

*Contrasting inclusions:*
• The poorly drained Glawe and Gogomain soils in depressions
• The well drained Superior soils in the higher landscape positions
• The somewhat poorly drained Moltke soils in landscape positions similar to those of the Engadine soil

*Similar inclusions:*
• Soils that are underlain by gravelly sandy loam
• Soils that have a sandy surface layer

### *Use and Management*

**Land use:** Dominant uses—cropland and pasture; other uses—woodland

**Cropland**
*Major management concerns:* Wetness, soil tilth
*Management measures:*
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Shallow surface ditches help to remove surface water after heavy rains.
• Minimizing tillage and tilling and harvesting at the proper soil moisture content help to prevent excessive compaction and maintain tilth.

**Pasture**
*Major management concerns:* Wetness
*Management measures:*
• Proper stocking rates and a planned grazing system help to keep the pasture in good condition.
• The only hay and pasture plants that should be seeded are those that can withstand periodic inundation and seasonal wetness.

**Woodland**
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel.

Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.
• Trees that can withstand seasonal wetness should be selected for planting.

### Interpretive Groups

*Land capability classification:* IIIw
*Woodland ordination symbol:* 2W
*Michigan soil management group:* 3/1b
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 93F—Ontonagon-Pickford, occasionally flooded, complex, 0 to 50 percent slopes

### Setting

*Landform:* Ontonagon—sides of ravines; Pickford—flood plains in ravines on lake plains
*Shape of areas:* Elongated
*Size of areas:* 25 to 300 acres

### Typical Profile

**Ontonagon**

*Surface layer:*
0 to 7 inches—dark reddish brown silt loam
*Subsoil:*
7 to 10 inches—reddish brown, firm clay and reddish gray, firm silty clay
10 to 21 inches—reddish brown, firm clay
*Substratum:*
21 to 80 inches—reddish brown clay

**Pickford**

*Surface layer:*
0 to 6 inches—very dark grayish brown silty clay loam
*Subsoil:*
6 to 9 inches—dark gray, firm, mottled clay
9 to 19 inches—reddish brown, firm, mottled clay
*Substratum:*
19 to 60 inches—reddish brown clay

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Very slow
*Available water capacity:* Moderate
*Drainage class:* Ontonagon—well drained; Pickford—poorly drained
*Seasonal high water table:* Ontonagon—at a depth of more than 60 inches; Pickford—1 foot above to 1 foot below the surface at times from November through June
*Surface runoff:* Ontonagon—rapid; Pickford—very slow or ponded
*Flooding:* Ontonagon—none; Pickford—occasional
*Hazard of water erosion:* Ontonagon—severe; Pickford—slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* Moderate
*Shrink-swell potential:* High

### Composition

Ontonagon soil and similar soils: 60 to 85 percent
Pickford soil and similar soils: 15 to 30 percent
Contrasting inclusions: 0 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Rudyard soils on foot slopes of ravines

*Similar inclusions:*
• Soils that have a surface layer of sand
• Soils that have a surface layer of muck

### Use and Management

**Land uses:** Woodland and habitat for wetland wildlife

**Woodland**

*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality, windthrow hazard
*Management measures:*
• Onsite investigation is needed to determine the feasibility of logging in areas of these soils without causing severe erosion of side slopes and deposition of sediments into streams.
• Cable yarding systems are generally safer than other logging methods and result in less surface disturbance.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Seedling mortality is severe in areas on flood plains, and the planting of trees is limited by the seasonal flooding and wetness.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIIe
*Woodland ordination symbol:* Ontonagon—2R; Pickford—6W
*Michigan soil management group:* Ontonagon—Oa; Pickford—1c

*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 94A—Markey-Spot-Finch complex, 0 to 3 percent slopes

### *Setting*

*Landform:* Markey—organic depressions; Spot and Finch—depressions and nearly level areas on lake plains and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 10 to 750 acres

### *Typical Profile*

**Markey**

*Surface layer:*
0 to 18 inches—black muck
18 to 27—very dark brown and very dark grayish brown muck

*Substratum:*
27 to 60 inches—dark gray and dark grayish brown sand

**Spot**

*Surface layer:*
0 to 1 inch—slightly decomposed organic matter
1 to 2 inches—black muck

*Subsurface layer:*
2 to 8 inches—light brownish gray, mottled sand

*Subsoil:*
8 to 12 inches—dark reddish brown and dark brown, cemented sand
12 to 18 inches—strong brown, friable sand

*Substratum:*
18 to 80 inches—light brown and light yellowish brown sand

**Finch**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 11 inches—pinkish gray sand

*Subsoil:*
11 to 42 inches—dark brown, dark reddish brown, and brown, mottled, cemented sand

*Substratum:*
42 to 80 inches—yellowish brown fine sand

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Markey—moderately slow to moderately rapid in the upper part and rapid in the lower part; Spot and Finch—moderate or moderately rapid in the cemented layer and rapid in the rest of the profile
*Available water capacity:* Markey—very high; Spot—low; Finch—very low
*Drainage class:* Markey—very poorly drained; Spot—poorly drained; Finch—somewhat poorly drained
*Seasonal high water table:* Markey—1 foot above to 1 foot below the surface at times from November through June; Spot—1 foot above to 1 foot below the surface at times from September through June; Finch—at a depth of 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Markey and Spot—very slow or ponded; Finch—slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Markey—moderate; Spot and Finch—severe
*Potential for frost action:* Markey—high; Spot and Finch—moderate
*Shrink-swell potential:* Low

### *Composition*

Markey soil and similar soils: 40 to 55 percent
Spot soil and similar soils: 25 to 40 percent
Finch soil and similar soils: 15 to 25 percent
Contrasting inclusions: 5 to 20 percent

### *Inclusions*

*Contrasting inclusions:*
• The moderately well drained Croswell and Paquin soils in the slightly higher landscape positions
• The very poorly drained Carbondale soils in landscape positions similar to those of the Markey soil

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Access is easiest during periods in winter when access roads are frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Roads and trails should be located on the low ridges.
• Landing sites generally can be used only during the driest time of the year.
• Because of wetness and severe seedling mortality, trees are not planted in areas of these soils.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### *Interpretive Groups*

*Land capability classification:* Vw

*Woodland ordination symbol:* Markey and Spot—2W; Finch—4W
*Michigan soil management group:* Markey—M/4c; Spot—5c-h; Finch—5b-h
*Primary habitat type:* TTM
*Secondary habitat type:* TTS

## 95A—Bowers silt loam, 0 to 3 percent slopes

### *Setting*

*Landform:* Nearly level areas on lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 225 acres

### *Typical Profile*

*Surface layer:*
0 to 8 inches—dark grayish brown silt loam

*Subsurface layer:*
8 to 11 inches—grayish brown silt loam

*Subsoil:*
11 to 22 inches—reddish brown and brown, mottled, firm silty clay loam and silt loam

*Substratum:*
22 to 80 inches—reddish brown and light reddish brown, stratified silt loam, silty clay loam, and silty clay

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Slow
*Available water capacity:* High
*Drainage class:* Somewhat poorly drained
*Depth to seasonal high water table:* 1 to 2 feet at times from November through April
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* High
*Shrink-swell potential:* Moderate

### *Composition*

Bowers soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### *Inclusions*

*Contrasting inclusions:*
• The poorly drained Pickford soils in depressions

*Similar inclusions:*
• Soils that have clay in the substratum

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Because of the very slow permeability and the sticky and plastic subsoil, logging roads should be graveled and, in some areas, landings should be stabilized.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Trees that can withstand seasonal wetness should be selected for planting.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

**Cropland**
*Major management concerns:* Seasonal wetness, tilth of the surface layer, low organic matter content, compaction
*Management measures:*
• Shallow surface ditches help to remove surface water after heavy rains.
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Minimizing tillage and tilling and harvesting at the proper soil moisture content help to prevent excessive compaction and maintain tilth.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

**Pasture**
*Major management concerns:* Seasonal wetness, compaction
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.
• The only hay and pasture plants that should be seeded are those that can withstand periodic inundation and seasonal wetness.

### *Interpretive Groups*

*Land capability classification:* IIw
*Woodland ordination symbol:* 7W
*Michigan soil management group:* 1.5b
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 98—Glawe silt loam

### *Setting*

*Landform:* Depressions on lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 120 acres

### *Typical Profile*

*Surface layer:*
0 to 9 inches—black silt loam
*Subsoil:*
9 to 14 inches—grayish brown, mottled, friable silt loam
*Substratum:*
14 to 80 inches—brown, mottled silt loam

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate
*Available water capacity:* High
*Drainage class:* Poorly drained
*Seasonal high water table:* 1 foot above to 1 foot below the surface at times from October through May
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* High
*Shrink-swell potential:* Low

### *Composition*

Glawe soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### *Inclusions*

*Contrasting inclusions:*
• The somewhat poorly drained Engadine and Moltke soils in the slightly higher landscape positions
• The poorly drained Pickford soils in landscape positions similar to those of the Glawe soil
*Similar inclusions:*
• Soils that have clay in the substratum
• Soils that have loamy glacial till in the substratum

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Cropland**
*Major management concerns:* Ponding, tilth of the surface layer
*Management measures:*
• Shallow surface ditches help to remove surface water after heavy rains.
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Water-tolerant species should be selected for planting.
• Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.

**Pasture**
*Major management concerns:* Ponding, surface compaction
*Management measures:*
• Proper stocking rates and a planned grazing system help to keep the pasture in good condition.
• The only hay and pasture plants that should be seeded are those that can withstand periodic inundation and seasonal wetness.

**Woodland**
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Because of wetness and severe seedling mortality, trees are not planted in areas of this soil.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### *Interpretive Groups*

*Land capability classification:* Vw
*Woodland ordination symbol:* 2W
*Michigan soil management group:* 2.5c
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 100B—Greylock-Adams complex, 0 to 6 percent slopes

### *Setting*

*Landform:* Nearly level and undulating areas on ground moraines
*Shape of areas:* Irregular
*Size of areas:* 10 to 315 acres

### *Typical Profile*

**Greylock**
*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 6 inches—black fine sandy loam
*Subsurface layer:*
6 to 7 inches—reddish gray sandy loam

*Subsoil:*
7 to 19 inches—dark reddish brown and dark brown, friable fine sandy loam and sandy loam
19 to 26 inches—brown and reddish brown, firm loamy sand and sandy loam
26 to 34 inches—reddish brown, friable sandy loam and loamy sand

*Substratum:*
34 to 80 inches—brown sandy loam

**Adams**

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 4 inches—very dark gray sandy loam

*Subsurface layer:*
4 to 5 inches—reddish gray sandy loam

*Subsoil:*
5 to 7 inches—dark reddish brown, friable sandy loam
7 to 12 inches—reddish brown, friable loamy sand
12 to 26 inches—strong brown and yellowish brown, very friable sand

*Substratum:*
26 to 80 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Greylock—moderate; Adams—moderate in the upper part and rapid or very rapid in the lower part
*Available water capacity:* Greylock—moderate; Adams—low
*Drainage class:* Greylock—well drained; Adams—somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Greylock—moderate; Adams—low
*Shrink-swell potential:* Low

### Composition

Greylock soil and similar soils: 45 to 55 percent
Adams soil and similar soils: 30 to 50 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Solona soils in the slightly lower landscape positions
• The moderately well drained Graveraet soils in the slightly lower landscape positions

*Similar inclusions:*
• Soils that have a sandy surface layer
• Soils that have sand and gravel in the substratum

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**

*Major management concerns:* Equipment limitations
*Management measures:*
• Because of low strength in areas of the Greylock soil, suitable surfacing material is needed on year-round logging roads and landings.
• If trees are planted, site preparation by chemical or mechanical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

**Cropland**

*Major management concerns:* Water erosion, droughtiness, organic matter content
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content and conserve soil moisture.

**Pasture**

*Major management concerns:* Compaction, overgrazing, droughtiness
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### Interpretive Groups

*Land capability classification:* IIe
*Woodland ordination symbol:* Greylock—3L; Adams—3S
*Michigan soil management group:* Greylock—3a; Adams—4a
*Primary habitat type:* AVO-A
*Secondary habitat type:* ATD

## 100D—Greylock-Adams complex, 6 to 15 percent slopes

### Setting

*Landform:* Gently rolling and rolling areas on ground moraines
*Shape of areas:* Irregular
*Size of areas:* 10 to 65 acres

### Typical Profile

**Greylock**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 6 inches—black fine sandy loam

*Subsurface layer:*
6 to 7 inches—reddish gray sandy loam

*Subsoil:*
7 to 19 inches—dark reddish brown and dark brown, friable fine sandy loam and sandy loam
19 to 26 inches—brown and reddish brown, firm loamy sand and sandy loam
26 to 34 inches—reddish brown, friable sandy loam and loamy sand

*Substratum:*
34 to 80 inches—brown sandy loam

**Adams**

*Organic mat:*
1 inch to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 4 inches—very dark gray sandy loam

*Subsurface layer:*
4 to 5 inches—reddish gray sandy loam

*Subsoil:*
5 to 7 inches—dark reddish brown, friable sandy loam
7 to 12 inches—reddish brown, friable loamy sand
12 to 26 inches—strong brown and yellowish brown, very friable sand

*Substratum:*
26 to 80 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Greylock—moderate; Adams—moderate in the upper part and rapid or very rapid in the lower part
*Available water capacity:* Greylock—moderate; Adams—low
*Drainage class:* Greylock—well drained; Adams—somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Greylock—moderate; Adams—slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Greylock—moderate; Adams—low
*Shrink-swell potential:* Low

### Composition

Greylock soil and similar soils: 45 to 55 percent
Adams soil and similar soils: 30 to 50 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Solona soils in the lower landscape positions
• The moderately well drained Graveraet soils in the slightly lower landscape positions

*Similar inclusions:*
• Soils that have sand and gravel in the substratum

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations
*Management measures:*
• Because of low strength on the Greylock soil, suitable surfacing material is needed on year-round logging roads and landings.
• If trees are planted, site preparation by chemical or mechanical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

### Interpretive Groups

*Land capability classification:* IIIe
*Woodland ordination symbol:* Greylock—3L; Adams—3S
*Michigan soil management group:* Greylock—3a; Adams—4a
*Primary habitat type:* AVO-A
*Secondary habitat type:* ATD

## 108D—Shelter-Alpena complex, 0 to 15 percent slopes, stony

### Setting

*Landform:* Nearly level to rolling areas on ground moraines and lake benches
*Shape of areas:* Irregular
*Size of areas:* 5 to 65 acres

### Typical Profile

**Shelter**

*Organic mat:*
0 to 2 inches—well decomposed leaf litter

*Surface layer:*
2 to 8 inches—black very cobbly loam
8 to 10 inches—very dark grayish brown and dark yellowish brown very cobbly fine sandy loam

*Subsoil:*
10 to 14 inches—dark yellowish brown, friable very cobbly fine sandy loam
*Substratum:*
14 to 60 inches—light brown, mottled, firm very gravelly fine sandy loam

**Alpena**

*Surface layer:*
0 to 5 inches—very dark grayish brown gravelly loam
*Subsoil:*
5 to 10 inches—dark yellowish brown, friable extremely gravelly loam
*Substratum:*
10 to 25 inches—light yellowish brown very gravelly loamy coarse sand
25 to 60 inches—very pale brown very gravelly coarse sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Rock fragments on the surface:* Kind—stones and cobbles; percentage of the surface covered—0.01 to 0.1 percent
*Permeability:* Shelter—very slow; Alpena—very rapid
*Available water capacity:* Shelter—very low; Alpena—low
*Drainage class:* Shelter—somewhat poorly drained; Alpena—excessively drained
*Seasonal high water table:* Shelter—perched at a depth of 0.5 to 1.0 foot at times from October through May; Alpena—at a depth of more than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* Shelter—high; Alpena—low
*Shrink-swell potential:* Low

### Composition

Shelter soil and similar soils: 40 to 60 percent
Alpena soil and similar soils: 30 to 45 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Battydoe soils in the higher landscape positions
• The somewhat poorly drained Esau soils in landscape positions similar to those of the Shelter soil
*Similar inclusions:*
• Areas of extremely stony or bouldery soils

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Large stones on the surface can hinder harvesting activities and damage equipment.
• Landing sites generally can be located in the drier areas.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIw
*Woodland ordination symbol:* Shelter—4X; Alpena—3F
*Michigan soil management group:* Shelter—Gbc; Alpena—Ga
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 112—Soo silty clay loam

### Setting

*Landform:* Flats and depressions on lake plains
*Shape of areas:* Irregular
*Size of areas:* 10 to 400 acres

### Typical Profile

*Surface layer:*
0 to 7 inches—very dark gray silty clay loam
*Subsoil:*
7 to 17 inches—dark brown, mottled, very firm silty clay loam
*Substratum:*
17 to 60 inches—reddish brown, mottled silty clay loam that has thin bands of pinkish gray silt loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Slow
*Available water capacity:* High
*Drainage class:* Poorly drained
*Seasonal high water table:* Perched 1 foot above to 1 foot below the surface at times from October through June
*Surface runoff:* Very slow or ponded
*Flooding:* None

*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* High
*Shrink-swell potential:* Moderate

### Composition

Soo soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Bowers and Rudyard soils in the slightly higher landscape positions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Because of wetness, seedling mortality, and plant competition, trees are generally not planted on this soil.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* Vw
*Woodland ordination symbol:* 6W
*Michigan soil management group:* 1.5c
*Primary habitat type:* TTP
*Secondary habitat type:* None assigned

## 113—Ruse mucky loam

### Setting

*Landform:* Depressions on ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 65 acres

### Typical Profile

*Surface layer:*
0 to 7 inches—black mucky loam

*Subsoil:*
7 to 15 inches—grayish brown and pale brown, mottled, friable sandy loam

*Bedrock:*
15 inches—fractured limestone

### Soil Properties and Qualities

*Depth class:* Shallow
*Permeability:* Moderate or moderately rapid
*Available water capacity:* Low
*Drainage class:* Poorly drained
*Seasonal high water table:* 1 foot above to 1 foot below the surface at times from October through May
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Low
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

Ruse soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Ensign soils in the slightly higher landscape positions

*Similar inclusions:*
• Soils that have a thin surface layer of muck

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Because of wetness and severe seedling mortality, trees are not planted on this soil.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIIw
*Woodland ordination symbol:* 5W
*Michigan soil management group:* Rbc
*Primary habitat type:* TTM
*Secondary habitat type:* None assigned

## 116—Udipsamments and Udorthents, nearly level

### Setting

*Landform:* Flat areas that were excavated for borrow material, or cut and fill areas
*Shape of areas:* Irregular or elongated
*Size of areas:* 5 to 30 acres

### Soil Properties and Qualities

*Texture:* Sand to clay
*Depth class:* Very deep
*Permeability:* Variable
*Available water capacity:* Variable
*Drainage class:* Well drained
*Depth to seasonal high water table:* Variable
*Surface runoff:* Slow

### Composition

Udorthents: 100 percent

### Use and Management

**Land use:** Former use—source of borrow material or wetland; current uses—idle land or building site development
*Management measures:*
• Onsite investigation is needed to determine the suitability for specific uses.

### Interpretive Groups

*Land capability classification:* None assigned
*Woodland ordination symbol:* None assigned
*Michigan soil management group:* None assigned
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 117B—Manistee sand, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 80 acres

### Typical Profile

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 10 inches—pinkish gray sand
*Subsoil:*
10 to 26 inches—dark brown and strong brown, friable sand
26 to 36 inches—reddish brown and reddish gray, firm clay and silty clay loam
*Substratum:*
36 to 64 inches—reddish brown clay that has thin strata of light brown silty clay loam and silt loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid in the upper part and very slow in the lower part
*Available water capacity:* Low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* High

### Composition

Manistee soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Allendale soils in the lower landscape positions
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Manistee soil
*Similar inclusions:*
• Soils that have sand and gravel below a depth of 50 inches
• Soils that have limestone bedrock below a depth of 50 inches

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Equipment use should be limited to logging roads during spring snowmelt when the soil is wet and ruts form easily.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

**Cropland**
*Major management concerns:* Soil blowing, loss of nutrients, low organic matter content
*Management measures:*
• Conservation tillage, vegetative barriers, and cover crops help to control soil blowing.
• Timing fertilizer applications according to crop nutrient

needs, using split fertilizer applications, and applying fertilizer in bands may reduce the risk of nutrient leaching.
• Increasing the organic matter content in the root zone may increase the ability of the soil to hold water, nutrients, and pesticides and reduce the risk of groundwater pollution.
• Inclusion of green manure crops in the cropping sequence, no-till planting, and crop residue management increase the organic matter content.

**Pasture**
*Major management concerns:* Overgrazing
*Management measures:*
• Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.
• Applying lime and fertilizer according to soil tests ensures maximum growth of plants, especially legumes.

### *Interpretive Groups*

*Land capability classification:* IIIs
*Woodland ordination symbol:* 3S
*Michigan soil management group:* 4/1a
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 119—Gogomain very fine sandy loam

### *Setting*

*Landform:* Depressions on lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 270 acres

### *Typical Profile*

*Surface layer:*
0 to 10 inches—very dark gray very fine sandy loam
*Subsoil:*
10 to 18 inches—grayish brown and brown, mottled, friable loamy very fine sand, very fine sandy loam, and fine sandy loam
*Substratum:*
18 to 80 inches—reddish brown clay

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderately rapid in the upper part and very slow in the lower part
*Available water capacity:* Moderate
*Drainage class:* Poorly drained
*Seasonal high water table:* Perched 1 foot above to 1 foot below the surface at times from November through June
*Surface runoff:* Very slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* High
*Shrink-swell potential:* High

### *Composition*

Gogomain soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### *Inclusions*

*Contrasting inclusions:*
• The poorly drained Pickford soils in landscape positions similar to those of the Gogomain soil
• The poorly drained Glawe soils in landscape positions similar to those of the Gogomain soil
• The somewhat poorly drained Engadine soils in the slightly higher landscape positions

*Similar inclusions:*
• Soils that have a mucky surface layer

### *Use and Management*

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Because of wetness and severe seedling mortality, trees are not planted on this soil.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

**Cropland**
*Major management concerns:* Ponding, tilth of the surface layer, compaction
*Management measures:*
• Shallow surface ditches help to remove surface water after heavy rains.
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Water-tolerant species should be selected for planting.
• Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.

**Pasture**
*Major management concerns:* Ponding, compaction

*Management measures:*
• Proper stocking rates and a planned grazing system help to keep the pasture in good condition.
• The only hay and pasture plants that should be seeded are those that can withstand periodic inundation and seasonal wetness.

### Interpretive Groups

*Land capability classification:* Vw
*Woodland ordination symbol:* 4W
*Michigan soil management group:* 3/1c
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 122—Pits, quarry

### Setting

*Landform:* Uplands
*Size of areas:* 5 to 1,500 acres

### Composition

Pits: 100 percent

### Use and Management

**Land use:** Source of limestone or dolomite
• Onsite investigation is needed to determine the suitability for specific uses.

### Interpretive Groups

*Land capability classification:* None assigned
*Woodland ordination symbol:* None assigned
*Michigan soil management group:* None assigned
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 123B—Borgstrom sand, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 125 acres

### Typical Profile

*Organic mat:*
2 inches to 0—slightly decomposed leaf litter
0 to 2 inches—well decomposed leaf litter
*Surface layer:*
2 to 9 inches—pinkish gray sand
*Subsoil:*
9 to 21 inches—brown and dark reddish brown, cemented sand
21 to 29 inches—yellowish brown, very friable sand
*Substratum:*
29 to 80 inches—pinkish gray, reddish brown, and brown, mottled, stratified fine sand to silt loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid in the sand, except for the cemented layers, which are moderately permeable or moderately rapidly permeable; moderately slow in the substratum
*Available water capacity:* Low
*Drainage class:* Moderately well drained
*Seasonal high water table:* Perched at a depth of 2.0 to 3.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Borgstrom soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Ingalls soils in the slightly lower landscape positions
• The somewhat excessively drained Kalkaska soils in landscape positions similar to those of the Borgstrom soil
• The well drained Alcona soils in landscape positions similar to those of the Borgstrom soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* 3S
*Michigan soil management group:* 5a-h

*Primary habitat type:* TMC-D
*Secondary habitat type:* ATD

## 124D—Alpena gravelly loam, 0 to 15 percent slopes

### *Setting*

*Landform:* Nearly level to rolling areas on glacial lake beach ridges
*Shape of areas:* Elongated
*Size of areas:* 5 to 80 acres

### *Typical Profile*

*Surface layer:*
0 to 5 inches—very dark grayish brown gravelly loam
*Subsoil:*
5 to 10 inches—dark yellowish brown, friable extremely gravelly loam
*Substratum:*
10 to 25 inches—light yellowish brown very gravelly loamy coarse sand
25 to 60 inches—very pale brown very gravelly coarse sand

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Very rapid
*Available water capacity:* Low
*Drainage class:* Excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### *Composition*

Alpena soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### *Inclusions*

*Contrasting inclusions:*
• The somewhat poorly drained Esau soils in the lower landscape positions
• The somewhat poorly drained Shelter soils in the slightly lower landscape positions
*Similar inclusions:*
• Soils that have a water table between depths of 40 and 60 inches
• Soils that have a sandy surface layer

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Seedling mortality
*Management measures:*
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### *Interpretive Groups*

*Land capability classification:* VIs
*Woodland ordination symbol:* 3F
*Michigan soil management group:* Ga
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 125B—Croswell-Markey complex, 0 to 6 percent slopes

### *Setting*

*Landform:* Croswell—low ridges; Markey—depressions on outwash plains and in dune areas
*Shape of areas:* Irregular
*Size of areas:* 10 to 225 acres

### *Typical Profile*

**Croswell**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 6 inches—light brownish gray sand
*Subsoil:*
6 to 15 inches—strong brown, very friable sand
15 to 22 inches—brownish yellow, loose sand
*Substratum:*
22 to 80 inches—light yellowish brown, mottled sand

**Markey**

*Surface layer:*
0 to 18 inches—black muck
18 to 27 inches—very dark brown and very dark grayish brown muck
*Substratum:*
27 to 60 inches—dark gray and dark grayish brown sand

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Croswell—rapid; Markey—moderately slow to moderately rapid in the upper part and rapid in the lower part
*Available water capacity:* Croswell—low; Markey—very high
*Drainage class:* Croswell—moderately well drained; Markey—very poorly drained
*Seasonal high water table:* Croswell—at a depth of 2.0 to 3.5 feet at times from November through May;

Markey—1 foot above to 1 foot below the surface at times from November through June
*Surface runoff:* Croswell—slow; Markey—very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Croswell—high; Markey—moderate
*Potential for frost action:* Croswell—low; Markey—high
*Shrink-swell potential:* Low

### Composition

Croswell soil and similar soils: 45 to 60 percent
Markey soil and similar soils: 25 to 45 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in slightly lower landscape positions than those of the Croswell soil
• The poorly drained Spot and Leafriver soils in landscape positions similar to those of the Markey soil
*Similar inclusions:*
• Soils that have a water table below a depth of 60 inches; at the top of ridges
• Soils that have muck more than 60 inches thick

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Access is easiest during periods in winter when the areas of muck are frozen.
• Roads and landings should be located only on the sandy ridges.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• On the sandy ridges, planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
• In the swales, seedling mortality and the windthrow hazard are severe because of wetness. Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* IVs
*Woodland ordination symbol:* Croswell—5S; Markey—2W
*Michigan soil management group:* Croswell—5a; Markey—M/4c
*Primary habitat type:* AQVac
*Secondary habitat type:* TTM

## 132B—Superior fine sandy loam, till substratum, 1 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on ground moraines and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 190 acres

### Typical Profile

*Surface layer:*
0 to 4 inches—black fine sandy loam
*Subsurface layer:*
4 to 7 inches—brown fine sandy loam
*Subsoil:*
7 to 16 inches—dark reddish brown, friable fine sandy loam
16 to 34 inches—reddish brown and brown, firm clay and silt loam
*Substratum:*
34 to 74 inches—reddish brown clay that has thin strata of dark brown silt loam
74 to 80 inches—grayish brown and reddish brown sandy clay loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate in the upper part and slow or very slow in the lower part
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Superior soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Engadine soils in the lower landscape positions
• The well drained Ontonagon soils in landscape positions similar to those of the Superior soil
• The well drained Battydoe soils in the slightly higher landscape positions
*Similar inclusions:*
• Soils that have limestone bedrock below a depth of 40 inches

• Soils that have stones on the surface

### *Use and Management*

**Land use:** Dominant uses—cropland and pasture; other uses—woodland

**Cropland**

*Major management concerns:* Water erosion, low organic matter content, tilth of the surface layer

*Management measures:*

• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.

• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

• Minimizing tillage and tilling and harvesting at the proper soil moisture content help to prevent excessive compaction and maintain tilth.

**Pasture**

*Major management concerns:* Surface compaction

*Management measures:*

• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

**Woodland**

*Major management concerns:* Equipment limitations

*Management measures:*

• Equipment use should be limited to logging roads during spring snowmelt when the soil is wet and ruts form easily.

### *Interpretive Groups*

*Land capability classification:* IIe
*Woodland ordination symbol:* 3L
*Michigan soil management group:* 1a
*Primary habitat type:* AVO-A
*Secondary habitat type:* AVO

## 132D—Superior fine sandy loam, till substratum, 6 to 15 percent slopes

### *Setting*

*Landform:* Rolling and gently rolling areas on ground moraines and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 100 acres

### *Typical Profile*

*Surface layer:*
0 to 4 inches—black fine sandy loam

*Subsurface layer:*
4 to 7 inches—brown fine sandy loam

*Subsoil:*
7 to 16 inches—dark reddish brown, friable fine sandy loam
16 to 34 inches—reddish brown and brown, firm clay and silt loam

*Substratum:*
34 to 74 inches—reddish brown clay that has strata of dark brown silt loam
74 to 80 inches—grayish brown and reddish brown sandy clay loam

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate in the upper part and slow or very slow in the lower part
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### *Composition*

Superior soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### *Inclusions*

*Contrasting inclusions:*

• The somewhat poorly drained Engadine soils in the lower landscape positions

• The well drained Ontonagon soils in landscape positions similar to those of the Superior soil

• The well drained Battydoe soils in the slightly higher landscape positions

*Similar inclusions:*

• Soils that have limestone bedrock below a depth of 40 inches

• Soils that have stones on the surface

### *Use and Management*

**Land use:** Dominant uses—cropland and pasture; other uses—woodland

**Cropland**

*Major management concerns:* Water erosion, low organic matter content, tilth of the surface layer

*Management measures:*

• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.

• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.

• Minimizing tillage and tilling and harvesting at the proper soil moisture content help to prevent excessive compaction and maintain tilth.

**Pasture**
*Major management concerns:* Surface compaction
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

**Woodland**
*Major management concerns:* Equipment limitations
*Management measures:*
• Equipment use should be limited to logging roads during spring snowmelt when the soil is wet and ruts form easily.

### *Interpretive Groups*

*Land capability classification:* IIIe
*Woodland ordination symbol:* 3L
*Michigan soil management group:* 1a
*Primary habitat type:* AVO-A
*Secondary habitat type:* AVO

## 132F—Superior fine sandy loam, 25 to 50 percent slopes

### *Setting*

*Landform:* Rolling to very steep areas on ground moraines and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 100 acres

### *Typical Profile*

*Surface layer:*
0 to 4 inches—black fine sandy loam
*Subsurface layer:*
4 to 7 inches—dark reddish gray fine sandy loam
*Subsoil:*
7 to 16 inches—dark reddish brown, friable fine sandy loam
16 to 34 inches—reddish brown and brown, firm clay and silt loam
*Substratum:*
34 to 60 inches—reddish brown clay that has thin strata of dark brown silt loam

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate in the upper part and slow or very slow in the lower part
*Available water capacity:* Moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Rapid
*Flooding:* None
*Hazard of water erosion:* Severe
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### *Composition*

Superior soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### *Inclusions*

*Contrasting inclusions:*
• The well drained Ontonagon soils in landscape positions similar to those of the Superior soil
*Similar inclusions:*
• Soils that have stratified, loamy textures below a depth of 40 inches

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard
*Management measures:*
• Onsite investigation is needed to determine the feasibility of logging in areas of this soil without causing severe erosion of side slopes and deposition of sediments into streams.
• Cable yarding systems are generally safer than other logging methods and result in less surface disturbance.
• Because of the erosion hazard, skid roads and skid trails should be established on the contour and water should be removed by water bars, out-sloping road surfaces, culverts, and drop structures.

### *Interpretive Groups*

*Land capability classification:* VIIe
*Woodland ordination symbol:* 6R
*Michigan soil management group:* 1a
*Primary habitat type:* AVO-A
*Secondary habitat type:* AVO

## 133—Dorval muck

### *Setting*

*Landform:* Depressions on lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 300 acres

### *Typical Profile*

*Surface layer:*
0 to 16 inches—black muck
*Substratum:*
16 to 18 inches—dark gray, mottled clay

18 to 60 inches—reddish brown clay

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the upper part and very slow in the lower part
*Available water capacity:* High
*Drainage class:* Very poorly drained
*Seasonal high water table:* Perched 1 foot above to 1 foot below the surface at times from November through May
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* High
*Shrink-swell potential:* High

### Composition

Dorval soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Pickford soils in landscape positions similar to those of the Dorval soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Wetness and instability of the muck limit logging to periods in the winter when roads are frozen.
• Because of wetness and severe seedling mortality, trees are not planted on this soil.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* Vw
*Woodland ordination symbol:* 2W
*Michigan soil management group:* M/1c
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 135B—Longrie-Battydoe, stony, complex, 1 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on bedrock-controlled ground moraines
*Shape of areas:* Irregular
*Size of areas:* 10 to 170 acres

### Typical Profile

**Longrie**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
1 to 2 inches—well decomposed leaf litter

*Surface layer:*
2 to 6 inches—reddish gray sandy loam

*Subsoil:*
6 to 23 inches—dark reddish brown and dark brown, friable fine sandy loam

*Substratum:*
23 to 36 inches—brown sandy loam

*Bedrock:*
36 inches—fractured limestone

**Battydoe**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 3 inches—black fine sandy loam

*Subsurface layer:*
3 to 5 inches—reddish gray loamy sand

*Subsoil:*
5 to 20 inches—dark reddish brown and reddish brown, friable fine sandy loam and loamy sand
20 to 28 inches—brown, friable gravelly fine sandy loam

*Substratum:*
28 to 80 inches—light brown gravelly fine sandy loam

### Soil Properties and Qualities

*Depth class:* Longrie—moderately deep; Battydoe—very deep
*Rock fragments on the surface:* Kind—stones; percentage of the surface covered—0.01 to 0.1 percent on the Battydoe soil
*Permeability:* Moderate
*Available water capacity:* Longrie—low; Battydoe—moderate
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Longrie soil and similar soils: 40 to 55 percent
Battydoe soil and similar soils: 35 to 40 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
- The somewhat poorly drained Shelter soils in the lower landscape positions
- The well drained Guardlake soils in landscape positions similar to those of the major soils
- Widely scattered outcroppings of limestone bedrock

*Similar inclusions:*
- Soils that are shallow over bedrock

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**

*Major management concerns:* Equipment limitations, windthrow hazard

*Management measures:*
- Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
- Large stones on the surface can hinder harvesting and damage equipment.
- Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

**Cropland**

*Major management concerns:* Water erosion, tilth of the surface layer, low organic matter content

*Management measures:*
- Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
- Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.
- Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.
- Stones on the surface of the Battydoe soil may interfere with the use of tillage and planting equipment and some harvesting equipment. Removing the stones minimizes wear on equipment.

**Pasture**

*Major management concerns:* Compaction, overgrazing

*Management measures:*
- Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### Interpretive Groups

*Land capability classification:* IIe

*Woodland ordination symbol:* Longrie—3D; Battydoe—3L

*Michigan soil management group:* Longrie—3/Ra; Battydoe—3a

*Primary habitat type:* AVO

*Secondary habitat type:* None assigned

## 135D—Longrie-Battydoe, stony, complex, 6 to 15 percent slopes

### Setting

*Landform:* Gently rolling and rolling areas on bedrock-controlled ground moraines

*Shape of areas:* Irregular

*Size of areas:* 10 to 270 acres

### Typical Profile

**Longrie**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
1 to 2 inches—well decomposed leaf litter

*Surface layer:*
2 to 6 inches—reddish gray sandy loam

*Subsoil:*
6 to 23 inches—dark reddish brown and dark brown, friable fine sandy loam

*Substratum:*
23 to 36 inches—brown sandy loam

*Bedrock:*
36 inches—fractured limestone

**Battydoe**

*Organic mat:*
0 to 1 inch—leaf litter

*Surface layer:*
1 to 3 inches—black fine sandy loam

*Subsurface layer:*
3 to 5 inches—reddish gray loamy sand

*Subsoil:*
5 to 20 inches—dark reddish brown and reddish brown, friable fine sandy loam and loamy sand
20 to 28 inches—brown, friable gravelly fine sandy loam

*Substratum:*
28 to 80 inches—light brown gravelly fine sandy loam

### Soil Properties and Qualities

*Depth class:* Longrie—moderately deep; Battydoe—very deep

*Rock fragments on the surface:* Kind—stones; percentage of the surface covered—0.01 to 0.1 percent on the Battydoe soil

*Permeability:* Moderate

*Available water capacity:* Longrie—low; Battydoe—moderate

*Drainage class:* Well drained

*Depth to seasonal high water table:* More than 60 inches

*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Longrie soil and similar soils: 40 to 55 percent
Battydoe soil and similar soils: 35 to 40 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Shelter soils in the lower landscape positions
• The well drained Guardlake soils in landscape positions similar to those of the major soils
• Widely scattered outcroppings of limestone bedrock

*Similar inclusions:*
• Soils that are shallow over bedrock

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations, windthrow hazard
*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• Large stones on the surface can hinder harvesting and damage equipment.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced and by using such harvest methods as selective cutting and strip cutting.

**Cropland**
*Major management concerns:* Water erosion, tilth of the surface layer, low organic matter content
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.
• Stones on the surface of the Battydoe soil may interfere with the use of tillage and planting equipment and some harvesting equipment. Removing the stones minimizes wear on equipment.

**Pasture**
*Major management concerns:* Compaction, overgrazing
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.

### Interpretive Groups

*Land capability classification:* IIIe
*Woodland ordination symbol:* Longrie—3D; Battydoe—3L
*Michigan soil management group:* Longrie—3/Ra; Battydoe—3a
*Primary habitat type:* AVO
*Secondary habitat type:* None assigned

## 143—Caffey muck

### Setting

*Landform:* Depressions on outwash plains, lake plains, and deltas
*Shape of areas:* Irregular
*Size of areas:* 5 to 60 acres

### Typical Profile

*Surface layer:*
0 to 6 inches—black muck

*Substratum:*
6 to 21 inches—brown, grayish brown, and dark yellowish brown, mottled sand and fine sand
21 to 35 inches—gray to light olive brown, mottled, stratified very fine sandy loam and loamy very fine sand
35 to 80 inches—grayish brown very fine sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid or moderately rapid in the upper part and moderately slow in the lower part
*Available water capacity:* High
*Drainage class:* Poorly drained and very poorly drained
*Seasonal high water table:* 1 foot above to 1 foot below the surface at times from October through May
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Caffey soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Glawe soils in landscape positions similar to those of the Caffey soil
• The somewhat poorly drained Ingalls and Moltke soils in the slightly higher landscape positions

*Similar inclusions:*
• Soils that have sand in the lower part of the substratum
• Soils that have gravelly sandy loam in the lower part of the substratum

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Site preparation methods, such as bedding, trenching, or mounding, can maximize seedling survival and growth in new plantations.

### Interpretive Groups

*Land capability classification:* Vw
*Woodland ordination symbol:* 2W
*Michigan soil management group:* 4/2c
*Primary habitat type:* TTM
*Secondary habitat type:* None assigned

## 146A—Allendale-Wakeley complex, 0 to 3 percent slopes

### Setting

*Landform:* Allendale—nearly level areas; Wakeley—depressions on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 600 acres

### Typical Profile

**Allendale**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 3 inches—black fine sand
*Subsurface layer:*
3 to 7 inches—brown fine sand
*Subsoil:*
7 to 23 inches—dark reddish brown and yellowish brown, loose, mottled fine sand
23 to 29 inches—pale brown, loose, mottled fine sand
29 to 37 inches—light reddish brown, firm, mottled silty clay
*Substratum:*
37 to 80 inches—light reddish brown silty clay

**Wakeley**

*Surface layer:*
0 to 4 inches—black muck
4 to 5 inches—black loamy fine sand
*Substratum:*
5 to 24 inches—dark grayish brown and pale brown, mottled loamy fine sand and fine sand
24 to 60 inches—reddish brown, mottled silty clay

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid in the upper part and very slow in the lower part
*Available water capacity:* Allendale—low; Wakeley—moderate
*Drainage class:* Allendale—somewhat poorly drained; Wakeley—poorly drained
*Seasonal high water table:* Allendale—perched at a depth of 0.5 foot to 1.5 feet at times from November through May; Wakeley—perched 1 foot above to 1 foot below the surface at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Allendale—severe; Wakeley—moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Allendale—low; Wakeley—high

### Composition

Allendale soil and similar soils: 40 to 50 percent
Wakeley soil and similar soils: 30 to 45 percent
Contrasting inclusions: 15 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in landscape positions similar to those of the Allendale soil
• The poorly drained Pickford soils in landscape positions similar to those of the Wakeley soil
• The very poorly drained Markey soils in landscape

positions similar to those of the Wakeley soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Trees that can withstand seasonal wetness should be selected for planting.

### Interpretive Groups

*Land capability classification:* IIIw
*Woodland ordination symbol:* Allendale—4W; Wakeley—3W
*Michigan soil management group:* Allendale—4/1b; Wakeley—5/1c
*Primary habitat type:* TMC-D
*Secondary habitat type:* TTP

## 147B—Shelter very cobbly loam, 0 to 6 percent slopes, stony

### Setting

*Landform:* Nearly level and undulating areas on ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 110 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—well decomposed leaf litter

*Surface layer:*
2 to 8 inches—black very cobbly loam
8 to 10 inches—very dark grayish brown and dark yellowish brown very cobbly fine sandy loam

*Subsoil:*
10 to 14 inches—dark yellowish brown, friable very cobbly fine sandy loam

*Substratum:*
14 to 60 inches—light brown, mottled, firm very gravelly fine sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Rock fragments on the surface:* Kind—stones and cobbles; percentage of the surface covered—0.01 to 0.1 percent
*Permeability:* Very slow
*Available water capacity:* Very low
*Drainage class:* Somewhat poorly drained
*Seasonal high water table:* Perched at a depth of 0.5 to 1.0 foot at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

Shelter soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Battydoe soils in the higher landscape positions
• The excessively drained Alpena soils in landscape positions similar to those of the Shelter soil
• The poorly drained Beavertail soils in depressions

*Similar inclusions:*
• Soils that have a surface layer of silty clay loam
• Soils that have limestone bedrock at a depth of 40 to 60 inches
• Soils that contain fewer cobbles and stones; in the northern part of Clark Township

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Large stones on the surface can hinder harvesting and damage equipment.
• Trees that can withstand seasonal wetness should be selected for planting.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIw
*Woodland ordination symbol:* 4X
*Michigan soil management group:* Gbc
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 147D—Shelter very cobbly loam, 6 to 15 percent slopes, stony

### Setting

*Landform:* Gently rolling and rolling areas on ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 110 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—well decomposed leaf litter

*Surface layer:*
2 to 8 inches—black very cobbly loam
8 to 10 inches—very dark grayish brown and dark yellowish brown very cobbly fine sandy loam

*Subsoil:*
10 to 14 inches—dark yellowish brown, friable very cobbly fine sandy loam

*Substratum:*
14 to 60 inches—light brown, mottled, firm very gravelly fine sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Rock fragments on the surface:* Kind—stones and cobbles; percentage of the surface covered—0.01 to 0.1 percent
*Permeability:* Very slow
*Available water capacity:* Very low
*Drainage class:* Somewhat poorly drained
*Seasonal high water table:* Perched at a depth of 0.5 to 1.0 foot at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

Shelter soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Battydoe soils in the higher landscape positions
• The excessively drained Alpena soils in landscape positions similar to those of the Shelter soil
• The poorly drained Beavertail soils in depressions

*Similar inclusions:*
• Soils that have a surface layer of silty clay loam
• Soils that have limestone bedrock at a depth of 40 to 60 inches
• Soils that contain fewer rock fragments; in the northern part of Clark Township

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Large stones on the surface can hinder harvesting and damage equipment.
• Trees that can withstand seasonal wetness should be selected for planting.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIw
*Woodland ordination symbol:* 4X
*Michigan soil management group:* Gbc
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 151—Beavertail muck

### Setting

*Landform:* Depressions on ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 2,500 acres

### Typical Profile

*Surface layer:*
0 to 9 inches—black muck

*Subsoil:*
9 to 13 inches—yellowish brown, very friable very gravelly sandy loam
*Substratum:*
13 to 28 inches—light brown, mottled, firm very gravelly sandy loam
28 to 60 inches—pinkish gray, firm very gravelly sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Very slow
*Available water capacity:* Moderate
*Drainage class:* Poorly drained
*Seasonal high water table:* Perched 1 foot above to 1 foot below the surface at times from October through June
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

Beavertail soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Shelter soils in the slightly higher landscape positions
• The poorly drained Glawe soils in landscape positions similar to those of the Beavertail soil
*Similar inclusions:*
• Soils that have a sandy surface layer

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Because of wetness and severe seedling mortality, trees are not planted on this soil.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* Vw
*Woodland ordination symbol:* 3W
*Michigan soil management group:* Gbc
*Primary habitat type:* TTM
*Secondary habitat type:* None assigned

## 160B—Esau extremely gravelly sandy loam, 0 to 3 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on low beach ridges
*Shape of areas:* Elongated
*Size of areas:* 5 to 125 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 6 inches—very dark gray extremely gravelly sandy loam
*Subsoil:*
6 to 10 inches—yellowish brown, loose extremely gravelly coarse sand
*Substratum:*
10 to 60 inches—brown very gravelly coarse sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Very rapid
*Available water capacity:* Very low
*Drainage class:* Somewhat poorly drained
*Depth to seasonal high water table:* 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Esau soil and similar soils: 80 to 90 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Zela soils in depressions
• The excessively drained Alpena soils in the higher landscape positions
*Similar inclusions:*
• Soils that have a sandy surface layer

• Soils that have loamy glacial till below a depth of 40 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Trees that can withstand seasonal wetness should be selected for planting.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* 4W
*Michigan soil management group:* Gbc
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 161—Zela muck

### Setting

*Landform:* Swales and depressions on beach ridges
*Shape of areas:* Elongated
*Size of areas:* 5 to 165 acres

### Typical Profile

*Surface layer:*
0 to 9 inches—black muck
9 to 12 inches—black extremely gravelly loam
*Substratum:*
12 to 35 inches—grayish brown, mottled very gravelly sand
35 to 60 inches—yellowish brown very gravelly sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Very rapid
*Available water capacity:* Low
*Drainage class:* Poorly drained
*Seasonal high water table:* 1 foot above to 1 foot below the surface at times from October through June
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Zela soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Esau soils in the slightly higher landscape positions
• The very poorly drained Markey soils in landscape positions similar to those of the Zela soil
*Similar inclusions:*
• Soils that have gravelly loam below a depth of 24 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Because of wetness and severe seedling mortality, trees are not planted on this soil.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* Vw
*Woodland ordination symbol:* 3W
*Michigan soil management group:* Gbc
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 163B—Esau-Zela complex, 0 to 3 percent slopes

### Setting

*Landform:* Ridge-swale complex on beach ridges; Esau—on low ridges with slopes of 0 to 3 percent; Zela—in swales with slopes of 0 to 2 percent
*Shape of areas:* Elongated or irregular
*Size of areas:* 15 to 300 acres

### Typical Profile

**Esau**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter

*Surface layer:*
2 to 6 inches—very dark gray extremely gravelly sandy loam

*Subsoil:*
6 to 10 inches—yellowish brown, loose extremely gravelly coarse sand

*Substratum:*
10 to 60 inches—brown very gravelly coarse sand

**Zela**

*Surface layer:*
0 to 9 inches—black muck
9 to 12 inches—black extremely gravelly loam

*Substratum:*
12 to 35 inches—grayish brown, mottled very gravelly sand
35 to 60 inches—yellowish brown very gravelly sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Esau—very low; Zela—low
*Drainage class:* Esau—somewhat poorly drained; Zela—poorly drained
*Seasonal high water table:* Esau—at a depth of 0.5 foot to 1.5 feet at times from November through May; Zela—1 foot above to 1 foot below the surface at times from October through June
*Surface runoff:* Esau—slow; Zela—very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Esau—slight; Zela—moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Esau soil and similar soils: 40 to 55 percent
Zela soil and similar soils: 30 to 45 percent
Contrasting inclusions: 5 percent

### Inclusions

*Contrasting inclusions:*
• The very poorly drained Markey soils in landscape positions similar to those of the Zela soil
• Swales that contain ponded water

*Similar inclusions:*
• Soils that have a sandy surface layer
• Soils that have a water table between depths of 2 and 4 feet; on ridges
• Poorly drained soils that have loamy material below a depth of 40 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Because of wetness and severe seedling mortality on the Zela soil, trees are not planted in areas of this unit.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* Esau—4W; Zela—3W
*Michigan soil management group:* Esau—Gbc; Zela—Gbc
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 164A—Moltke loam, 0 to 3 percent slopes

### Setting

*Landform:* Nearly level areas on lake plains and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 225 acres

### Typical Profile

*Surface layer:*
0 to 6 inches—very dark gray loam

*Subsurface layer:*
6 to 11 inches—dark grayish brown silt loam

*Subsoil:*
11 to 25 inches—reddish brown and brown, friable, mottled silt loam

*Substratum:*
25 to 60 inches—grayish brown and brown, mottled silt loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate
*Available water capacity:* High

*Drainage class:* Somewhat poorly drained
*Depth to seasonal high water table:* 0.5 foot to 1.5 feet at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

Moltke soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Glawe and Gogomain soils in depressions
• The somewhat poorly drained Solona soils in landscape positions similar to those of the Moltke soil

*Similar inclusions:*
• Soils that have a sandy surface layer
• Soils that have clay layers in the lower part of the substratum

### Use and Management

**Land use:** Dominant use—woodland; other uses—cropland and pasture

**Woodland**
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Trees that can withstand seasonal wetness should be selected for planting.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

**Cropland**
*Major management concerns:* Wetness
*Management measures:*
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Water-tolerant species should be selected for planting.

**Pasture**
*Major management concerns:* Seasonal wetness
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during dry periods help to keep the pasture in good condition.
• The only hay and pasture plants that should be seeded are those that can withstand periodic inundation and seasonal wetness.

### Interpretive Groups

*Land capability classification:* IIw
*Woodland ordination symbol:* 3W
*Michigan soil management group:* 3b-s
*Primary habitat type:* TMC-D
*Secondary habitat type:* None assigned

## 165A—Engadine-Rudyard complex, 0 to 3 percent slopes

### Setting

*Landform:* Nearly level areas on lake plains
*Shape of areas:* Irregular
*Size of areas:* 10 to 250 acres

### Typical Profile

**Engadine**

*Surface layer:*
0 to 9 inches—very dark grayish brown fine sandy loam

*Subsurface layer*
9 to 10 inches—grayish brown, mottled fine sandy loam

*Subsoil:*
10 to 14 inches—dark brown and brown, friable, mottled fine sandy loam and sandy loam
14 to 18 inches—brown, firm, mottled silty clay loam and loamy fine sand
18 to 25 inches—reddish brown, firm, mottled clay

*Substratum:*
25 to 80 inches—brown, mottled clay

**Rudyard**

*Surface layer:*
0 to 10 inches—dark grayish brown silty clay loam

*Subsoil:*
10 to 19 inches—reddish brown, firm, mottled clay

*Substratum:*
19 to 60 inches—reddish brown, mottled clay

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Engadine—moderate in the upper part and very slow in the lower part; Rudyard—very slow
*Available water capacity:* Moderate
*Drainage class:* Somewhat poorly drained
*Seasonal high water table:* Perched at a depth of 0.5

foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Engadine—high; Rudyard—moderate
*Shrink-swell potential:* High

### Composition

Engadine soil and similar soils: 40 to 50 percent
Rudyard soil and similar soils: 35 to 45 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Glawe, Gogomain, and Pickford soils in depressions
*Similar inclusions:*
• Soils that have loamy and gravelly textures below a depth of 50 inches
• Soils that have limestone bedrock below a depth of 40 inches

### Use and Management

**Land use:** Dominant uses—cropland and pasture; other uses—woodland

**Cropland**
*Major management concerns:* Seasonal wetness, tilth of the surface layer, soil compaction
*Management measures:*
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Shallow surface ditches help to remove surface water after heavy rains.
• Minimizing tillage and tilling and harvesting at the proper soil moisture content help to prevent excessive compaction and maintain tilth.

**Pasture**
*Major management concerns:* Seasonal wetness, compaction
*Management measures:*
• Proper stocking rates and a planned grazing system help to keep the pasture in good condition.
• The only hay and pasture plants that should be seeded are those that can withstand periodic inundation and seasonal wetness.

**Woodland**
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Trees that can withstand seasonal wetness should be selected for planting.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* IIIw
*Woodland ordination symbol:* Engadine—2W; Rudyard—6W
*Michigan soil management group:* Engadine—3/1b; Rudyard—Ob
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 166—Gogomain-Pickford complex

### Setting

*Landform:* Depressions and flat areas on lake plains
*Shape of areas:* Irregular
*Size of areas:* 20 to 640 acres

### Typical Profile

**Gogomain**
*Surface layer:*
0 to 10 inches—very dark gray very fine sandy loam
*Subsoil:*
10 to 18 inches—grayish brown and brown, mottled, friable loamy very fine sand, very fine sandy loam, and fine sandy loam
*Substratum:*
18 to 80 inches—reddish brown clay

**Pickford**
*Surface layer:*
0 to 6 inches—very dark grayish brown silty clay loam
*Subsoil:*
6 to 9 inches—dark gray, firm, mottled clay
9 to 19 inches—reddish brown, firm, mottled clay
*Substratum:*
19 to 60 inches—reddish brown clay

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Gogomain—moderately rapid in the upper part and very slow in the lower part; Pickford—very slow
*Available water capacity:* Moderate

*Drainage class:* Poorly drained
*Seasonal high water table:* Perched 1 foot above to 1 foot below the surface at times from November through June
*Surface runoff:* Very slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Gogomain—moderate; Pickford—slight
*Potential for frost action:* Gogomain—high; Pickford—moderate
*Shrink-swell potential:* High

### Composition

Gogomain soil and similar soils: 40 to 55 percent
Pickford soil and similar soils: 35 to 40 percent
Contrasting inclusions: 10 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Engadine and Rudyard soils in the slightly higher landscape positions
• The silty Glawe soils in landscape positions similar to those of the major soils

*Similar inclusions:*
• Soils that have limestone bedrock below a depth of 40 inches

### Use and Management

**Land use:** Dominant uses—cropland and pasture; other uses—woodland

**Cropland**
*Major management concerns:* Ponding, tilth of the surface layer, soil compaction
*Management measures:*
• Shallow surface ditches help to remove surface water after heavy rains.
• Subsurface drains can reduce the wetness if a suitable outlet is available.
• Water-tolerant species should be selected for planting.
• Minimizing tillage and tilling at the proper soil moisture content help to maintain good tilth.

**Pasture**
*Major management concerns:* Ponding, compaction
*Management measures:*
• Proper stocking rates and a planned grazing system help to keep the pasture in good condition.
• The only hay and pasture plants that should be seeded are those that can withstand periodic inundation and seasonal wetness.

**Woodland**
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Because of wetness and severe seedling mortality, trees are not planted on these soils.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* Vw
*Woodland ordination symbol:* Gogomain—4W; Pickford—6W
*Michigan soil management group:* Gogomain—3/1c; Pickford—1c
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 167B—Battydoe, stony-Wallace complex, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on ground moraines
*Shape of areas:* Irregular
*Size of areas:* 25 to 180 acres

### Typical Profile

**Battydoe**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 3 inches—black fine sandy loam

*Subsurface layer:*
3 to 5 inches—reddish gray loamy sand

*Subsoil:*
5 to 20 inches—dark reddish brown and reddish brown, friable fine sandy loam and loamy sand
20 to 28 inches—brown, friable gravelly fine sandy loam

*Substratum:*
28 to 80 inches—light brown gravelly fine sandy loam

**Wallace**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter

*Surface layer:*
2 to 10 inches—light brownish gray sand
*Subsoil:*
10 to 11 inches—dark reddish brown, very friable sand
11 to 26 inches—dark brown, cemented sand
26 to 59 inches—brownish yellow, loose sand
*Substratum:*
59 to 80 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Rock fragments on the surface:* Kind—stones; percentage of the surface covered—0.01 to 0.1 percent on the Battydoe soil
*Permeability:* Battydoe—moderate; Wallace—moderate or moderately rapid in the cemented layer and rapid in the rest of the profile
*Available water capacity:* Battydoe—moderate; Wallace—very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Battydoe—moderate; Wallace—severe
*Potential for frost action:* Battydoe—moderate; Wallace—low
*Shrink-swell potential:* Low

### Composition

Battydoe soil and similar soils: 50 to 60 percent
Wallace soil and similar soils: 25 to 40 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the lower landscape positions
• The moderately well drained Paquin soils in the slightly lower landscape positions
• The well drained Menominee soils in landscape positions similar to those of the Battydoe soil
*Similar inclusions:*
• Battydoe soils that have a water table between depths of 40 and 60 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because of low strength in areas of the Battydoe soil, suitable surfacing material is needed on year-round logging roads and landings.
• Loose sand on the Wallace soil can interfere with the traction of wheeled equipment. Logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate on the Wallace soil.

### Interpretive Groups

*Land capability classification:* IIIe
*Woodland ordination symbol:* Battydoe—3L; Wallace—7D
*Michigan soil management group:* Battydoe—3a; Wallace—5a-h
*Primary habitat type:* AVO
*Secondary habitat type:* ATD

## 167D—Battydoe, stony-Wallace complex, 6 to 15 percent slopes

### Setting

*Landform:* Gently rolling and rolling areas on ground moraines
*Shape of areas:* Irregular
*Size of areas:* 25 to 180 acres

### Typical Profile

**Battydoe**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 3 inches—black fine sandy loam
*Subsurface layer:*
3 to 5 inches—reddish gray loamy sand
*Subsoil:*
5 to 20 inches—dark reddish brown and reddish brown, friable fine sandy loam and loamy sand
20 to 28 inches—brown, friable gravelly fine sandy loam
*Substratum:*
28 to 80 inches—light brown gravelly fine sandy loam

**Wallace**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 10 inches—light brownish gray sand
*Subsoil:*
10 to 11 inches—dark reddish brown, very friable sand
11 to 26 inches—dark brown, cemented sand
26 to 59 inches—brownish yellow, loose sand
*Substratum:*
59 to 80 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Rock fragments on the surface:* Kind—stones; percentage of the surface covered—0.01 to 0.1 percent on the Battydoe soil
*Permeability:* Battydoe—moderate; Wallace—moderate or moderately rapid in the cemented layer and rapid in the rest of the profile
*Available water capacity:* Battydoe—moderate; Wallace—very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Battydoe—moderate; Wallace—slight
*Hazard of soil blowing:* Battydoe—moderate; Wallace—severe
*Potential for frost action:* Battydoe—moderate; Wallace—low
*Shrink-swell potential:* Low

### Composition

Battydoe soil and similar soils: 50 to 60 percent
Wallace soil and similar soils: 25 to 40 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the lower landscape positions
• The moderately well drained Paquin soils in the slightly lower landscape positions
• The well drained Menominee soils in landscape positions similar to those of the Battydoe soil

*Similar inclusions:*
• Battydoe soils that have a water table between depths of 40 and 60 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because of low strength in areas of the Battydoe soil, suitable surfacing material is needed on year-round logging roads and landings.
• Loose sand on the Wallace soil can interfere with the traction of wheeled equipment. Logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate on the Wallace soil.

### Interpretive Groups

*Land capability classification:* IVe
*Woodland ordination symbol:* Battydoe—3L; Wallace—7D
*Michigan soil management group:* Battydoe—3a; Wallace—5a-h
*Primary habitat type:* AVO
*Secondary habitat type:* ATD

## 167E—Battydoe, stony-Wallace complex, 15 to 35 percent slopes

### Setting

*Landform:* Rolling to steep areas on ground moraines
*Shape of areas:* Irregular or elongated
*Size of areas:* 25 to 180 acres

### Typical Profile

**Battydoe**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter
*Surface layer:*
1 to 3 inches—black fine sandy loam
*Subsurface layer:*
3 to 5 inches—reddish gray loamy sand
*Subsoil:*
5 to 20 inches—dark reddish brown and reddish brown, friable fine sandy loam and loamy sand
20 to 28 inches—brown, friable gravelly fine sandy loam
*Substratum:*
28 to 80 inches—light brown gravelly fine sandy loam

**Wallace**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 10 inches—light brownish gray sand
*Subsoil:*
10 to 11 inches—dark reddish brown, very friable sand
11 to 26 inches—dark brown, cemented sand
26 to 59 inches—brownish yellow, loose sand
*Substratum:*
59 to 80 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Rock fragments on the surface:* Kind—stones; percentage of the surface covered—0.01 to 0.1 percent on the Battydoe soil
*Permeability:* Battydoe—moderate; Wallace—moderate or moderately rapid in the cemented layer and rapid in the rest of the profile

*Available water capacity:* Battydoe—moderate; Wallace—very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Battydoe—medium; Wallace—slow
*Flooding:* None
*Hazard of water erosion:* Battydoe—severe; Wallace—moderate
*Hazard of soil blowing:* Battydoe—moderate; Wallace—severe
*Potential for frost action:* Battydoe—moderate; Wallace—low
*Shrink-swell potential:* Low

### Composition

Battydoe soil and similar soils: 50 to 60 percent
Wallace soil and similar soils: 25 to 40 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The moderately well drained Paquin soils in the slightly lower landscape positions
• The well drained Menominee soils in landscape positions similar to those of the Battydoe soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Erosion hazard, equipment limitations, seedling mortality
*Management measures:*
• The risk of erosion can be reduced by seeding logging roads, landings, and areas that have been cut and filled and by installing water bars and culverts.
• Because of low strength in areas of the Battydoe soil, suitable surfacing material is needed on year-round logging roads and landings.
• Loose sand on the Wallace soil can interfere with the traction of wheeled equipment. Logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate on the Wallace soil.

### Interpretive Groups

*Land capability classification:* VIIe
*Woodland ordination symbol:* Battydoe—3R; Wallace—7R
*Michigan soil management group:* Battydoe—3a; Wallace—5a-h
*Primary habitat type:* AVO
*Secondary habitat type:* ATD

## 168B—Caffey-Ingalls-Iosco complex, 0 to 6 percent slopes

### Setting

*Landform:* Caffey—depressions; Ingalls and Iosco—nearly level areas on lake plains and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 40 to 3,300 acres

### Typical Profile

**Caffey**

*Surface layer:*
0 to 6 inches—black muck

*Substratum:*
6 to 21 inches—grayish brown and dark yellowish brown, mottled sand and fine sand
21 to 35 inches—gray to light olive brown, mottled, stratified very fine sandy loam and loamy very fine sand
35 to 80 inches—grayish brown very fine sandy loam

**Ingalls**

*Organic mat:*
0 to 2 inches—well decomposed leaf litter

*Surface layer:*
2 to 8 inches—grayish brown fine sand

*Subsoil:*
8 to 20 inches—dark brown, mottled, very friable fine sand

*Substratum:*
20 to 27 inches—light yellowish brown, mottled, stratified loamy very fine sand, very fine sand, and silt loam
27 to 60 inches—pale brown and light brown, mottled, stratified silt loam, loamy very fine sand, and very fine sand

**Iosco**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
2 to 6 inches—well decomposed leaf litter

*Surface layer:*
6 to 9 inches—dark grayish brown, mottled sand

*Subsurface layer:*
9 to 11 inches—brown, mottled sand

*Subsoil:*
11 to 27 inches—dark brown and yellowish brown, mottled, friable sand
27 to 38 inches—reddish brown, mottled, friable loam

*Substratum:*
38 to 60 inches—light brown loam

### Soil Properties and Qualities

*Depth class:* Very deep

*Permeability:* Caffey—rapid or moderately rapid in the upper part and moderately slow in the lower part; Ingalls—rapid in the upper part and moderately slow in the lower part; Iosco—rapid in the upper part and moderate in the lower part
*Available water capacity:* Caffey—high; Ingalls and Iosco—moderate
*Drainage class:* Caffey—poorly drained; Ingalls and Iosco—somewhat poorly drained
*Seasonal high water table:* Caffey—1 foot above to 1 foot below the surface at times from October through May; Ingalls and Iosco—at a depth of 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Caffey—moderate; Ingalls and Iosco—severe
*Potential for frost action:* Caffey and Ingalls—high; Iosco—moderate
*Shrink-swell potential:* Low

### Composition

Caffey soil and similar soils: 25 to 40 percent
Ingalls soil and similar soils: 20 to 35 percent
Iosco soil and similar soils: 20 to 35 percent
Contrasting inclusions: 15 to 25 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Spot and Glawe soils in landscape positions similar to those of the Caffey soil
• The moderately well drained Paquin and Borgstrom soils in the slightly higher landscape positions
• The somewhat poorly drained Finch and Moltke soils in landscape positions similar to those of the Ingalls soil
*Similar inclusions:*
• Soils that have cobbles on the surface

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Landing sites generally can be used only during the driest time of the year.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Trees that can withstand seasonal wetness should be planted.
• Planting on the low knolls and ridges increases the seedling survival rate.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* Vw
*Woodland ordination symbol:* Caffey—2W; Ingalls and Iosco—4W
*Michigan soil management group:* Caffey—4/2c; Ingalls and Iosco—4/2b
*Primary habitat type:* TTM
*Secondary habitat type:* None assigned

## 169E—Ontonagon-Fluvaquents, frequently flooded, complex, 0 to 35 percent slopes

### Setting

*Landform:* Ontonagon—sides of ravines; Fluvaquents—ravine bottoms on lake plains
*Shape of areas:* Elongated
*Size of area:* One delineation of about 500 acres

### Typical Profile

**Ontonagon**

*Surface layer:*
0 to 7 inches—dark reddish brown silt loam
*Subsoil:*
7 to 10 inches—reddish brown, firm clay and reddish gray, firm silty clay
10 to 21 inches—reddish brown, firm clay
*Substratum:*
21 to 80 inches—reddish brown clay

**Fluvaquents**

*Surface layer:*
0 to 7 inches—muck
*Substratum:*
7 to 60 inches—stratified textures ranging from sand to clay

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Ontonagon—very slow; Fluvaquents—variable
*Available water capacity:* Ontonagon—moderate; Fluvaquents—variable
*Drainage class:* Ontonagon—well drained; Fluvaquents—very poorly drained and poorly drained
*Seasonal high water table:* Ontonagon—at a depth of more than 60 inches; Fluvaquents—3 feet above to

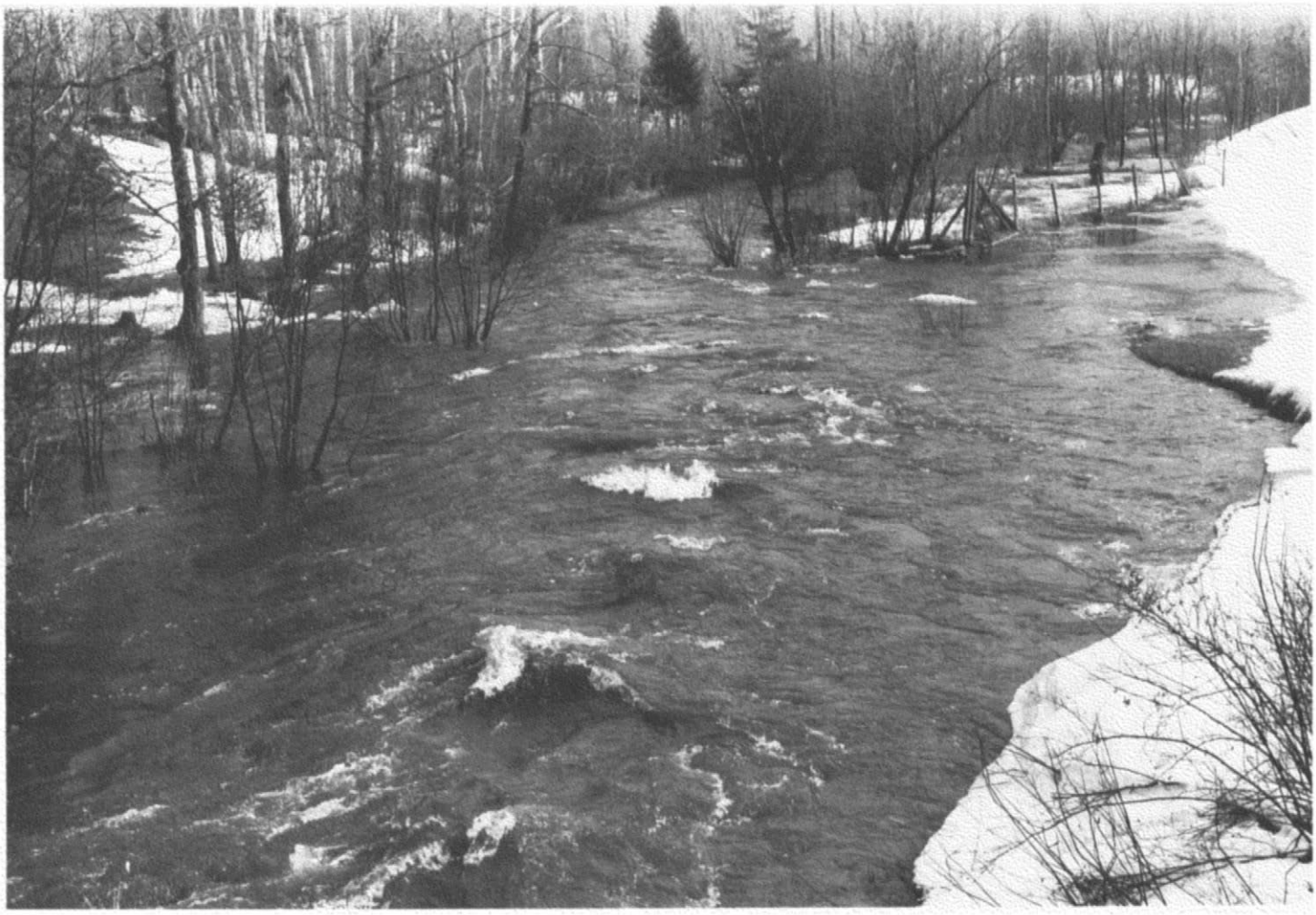

**Figure 8.—Spring flooding in an area of Ontonagon-Fluvaquents, frequently flooded, complex, 0 to 35 percent slopes.**

1 foot below the surface at times from October through June
*Surface runoff:* Ontonagon—rapid; Fluvaquents—ponded
*Flooding:* Fluvaquents—frequent (fig. 8)
*Hazard of water erosion:* Ontonagon—severe; Fluvaquents—slight
*Hazard of soil blowing:* Slight
*Potential for frost action:* Ontonagon—moderate; Fluvaquents—variable
*Shrink-swell potential:* Ontonagon—high; Fluvaquents—variable

### *Composition*

Ontonagon soil and similar soils: 50 to 80 percent
Fluvaquents and similar soils: 20 to 50 percent

### *Inclusions*

*Similar inclusions:*
• Soils that have thin layers of sand

### *Use and Management*

**Land use:** Woodland and habitat for wetland wildlife

**Woodland**

*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality, windthrow hazard
*Management measures:*
• Onsite investigation is needed to determine the feasibility of logging in areas of these soils without causing severe erosion of side slopes and deposition of sediments into streams.

• Cable yarding systems are generally safer than other logging methods and result in less surface disturbance.
• Windthrow can be minimized by using harvest methods that do not leave trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIIe
*Woodland ordination symbol:* Ontonagon—2R; Fluvaquents—none assigned
*Michigan soil management group:* Ontonagon—Oa; Fluvaquents—none assigned
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 170B—Pullup fine sand, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on dunes, beach ridges, and bars
*Shape of areas:* Irregular or elongated
*Size of areas:* 5 to 40 acres

### Typical Profile

*Organic mat:*
2 inches to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 8 inches—light brownish gray fine sand

*Subsoil:*
8 to 12 inches—dark brown, very friable fine sand
12 to 22 inches—dark brown and pinkish gray, cemented fine sand

*Substratum:*
22 to 80 inches—very pale brown fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layer and rapid in the rest of the profile
*Available water capacity:* Low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Pullup soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch and Wainola soils in the lower landscape positions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* 7S
*Michigan soil management group:* 5.3a-h
*Primary habitat type:* QAE
*Secondary habitat type:* None assigned

## 170D—Pullup fine sand, 6 to 15 percent slopes

### Setting

*Landform:* Gently rolling and rolling areas on dunes, beach ridges, and bars
*Shape of areas:* Irregular or elongated
*Size of areas:* 5 to 25 acres

### Typical Profile

*Organic mat:*
2 inches to 0—slightly decomposed leaf litter

*Surface layer:*
0 to 8 inches—light brownish gray fine sand

*Subsoil:*
8 to 12 inches—dark brown, very friable fine sand
12 to 22 inches—dark brown and pinkish gray, cemented fine sand

*Substratum:*
22 to 80 inches—very pale brown fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layer and rapid in the rest of the profile
*Available water capacity:* Low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight

*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Pullup soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch and Wainola soils in the lower landscape positions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* 7S
*Michigan soil management group:* 5.3a-h
*Primary habitat type:* QAE
*Secondary habitat type:* None assigned

## 170E—Pullup fine sand, 15 to 35 percent slopes

### Setting

*Landform:* Rolling to steep areas on dunes, beach ridges, and bars
*Shape of areas:* Irregular or elongated
*Size of areas:* 10 to 115 acres

### Typical Profile

*Organic mat:*
2 inches to 0—slightly decomposed leaf litter
*Surface layer:*
0 to 8 inches—light brownish gray fine sand
*Subsoil:*
8 to 12 inches—dark brown, very friable fine sand
12 to 22 inches—dark brown and pinkish gray, cemented fine sand
*Substratum:*
22 to 80 inches—very pale brown fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layers and rapid in the rest of the profile
*Available water capacity:* Low
*Drainage class:* Somewhat excessively drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Pullup soil and similar soils: 95 percent
Contrasting inclusions: 5 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch and Wainola soils in the lower landscape positions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• The nearly level areas should be selected as sites for landings.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* 7R
*Michigan soil management group:* 5.3a-h
*Primary habitat type:* QAE
*Secondary habitat type:* None assigned

## 172B—Leafriver-Croswell-Wainola complex, 0 to 6 percent slopes

### Setting

*Landform:* Swale-ridge complex along Lake Michigan; Leafriver—in depressions and swales with slopes of 0 to 2 percent; Croswell—on dunes with slopes of 2 to 6 percent; Wainola—on low ridges with slopes of 0 to 3 percent
*Shape of areas:* Elongated
*Size of areas:* 25 to 3,000 acres

### Typical Profile

**Leafriver**

*Surface layer:*
0 to 8 inches—black mucky peat and muck
8 to 10 inches—black, mottled loamy fine sand

*Substratum:*
10 to 60 inches—grayish brown and dark grayish brown, mottled fine sand

**Croswell**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter

*Surface layer:*
2 to 6 inches—light brownish gray sand

*Subsoil:*
6 to 8 inches—strong brown, very friable sand
8 to 15 inches—strong brown, very friable sand
15 to 22 inches—brownish yellow, loose sand

*Substratum:*
22 to 80 inches—light yellowish brown, mottled sand

**Wainola**

*Organic mat:*
0 to 3 inches—partially decomposed leaf litter

*Surface layer:*
3 to 14 inches—pinkish gray fine sand

*Subsoil:*
14 to 17 inches—dark brown and dark reddish brown, mottled, very friable fine sand
17 to 26 inches—strong brown, mottled, very friable fine sand
26 to 30 inches—yellowish brown, loose fine sand

*Substratum:*
30 to 80 inches—light yellowish brown fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Rapid
*Available water capacity:* Leafriver—moderate; Croswell and Wainola—low
*Drainage class:* Leafriver—very poorly drained; Croswell—moderately well drained; Wainola—somewhat poorly drained
*Seasonal high water table:* Leafriver—1 foot above to 1 foot below the surface at times from October through May; Croswell—at a depth of 2.0 to 3.5 feet at times from November through May; Wainola—at a depth of 0.5 foot to 1.5 feet at times from November through May
*Surface runoff:* Leafriver—very slow or ponded; Croswell and Wainola—slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Leafriver—moderate; Croswell and Wainola—severe
*Potential for frost action:* Leafriver—high; Croswell—low; Wainola—moderate
*Shrink-swell potential:* Low

### Composition

Leafriver soil and similar soils: 40 to 50 percent
Croswell soil and similar soils: 15 to 25 percent
Wainola soil and similar soils: 15 to 25 percent
Contrasting inclusions: 5 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The excessively drained Eastport soils in the higher landscape positions
• Small perennial ponds

*Similar inclusions:*
• Soils that have layers of muck 10 to 15 inches thick
• Soils in areas that contain small perennial ponds

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• In areas of the Leafriver soil, seedling mortality and the windthrow hazard are severe because of wetness. Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Roads and landings should be located on the sandy ridges.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• In areas of the Croswell and Wainola soils, planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIw
*Woodland ordination symbol:* Leafriver—2W; Croswell—5S; Wainola—6W
*Michigan soil management group:* Leafriver—5c; Croswell—5a; Wainola—5b
*Primary habitat type:* FMC
*Secondary habitat type:* AQVac

## 173B—Paquin-Finch sands, 0 to 6 percent slopes

### Setting

*Landform:* Paquin—nearly level and undulating areas on outwash plains and lake plains; Finch—nearly level areas on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 320 acres

### Typical Profile

**Paquin**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter

*Surface layer:*
2 to 12 inches—brown sand

*Subsoil:*
12 to 14 inches—very dark brown, very friable sand
14 to 27 inches—very dark brown and dark brown, cemented sand
27 to 34 inches—strong brown, mottled, loose sand

*Substratum:*
34 to 80 inches—yellowish brown, mottled sand

**Finch**

*Organic mat:*
0 to 1 inch—partially decomposed leaf litter

*Surface layer:*
1 to 11 inches—pinkish gray sand

*Subsoil:*
11 to 42 inches—dark brown, dark reddish brown, and brown, mottled, cemented sand

*Substratum:*
42 to 80 inches—yellowish brown fine sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layers and rapid in the rest of the profile
*Available water capacity:* Paquin—low; Finch—very low
*Drainage class:* Paquin—moderately well drained; Finch—somewhat poorly drained
*Depth to seasonal high water table:* Paquin—2.0 to 3.5 feet at times from November through May; Finch—0.5 foot to 1.5 feet at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Paquin—low; Finch—moderate
*Shrink-swell potential:* Low

### Composition

Paquin soil and similar soils: 45 to 55 percent
Finch soil and similar soils: 40 to 45 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The poorly drained Spot soils in depressions
• The well drained Wallace soils in the higher landscape positions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* Paquin—3S; Finch—4W
*Michigan soil management group:* Paquin—5a-h; Finch—5b-h
*Primary habitat type:* ATD
*Secondary habitat type:* TMC

## 174B—Croswell-Spot complex, 0 to 6 percent slopes

### Setting

*Landform:* Croswell—nearly level and undulating areas on outwash plains and lake plains; Spot—depressions on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* One delineation of about 650 acres

### Typical Profile

**Croswell**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter

*Surface layer:*
2 to 6 inches—light brownish gray sand

*Subsoil:*
6 to 15 inches—strong brown, very friable sand

15 to 22 inches—brownish yellow, loose sand
*Substratum:*
22 to 80 inches—light yellowish brown, mottled sand

**Spot**

*Surface layer:*
0 to 1 inch—slightly decomposed organic material
1 to 2 inches—black muck
*Subsurface layer:*
2 to 8 inches—light brownish gray, mottled sand
*Subsoil:*
8 to 12 inches—dark reddish brown and dark brown, cemented sand
12 to 18 inches—strong brown, friable sand
*Substratum:*
18 to 80 inches—light brown and light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Croswell—rapid; Spot—moderate or moderately rapid in the cemented layers and rapid in the rest of the profile
*Available water capacity:* Low
*Drainage class:* Croswell—moderately well drained; Spot—poorly drained
*Seasonal high water table:* Croswell—at a depth of 2.0 to 3.5 feet at times from November through May; Spot—1 foot above to 1 foot below the surface at times from September through June
*Surface runoff:* Croswell—slow; Spot—very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Croswell—severe; Spot—moderate
*Potential for frost action:* Croswell—low; Spot—moderate
*Shrink-swell potential:* Low

### Composition

Croswell soil and similar soils: 45 to 55 percent
Spot soil and similar soils: 40 to 50 percent
Contrasting inclusions: 5 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in landscape positions intermediate between those of the Spot and Croswell soils
• The excessively drained Rubicon soils in the higher landscape positions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Roads and landings should be located on the ridges. Culverts are needed in the depressions to maintain the natural drainage system.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• On the ridges, planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
• In the swales, site preparation methods, such as bedding, trenching, or mounding, can maximize seedling survival and growth in new plantations.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* IVs
*Woodland ordination symbol:* Croswell—5S; Spot—2W
*Michigan soil management group:* Croswell—5a; Spot—5c-h
*Primary habitat type:* AQVac
*Secondary habitat type:* TTS

## 175D—Wallace-Spot complex, 0 to 15 percent slopes

### Setting

*Landform:* Ridge-swale complex on outwash plains and lake plains; Wallace—on ridges with slopes of 2 to 15 percent; Spot—in swales with slopes of 0 to 2 percent
*Shape of areas:* Irregular
*Size of areas:* 100 to 360 acres

### Typical Profile

**Wallace**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 10 inches—light brownish gray sand
*Subsoil:*
10 to 11 inches—dark reddish brown, very friable sand
11 to 26 inches—dark brown, cemented sand
26 to 59 inches—brownish yellow, loose sand
*Substratum:*
59 to 80 inches—light yellowish brown sand

**Spot**

*Surface layer:*
0 to 1 inch—slightly decomposed organic matter
1 to 2 inches—black muck

*Subsurface layer:*
2 to 8 inches—light brownish gray, mottled sand
*Subsoil:*
8 to 12 inches—dark reddish brown and dark brown, cemented sand
12 to 18 inches—strong brown, friable sand
*Substratum:*
18 to 80 inches—light brown and light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layers and rapid in the rest of the profile
*Available water capacity:* Wallace—very low; Spot—low
*Drainage class:* Wallace—well drained; Spot—poorly drained
*Seasonal high water table:* Wallace—at a depth of more than 60 inches; Spot—1 foot above to 1 foot below the surface at times from September through June
*Surface runoff:* Wallace—slow; Spot—very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Wallace—severe; Spot—moderate
*Potential for frost action:* Wallace—low; Spot—moderate
*Shrink-swell potential:* Low

### Composition

Wallace soil and similar soils: 40 to 50 percent
Spot soil and similar soils: 30 to 45 percent
Contrasting inclusions: 15 to 20 percent

### Inclusions

*Contrasting inclusions:*
- The somewhat poorly drained Finch soils in slightly higher positions on the landscape than those of the Spot soil
- The very poorly drained Dawson soils in swales
- The moderately well drained Paquin soils in slightly lower positions on the landscape than those of the Wallace soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
- Access is easiest during periods in winter when access roads are frozen.
- Roads and landings should be located on the ridges. Culverts are needed to maintain the natural drainage system.
- Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
- On the ridges, planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
- In the swales, site preparation methods, such as bedding, trenching, or mounding, can maximize seedling survival and growth in new plantations.
- Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* Wallace—7D; Spot—2W
*Michigan soil management group:* Wallace—5a-h; Spot—5c-h
*Primary habitat type:* ATD
*Secondary habitat type:* TTS

## 176B—Paquin-Spot complex, 0 to 6 percent slopes

### Setting

*Landform:* Paquin—nearly level and undulating areas on outwash plains and lake plains; Spot—depressions on outwash plains and lake plains
*Shape of areas:* Irregular
*Size of areas:* 150 to 200 acres

### Typical Profile

**Paquin**

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 12 inches—brown sand
*Subsoil:*
12 to 14 inches—very dark brown, very friable sand
14 to 27 inches—very dark brown and dark brown, cemented sand
27 to 34 inches—strong brown, mottled, loose sand
*Substratum:*
34 to 80 inches—yellowish brown, mottled sand

**Spot**

*Surface layer:*
0 to 1 inch—slightly decomposed organic matter
1 to 2 inches—black muck
*Subsurface layer:*
2 to 8 inches—light brownish gray, mottled sand
*Subsoil:*
8 to 12 inches—dark reddish brown and dark brown, cemented sand
12 to 18 inches—strong brown, friable sand

*Substratum:*
18 to 80 inches—light brown and light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layers and rapid in the rest of the profile
*Available water capacity:* Low
*Drainage class:* Paquin—moderately well drained; Spot—poorly drained
*Seasonal high water table:* Paquin—at a depth of 2.0 to 3.5 feet at times from November through May; Spot—1 foot above to 1 foot below the surface at times from September through June
*Surface runoff:* Paquin—slow; Spot—very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Paquin—severe; Spot—moderate
*Potential for frost action:* Paquin—low; Spot—moderate
*Shrink-swell potential:* Low

### Composition

Paquin soil and similar soils: 40 to 50 percent
Spot soil and similar soils: 30 to 45 percent
Contrasting inclusions: 15 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Wallace soils in the higher landscape positions
• The somewhat poorly drained Finch soils in slightly higher positions on the landscape than those of the Spot soil
• The very poorly drained Dawson soils in landscape positions similar to those of the Spot soil

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Roads and landings should be located on the ridges. Culverts are needed in the depressions to maintain the natural drainage system.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• On the ridges, planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.
• In the swales, site preparation methods, such as bedding, trenching, or mounding, can maximize seedling survival and growth in new plantations.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* Paquin—3S; Spot—2W
*Michigan soil management group:* Paquin—5a-h; Spot—5c-h
*Primary habitat type:* ATD
*Secondary habitat type:* TTS

## 177B—Millecoquins-Superior, till substratum, complex, 1 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on lake plains
*Shape of areas:* Irregular
*Size of areas:* 10 to 160 acres

### Typical Profile

**Millecoquins**

*Surface layer:*
0 to 4 inches—black very fine sandy loam
*Subsurface layer:*
4 to 6 inches—reddish gray very fine sandy loam
*Subsoil:*
6 to 17 inches—dark brown and brown, friable very fine sandy loam
17 to 28 inches—reddish brown and brown, friable silty clay loam and silt loam
28 to 37 inches—pale brown, reddish brown, and dark brown, mottled, friable, stratified fine sandy loam, silt loam, and silty clay loam
*Substratum:*
37 to 80 inches—stratified, mottled yellowish brown and reddish brown silt loam and silty clay loam

**Superior**

*Surface layer:*
0 to 4 inches—black fine sandy loam
*Subsurface layer:*
4 to 7 inches—brown fine sandy loam
*Subsoil:*
7 to 16 inches—dark reddish brown, friable fine sandy loam
16 to 34 inches—reddish brown and brown, firm clay and silt loam
*Substratum:*
34 to 74 inches—reddish brown clay that has thin strata of dark brown silt loam

74 to 80 inches—grayish brown and reddish brown sandy clay loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Millecoquins—moderate in the upper part and moderately slow in the lower part; Superior—moderate in the upper part and very slow in the lower part
*Available water capacity:* Millecoquins—high; Superior—moderate
*Drainage class:* Millecoquins—moderately well drained; Superior—well drained
*Seasonal high water table:* Millecoquins—perched at a depth of 2.0 to 3.5 feet at times from October through May; Superior—at a depth of more than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Millecoquins—high; Superior—moderate
*Shrink-swell potential:* Low

### Composition

Millecoquins soil and similar soils: 45 to 50 percent
Superior soil and similar soils: 30 to 40 percent
Contrasting inclusions: 15 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Engadine and Moltke soils in the lower landscape positions
• The well drained Battydoe soils in landscape positions similar to those of the major soils
• The well drained Ontonagon soils in landscape positions similar to those of the major soils

### Use and Management

**Land use:** Dominant uses—cropland and pasture (fig. 9); other uses—woodland

**Cropland**
*Major management concerns:* Water erosion, low organic matter content, tilth of the surface layer
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.
• Minimizing tillage and tilling and harvesting at the proper soil moisture content help to prevent excessive compaction and maintain tilth.

**Pasture**
*Major management concerns:* Surface compaction, overgrazing, seasonal wetness
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during wet periods help to keep the pasture in good condition.

**Woodland**
*Major management concerns:* Equipment limitations
*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• Equipment use should be limited to logging roads during spring snowmelt when the soil is wet and ruts form easily.

### Interpretive Groups

*Land capability classification:* IIe
*Woodland ordination symbol:* 3L
*Michigan soil management group:* Millecoquins—3a-s; Superior—1a
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 177D—Millecoquins-Superior, till substratum, complex, 6 to 15 percent slopes

### Setting

*Landform:* Gently rolling and rolling areas on lake plains
*Shape of areas:* Irregular
*Size of areas:* 10 to 200 acres

### Typical Profile

**Millecoquins**

*Surface layer:*
0 to 4 inches—black very fine sandy loam

*Subsurface layer:*
4 to 6 inches—reddish gray very fine sandy loam

*Subsoil:*
6 to 17 inches—dark brown and brown, friable very fine sandy loam
17 to 28 inches—reddish brown and brown, friable silty clay loam and silt loam
28 to 37 inches—pale brown, reddish brown, and dark brown, mottled, friable, stratified fine sandy loam, silt loam, and silty clay loam

*Substratum:*
37 to 80 inches—stratified, mottled yellowish brown and reddish brown silt loam and silty clay loam

**Superior**

*Surface layer:*
0 to 4 inches—black fine sandy loam

**Figure 9.—An area of Millecoquins-Superior, till substratum, complex, 1 to 6 percent slopes. These soils are prime farmland and are well suited to agriculture.**

*Subsurface layer:*
4 to 7 inches—brown fine sandy loam

*Subsoil:*
7 to 16 inches—dark reddish brown, friable fine sandy loam
16 to 34 inches—reddish brown and brown, firm clay and silt loam

*Substratum:*
34 to 74 inches—reddish brown clay that has thin strata of dark brown silt loam
74 to 80 inches—grayish brown and reddish brown sandy clay loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Millecoquins—moderate in the upper part and moderately slow in the lower part; Superior—moderate in the upper part and very slow in the lower part
*Available water capacity:* Millecoquins—high; Superior—moderate
*Drainage class:* Millecoquins—moderately drained; Superior—well drained
*Seasonal high water table:* Millecoquins—perched at a depth of 2.0 to 3.5 feet at times from October through May; Superior—at a depth of more than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Millecoquins—high; Superior—moderate

*Shrink-swell potential:* Low

### Composition

Millecoquins soil and similar soils: 45 to 50 percent
Superior soil and similar soils: 30 to 40 percent
Contrasting inclusions: 15 to 20 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Engadine and Moltke soils in the lower landscape positions
• The well drained Battydoe soils in landscape positions similar to those of the major soils
• The well drained Ontonagon soils in landscape positions similar to those of the major soils

### Use and Management

**Land use:** Dominant uses—cropland and pasture; other uses—woodland

**Cropland**
*Major management concerns:* Water erosion, low organic matter content, tilth of the surface layer
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.
• Minimizing tillage and tilling and harvesting at the proper soil moisture content help to prevent excessive compaction and maintain tilth.

**Pasture**
*Major management concerns:* Surface compaction, overgrazing, seasonal wetness
*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during wet periods help to keep the pasture in good condition.

**Woodland**
*Major management concerns:* Equipment limitations
*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• Equipment use should be limited to logging roads during spring snowmelt when the soil is wet and ruts form easily.

### Interpretive Groups

*Land capability classification:* IIIe
*Woodland ordination symbol:* 3L
*Michigan soil management group:* Millecoquins—3a-s; Superior—1a
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 178B—Dinkey muck, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on high stream terraces
*Shape of areas:* Elongated
*Size of areas:* 5 to 150 acres

### Typical Profile

*Surface layer:*
0 to 9 inches—dusky red and black muck
*Substratum:*
9 to 28 inches—light yellowish brown fine sand that has thin layers of black muck
28 to 33 inches—black muck
33 to 80 inches—brownish yellow sand and brown fine sand that has thin layers of black muck

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid
*Available water capacity:* High
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Dinkey soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The well drained Wallace soils in the slightly higher landscape positions

*Similar inclusions:*
• Soils that have a thicker surface layer of muck

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations
*Management measures:*
• Opportunities for logging are limited because the soil supports very few trees and because of the low strength of the muck

### Interpretive Groups

*Land capability classification:* IIIs
*Woodland ordination symbol:* None assigned
*Michigan soil management group:* L-4a
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 179B—Wallace sand, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on dunes, outwash plains, and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 350 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 10 inches—light brownish gray sand
*Subsoil:*
10 to 11 inches—dark reddish brown, very friable sand
11 to 26 inches—dark brown, cemented sand
26 to 59 inches—brownish yellow, loose sand
*Substratum:*
59 to 80 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layers and rapid in the rest of the profile
*Available water capacity:* Very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Wallace soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the lower landscape positions
*Similar inclusions:*
• Soils that have a seasonal high water table between depths of 40 and 60 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* 7D
*Michigan soil management group:* 5a-h
*Primary habitat type:* ATD
*Secondary habitat type:* TM

## 179D—Wallace sand, 6 to 15 percent slopes

### Setting

*Landform:* Gently rolling and rolling areas on dunes, outwash plains, and lake plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 150 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 10 inches—light brownish gray sand
*Subsoil:*
10 to 11 inches—dark reddish brown, very friable sand
11 to 26 inches—dark brown, cemented sand
26 to 59 inches—brownish yellow, loose sand
*Substratum:*
59 to 80 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layers and rapid in the rest of the profile
*Available water capacity:* Very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Wallace soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the lower landscape positions
*Similar inclusions:*
• Soils that have a seasonal high water table between depths of 40 and 60 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality
*Management measures:*
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIs
*Woodland ordination symbol:* 7D
*Michigan soil management group:* 5a-h
*Primary habitat type:* ATD
*Secondary habitat type:* TM

## 179E—Wallace sand, 15 to 35 percent slopes

### Setting

*Landform:* Rolling to steep areas on dunes, lake plains, and outwash plains
*Shape of areas:* Elongated or irregular
*Size of areas:* 5 to 50 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 10 inches—light brownish gray sand
*Subsoil:*
10 to 11 inches—dark reddish brown, very friable sand
11 to 26 inches—dark brown, cemented sand
26 to 59 inches—brownish yellow, loose sand
*Substratum:*
59 to 80 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the cemented layers and rapid in the rest of the profile
*Available water capacity:* Very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Moderate
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Wallace soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Finch soils in the lower landscape positions

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• The nearly level areas should be selected as sites for landings.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* 7R
*Michigan soil management group:* 5a-h
*Primary habitat type:* ATD
*Secondary habitat type:* TM

## 179F—Wallace sand, 35 to 60 percent slopes

### Setting

*Landform:* Very steep areas on dunes, lake plains, and outwash plains
*Shape of areas:* Elongated or irregular
*Size of areas:* 5 to 50 acres

### Typical Profile

*Organic mat:*
0 to 2 inches—partially decomposed leaf litter
*Surface layer:*
2 to 10 inches—light brownish gray sand
*Subsoil:*
10 to 11 inches—dark reddish brown, very friable sand
11 to 26 inches—dark brown, cemented sand
26 to 59 inches—brownish yellow, loose sand
*Substratum:*
59 to 80 inches—light yellowish brown sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate or moderately rapid in the

cemented layers and rapid in the rest of the profile
*Available water capacity:* Very low
*Drainage class:* Well drained
*Depth to seasonal high water table:* More than 60 inches
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Severe
*Hazard of soil blowing:* Severe
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Wallace soil and similar soils: 100 percent

### Use and Management

**Land use:** Woodland
*Major management concerns:* Equipment limitations, erosion hazard, seedling mortality
*Management measures:*
• Because of the slope, special care is needed in laying out logging roads and landings and in operating logging equipment. Logging roads should be designed so that they conform to the topography.
• The nearly level areas should be selected as sites for landings.
• Because loose sand can interfere with the traction of wheeled equipment, logging roads should be stabilized.
• Planting special nursery stock or containerized seedlings can reduce the seedling mortality rate.

### Interpretive Groups

*Land capability classification:* VIIs
*Woodland ordination symbol:* 7R
*Michigan soil management group:* 5a-h
*Primary habitat type:* ATD
*Secondary habitat type:* TM

## 180B—Millecoquins very fine sandy loam, 1 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on lake plains and deltas
*Shape of areas:* Irregular
*Size of areas:* 10 to 160 acres

### Typical Profile

**Millecoquins**

*Surface layer:*
0 to 4 inches—black very fine sandy loam

*Subsurface layer:*
4 to 6 inches—reddish gray very fine sandy loam

*Subsoil:*
6 to 17 inches—dark brown and brown, friable very fine sandy loam
17 to 28 inches—reddish brown and brown, friable silty clay loam and silt loam
28 to 37 inches—pale brown, reddish brown, and dark brown, mottled, friable, stratified fine sandy loam, silt loam, and silty clay loam

*Substratum:*
37 to 80 inches—stratified, mottled yellowish brown and reddish brown silt loam and silty clay loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderate in the upper part and moderately slow in the lower part
*Available water capacity:* High
*Drainage class:* Moderately well drained
*Seasonal high water table:* Perched at a depth of 2.0 to 3.5 feet at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* High
*Shrink-swell potential:* Low

### Composition

Millecoquins soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The somewhat poorly drained Engadine and Moltke soils in the lower landscape positions

### Use and Management

**Land use:** Dominant uses—cropland and pasture; other uses—woodland

**Cropland**
*Major management concerns:* Water erosion, low organic matter content, tilth of the surface layer
*Management measures:*
• Crop rotations that include grasses or legumes, conservation tillage, grassed waterways, and cover crops help to control water erosion.
• Keeping crop residue on the surface, regularly adding other organic material, and applying a system of no-till planting increase the organic matter content.
• Minimizing tillage and tilling and harvesting at the proper soil moisture content help to prevent excessive compaction and maintain tilth.

**Pasture**
*Major management concerns:* Surface compaction, overgrazing, seasonal wetness

*Management measures:*
• Proper stocking rates, controlled grazing, and restricted use during wet periods help to keep the pasture in good condition.

**Woodland**
*Major management concerns:* Equipment limitations
*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• Equipment use should be limited to logging roads during spring snowmelt when the soil is wet and ruts form easily.

### *Interpretive Groups*

*Land capability classification:* IIe
*Woodland ordination symbol:* 3L
*Michigan soil management group:* 3a-s
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

## 181A—Mattix sandy loam, 0 to 3 percent slopes

### *Setting*

*Landform:* Nearly level areas on outwash plains and ground moraines
*Shape of areas:* Irregular
*Size of areas:* 5 to 125 acres

### *Typical Profile*

*Organic mat:*
0 to 3 inches—well decomposed leaf litter
*Surface layer:*
3 to 5 inches—pinkish gray sandy loam
*Subsoil:*
5 to 11 inches—dark reddish brown, friable sandy loam
11 to 24 inches—dark brown, friable loamy sand
*Substratum:*
24 to 80 inches—light yellowish brown and pale brown gravelly sand and very gravelly sand

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderately rapid in the upper part and very rapid in the lower part
*Available water capacity:* Low
*Drainage class:* Somewhat poorly drained
*Depth to seasonal high water table:* 0.5 foot to 1.5 feet at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### *Composition*

Mattix soil and similar soils: 90 to 95 percent
Contrasting inclusions: 5 to 10 percent

### *Inclusions*

*Contrasting inclusions:*
• The moderately well drained Cozy and Heinz soils in the slightly higher landscape positions
*Similar inclusions:*
• Soils that have gravelly sandy loam till below a depth of 40 inches

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.
• Trees that can withstand seasonal wetness should be selected for planting.

### *Interpretive Groups*

*Land capability classification:* IVw
*Woodland ordination symbol:* 5W
*Michigan soil management group:* 4/Gb
*Primary habitat type:* TMC
*Secondary habitat type:* None assigned

## 182B—Heinz sandy loam, 0 to 6 percent slopes

### *Setting*

*Landform:* Nearly level and undulating areas on ground moraines and outwash plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 65 acres

### *Typical Profile*

*Organic mat:*
0 to 1 inch—well decomposed leaf litter

*Surface layer:*
1 to 5 inches—black sandy loam

*Subsurface layer:*
5 to 6 inches—pinkish gray sandy loam

*Subsoil:*
6 to 8 inches—dark reddish brown, friable sandy loam
8 to 25 inches—dark brown, friable loamy sand and very friable sand

*Substratum:*
25 to 80 inches—brown gravelly sand and pale brown very gravelly sand

### Soil Properties and Qualities

*Depth class:* Very deep
*Permeability:* Moderately rapid in the upper part and very rapid in the lower part
*Available water capacity:* Low
*Drainage class:* Moderately well drained
*Depth to seasonal high water table:* 2.0 to 3.5 feet at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Low
*Shrink-swell potential:* Low

### Composition

Heinz soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The moderately well drained Cozy soils in landscape positions similar to those of the Heinz soil
• The somewhat poorly drained Mattix soils in the slightly lower landscape positions

*Similar inclusions:*
• Soils that have gravelly loamy till below a depth of 40 inches

### Use and Management

**Land use:** Woodland
*Major management concerns:* None

### Interpretive Groups

*Land capability classification:* IVs
*Woodland ordination symbol:* 3A
*Michigan soil management group:* 4/Ga
*Primary habitat type:* ATD
*Secondary habitat type:* TM

## 183B—Cozy cobbly fine sandy loam, 0 to 6 percent slopes

### Setting

*Landform:* Nearly level and undulating areas on ground moraines and drumlins
*Shape of areas:* Irregular
*Size of areas:* 5 to 160 acres

### Typical Profile

*Organic mat:*
0 to 5 inches—well decomposed leaf litter

*Surface layer:*
5 to 6 inches—brown cobbly fine sandy loam

*Subsoil:*
6 to 14 inches—dark brown, friable cobbly fine sandy loam and cobbly sandy loam

*Substratum:*
14 to 60 inches—light brown, firm very gravelly sandy loam

### Soil Properties and Qualities

*Depth class:* Very deep
*Rock fragments on the surface:* Kind—cobbles; percentage of the surface covered—0.01 to 0.1 percent
*Permeability:* Moderate in the upper part and very slow in the lower part
*Available water capacity:* Low
*Drainage class:* Moderately well drained
*Seasonal high water table:* Perched at a depth of 1 to 2 feet at times from October through May
*Surface runoff:* Slow
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* Moderate
*Shrink-swell potential:* Low

### Composition

Cozy soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

### Inclusions

*Contrasting inclusions:*
• The well drained, moderately deep Longrie soils and Guardlake soils that have a substratum of gravelly sand; in landscape positions similar to those of the Cozy soil
• The somewhat poorly drained Shelter soils in the slightly lower landscape positions

*Similar inclusions:*
• Soils that have a sandy surface layer

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Because of low strength, suitable surfacing material is needed on year-round logging roads and landings.
• Equipment use should be limited to logging roads during spring snowmelt when the soil is wet and ruts form easily.

### *Interpretive Groups*

*Land capability classification:* IIIs
*Woodland ordination symbol:* 3W
*Michigan soil management group:* Ga
*Primary habitat type:* AVO
*Secondary habitat type:* AVO-A

## 185—Ermatinger silt loam

### *Setting*

*Landform:* Depressions on flood plains
*Shape of areas:* Irregular
*Size of areas:* 5 to 85 acres

### *Typical Profile*

*Surface layer:*
0 to 8 inches—black silt loam
*Substratum:*
8 to 12 inches—grayish brown, mottled silt loam
12 to 60 inches—gray and brown, mottled very fine sandy loam and loamy very fine sand

### *Soil Properties and Qualities*

*Depth class:* Very deep
*Permeability:* Moderate
*Available water capacity:* High
*Drainage class:* Poorly drained
*Seasonal high water table:* 1 foot above to 1 foot below the surface at times from October through June
*Surface runoff:* Very slow or ponded
*Flooding:* None
*Hazard of water erosion:* Slight
*Hazard of soil blowing:* Moderate
*Potential for frost action:* High
*Shrink-swell potential:* Low

### *Composition*

Ermatinger soil and similar soils: 100 percent

### *Inclusions*

*Similar inclusions:*
• Soils that have clay below a depth of 40 inches
• Soils that have loamy glacial till below a depth of 40 inches

### *Use and Management*

**Land use:** Woodland
*Major management concerns:* Equipment limitations, seedling mortality, windthrow hazard
*Management measures:*
• Equipment can be used only during dry summer months and during periods in winter when the snow cover is adequate or the soil is frozen.
• Year-round logging roads require roadfill and gravel. Culverts are needed to maintain the natural drainage system.
• Landing sites generally can be used only during the driest time of the year.
• Because of wetness and severe seedling mortality, trees are not planted on this soil.
• Windthrow can be minimized by using harvest methods that do not leave the remaining trees widely spaced.

### *Interpretive Groups*

*Land capability classification:* Vw
*Woodland ordination symbol:* 2W
*Michigan soil management group:* 2.5c
*Primary habitat type:* None assigned
*Secondary habitat type:* None assigned

# Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

## Crops and Pasture

General management needed for crops and pasture is suggested in this section. The estimated yields of the main crops and pasture plants are listed for each soil, the system of land capability classification used by the Natural Resources Conservation Service is explained, and prime farmland is described.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

The soils in the survey area are assigned to various interpretive groups at the end of each map unit description and in some of the tables. A summary is in the section "Interpretive Groups."

### Cropland

In 1982, about 12,500 acres was farmed in Mackinac County. The major crops grown are hay, small grain, silage corn, and pasture crops. Many of the farms are dairy or cow-calf operations. The potential of many of the soils in the county for hayland and pasture is excellent. Many farm fields that were once productive, however, are now overgrown with brush because of low farm income and outmigration.

Farm management practices needed for crops and pasture include improving drainage, preventing surface compaction, controlling water erosion and soil blowing, and improving soil fertility.

Soil wetness is the major concern on most of the cropland in the county. Improving soil drainage can increase crop production and the timeliness of fieldwork. Surface and subsurface drainage is needed on most farm fields. Subsurface drainage is rare in areas of hayland because of the cost and the minimal expected returns. Fieldwork is restricted when the soils are wet. Improving surface drainage and lowering the perched seasonal high water table allow earlier spring planting and extend the harvest season. Pickford, Rudyard, Engadine, Glawe, and Gogomain soils are examples of soils in Mackinac County in which improved drainage is needed.

Surface compaction is a management concern on clayey soils, such as Pickford, Rudyard, Gogomain, and

Bowers soils. Excessive cultivation and working the soil when it is wet can result in compaction. Allowing livestock to graze on these soils during wet periods also results in compaction and can retard the growth of pasture plants. Poor seedling emergence, lower water infiltration rates, restricted rooting depth, and reduced crop yields may result. Conservation tillage, rotation grazing, and additions of organic material help to prevent surface compaction.

Water erosion is a management concern on the undulating to rolling soils in the county, such as Greylock, Millecoquins, Ontonagon, and Superior soils. Erosion of the surface layer reduces productivity through the loss of topsoil and soil nutrients. Livestock may cause erosion along the banks of ditches or streams as a result of overgrazing. A system of conservation tillage that leaves a protective cover of crop residue on the surface helps to control surface runoff and erosion. Diversions, surface drains, grade-stabilization structures, and grassed waterways help to prevent gully erosion caused by concentrated runoff.

Soil blowing is a hazard on sandy and silty soils, such as Springlake, Millecoquins, and Ontonagon soils. A dry, bare surface is very susceptible to soil blowing. A permanent plant cover, windbreaks of trees or shrubs, surface mulch, spring plowing, or a system of conservation tillage helps to control soil blowing.

Soil fertility is naturally high or medium in the finer textured soils and low in the sandy soils. The clayey farmland soils in eastern Mackinac County have pH levels that are strongly acid to slightly acid. Applications of ground limestone are needed on these soils to raise the pH to the optimum level of 6.5. At this pH level, most nutrients are readily available for plant growth. Additions of lime and fertilizer should be based on the results of soil tests. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime needed (Michigan State University, 1985).

The western part of Mackinac County has a mixture of clayey and loamy soils that generally have higher pH levels than the soils in the eastern part. Soil tests should be used to determine the amounts of lime and fertilizer needed on these soils.

### Pasture

Pasture is an important land use in the county (fig. 10). Pastures should be topdressed every other year according to the results of soil tests. Clipping the pasture results in more uniform regrowth and controls weeds. A proper seeding mixture of pasture plants increases forage production. A mixture of birdsfoot trefoil, red clover, and timothy is commonly used. Alfalfa also is included in seeding mixtures in the better drained areas.

More specific information about seeding mixtures and seeding times is available at local offices of the Cooperative Extension Service and the Natural Resources Conservation Service.

The productivity of a pasture and its ability to protect the surface of the soil are influenced by the number of livestock that the pasture supports, the length of time that they graze, and the distribution of rainfall. Good pasture management includes stocking rates that maintain the desired forage species, pasture rotation, deferred grazing, and restricted grazing during wet and extremely dry periods.

### 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.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; 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 residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil 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 listed because the acreage of such crops is small. The local office of the Natural Resources Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

**Figure 10.—Hay production in an area of Millecoquins-Superior, till substratum, complex, 6 to 15 percent slopes.**

## Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops (USDA, 1961). Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland or for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit. Only class and subclass are used in this survey.

*Capability classes*, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. 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 miscellaneous areas 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 hazard is the 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 very cold or very 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. 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 shown in table 6. The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the section "Interpretive Groups."

Also given at the end of each map unit description is a Michigan soil management group. The soils are assigned to a group according to the dominant texture in the profile, the natural drainage class, and the major management concerns (Mokma and others, 1978). For soils in a complex, the management groups are listed in the same order as the series named in the complex.

### Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forest land, or other land, but it is not urban or built-up land or water areas. The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. It is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

About 45,000 acres in the survey area, or about 7 percent of the total acreage, meets the soil requirements for prime farmland.

The map units in the survey area that are considered prime farmland are listed in table 7. This list does not constitute a recommendation for a particular land use. On some soils included in the list, measures that overcome a hazard or limitation, such as flooding, wetness, and droughtiness, are needed. Onsite evaluation is needed to determine whether or not the hazard or limitation has been overcome by corrective measures. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

## Woodland Management and Productivity

William Peters, soil conservation district forester, helped prepare this section.

Woodland is the major land use in Mackinac County. It makes up about 87 percent of the county, or about 570,000 acres. State and Federal agencies control about 351,000 acres of the woodland. The remaining 219,000 acres is managed by forest industry companies and small landowners.

Productivity was measured on several of the major soil series in the county. The site index was determined using at least five trees per site. Twenty-six site indices were done on 13 different soil series (USDA/NRCS, National Forestry Manual).

Woodland is the dominant use on all but a few soil types. The upland soils in the county, which make up about 260,000 acres, support stands of northern

hardwoods, red pine, and white pine or have been planted to jack pine, red pine, or white pine. The wetter mineral soils, which make up about 136,000 acres, support stands of red maple, balsam fir, white spruce, quaking aspen, paper birch, and hemlock. The large muck areas, which make up about 174,000 acres, support stands of northern whitecedar, black spruce, tamarack, quaking aspen, paper birch, and red maple.

The wood products industry is an important employer in Mackinac County. Wood products vary from cedar shingles to hardwood lumber. Cedar posts, pulpwood, and logs for log homes are also an important part of the industry. Forest growth is greater than the actual harvest of wood products. In 1993, the average annual net growth of the growing stock and sawtimber was 16,967,000 cubic feet and the average annual removal of growing stock and sawtimber was 6,682,000 cubic feet (Schmidt, 1993). As the forest resource is more fully utilized, better forest management will be needed to ensure a continuous supply of the desired species.

Table 8 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce in a pure stand under natural conditions. The number 1 indicates low potential productivity; 2 or 3, moderate; 4 or 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; *F*, a high content of rock fragments in the soil; *L*, low strength; and *N*, snowpack. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, F, L, and N.

In table 8, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

*Erosion hazard* is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, and fire lanes and in log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities (fig. 11).

*Equipment limitation* reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment and season of use are not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

*Seedling mortality* refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

*Windthrow hazard* is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe*

**Figure 11.—A logging road in an area of Wallace sand, 0 to 6 percent slopes, that has been planted with a clover mixture. Seeding the road helps to control erosion and provides food for wildlife.**

indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site 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. Commonly grown 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.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand. The volume was determined using standard yield tables (USDA/NRCS, National Forestry Manual).

The first species listed under *common trees* for a soil is the indicator species for that soil. It generally is the most common species on the soil and is the one that determines the ordination class.

*Trees to plant* are those that are suitable for commercial wood production.

Logging and harvesting of wood resources are important to the economy of Mackinac County. Table 9 provides expanded information concerning the operability of harvesting equipment. The table gives information about operating harvesting or thinning equipment in logging areas and on skid roads, log landings, and haul roads. Limitations are given for the most limiting season and for the preferred operating season. The most limiting season in this survey area generally is spring or late fall. In some areas, however, it is during dry periods in summer, when loose sand can limit trafficability on deep, excessively drained to well drained, sandy soils.

The preferred operating season is the period when harvesting or thinning causes the least amount of soil

damage. This period generally is when the soil is not too wet or when the ground is frozen or partly frozen or has an adequate snow cover.

In table 9, a rating of *slight* indicates that the use of conventional logging equipment is not restricted if normal logging methods are used. A rating of *moderate* indicates that the use of equipment is restricted because of one or more soil factors. If wetness is a limitation, high flotation equipment or special procedures may be needed to prevent the formation of ruts. A rating of *severe* indicates that the kind of equipment that can be used is seriously restricted.

*Logging areas and skid roads* include areas where some or all of the trees are being cut. Generally, equipment traffic is least intensive in the logging areas. Skid roads, which generally are within the logging area, are roads or trails over which the logs are dragged or hauled from the stump to a log landing.

*Log landings* are areas where logs are assembled for transportation. Wheeled equipment may be used more frequently in these areas than in any other areas affected by logging.

*Haul roads* are access roads leading from primary or surfaced roads to the logging areas. The logging roads serve as transportation routes for wheeled logging equipment and logging trucks. Generally, they are unpaved roads. Some are graveled.

## Forest Habitat Types

The information in this section is derived from a field guide developed for the Upper Peninsula of Michigan and for northeastern Wisconsin (Coffman and others, 1980). The system of habitat classification used in the guide is based on the concept that plants occur in predictable patterns or communities and that these communities reflect differences in site characteristics.

Besides identifying the various habitat types by means of vegetative keys, the guide also provides information about the different possible successional stages for most of the habitat types. The successional stages depend largely on how the forest has been disturbed. They include the succession after logging in the original climax stands, the succession after logging in second-growth stands, and the succession in stands that have been both logged and burned.

The guide gives the suggested forest management for each of the successional stages. This management includes methods of thinning and harvesting, site preparation, and measures that improve regeneration of the stands. The potential productivity, in terms of a site index and mean annual volume in cubic feet per acre per year, is given for most of the habitat types. The development of the descriptive or interpretive information for some of the habitat types, however, is based on limited data and thus should be used with caution.

Habitat types have been determined for most of the map units in Mackinac County based upon data collected during the completion of the fieldwork for the county. A total of 262 note cards was collected, and the emphasis was on the major soils in the county. If data were inconclusive, no habitat type was assigned. For map units that have had habitat types assigned, the primary habitat type is the one that is most common on the map unit and the secondary habitat type is less common. Habitat types are listed at the end of the descriptions in the section "Detailed Soil Map Units" and in the section "Interpretive Groups," which follows the tables at the back of this survey.

The following paragraphs describe the habitat types in the county. They provide information about the potential climax species, some of the common understory species, and, if known, the potential productivity of the habitat type.

**ATD—Acer-Tsuga-Dryopteris habitat type.** This habitat type has a potential climax overstory dominated by sugar maple. Other species include eastern hemlock, American beech, and American basswood. Yellow birch, red maple, and American elm are in some areas. The dominant ground flora includes spinulose woodfern, rosy twistedstalk, Solomons seal, scarlet alder, and Canada mayflower. The potential productivity is moderately high for northern hardwoods and high for aspen. The potential productivity for red pine plantations is high if plant competition is controlled.

**AVO—Acer-Viola-Osmorhiza habitat type.** This habitat type has a potential climax overstory dominated by sugar maple. Other species include American basswood, white ash, yellow birch, eastern hophornbeam, eastern hemlock, and American elm. The dominant ground flora includes Canada white violet, sweet cicely, spinulose woodfern, ladyfern, Solomons seal, and rosy twistedstalk. The potential productivity is high for northern hardwoods and aspen. It also is high for red pine plantations if plant competition is controlled.

**AVO-A—Acer-Viola-Osmorhiza habitat type, Adiantum phase.** This habitat type has a potential climax overstory dominated by sugar maple. Other species include American basswood, white ash, yellow birch, eastern hophornbeam, eastern hemlock, and American elm. The dominant ground flora includes Canada white violet, sweet cicely, spinulose woodfern, wild leek, maidenhair fern, ladyfern, Solomons seal, and rosy twistedstalk. The potential productivity is high for

northern hardwoods and aspen. It also is high for red pine plantations if plant competition is controlled.

**AQVac—Acer-Quercus-Vaccinium habitat type.** This habitat type has a potential climax overstory dominated by red maple and northern red oak. Other species include eastern hemlock, eastern white pine, balsam fir, and white spruce. The dominant ground flora includes lowbush blueberry, Canada blueberry, brackenfern, wintergreen, bigleaf aster, and hazelnut. The potential productivity is moderately low for northern hardwoods, moderate for aspen, and moderately high for red pine and jack pine.

**FMC—Fraxinus-Mentha-Carex habitat type.** This habitat type has a potential climax overstory dominated by black ash and American elm. Other species include red maple and balsam fir. The dominant ground flora includes sedge, field mint, speckled alder, and jewelweed.

**PCS—Picea-Chamadaphne-Sphagnum habitat type.** This habitat type has a potential climax overstory dominated by black spruce. Other species include tamarack and northern whitecedar. The dominant ground flora includes leatherleaf, bog rosemary, pale laurel, sphagnum, Labrador tea ledum, sedge, and Canada blueberry.

**QAE—Quercus-Acer-Epigea habitat type.** This habitat type has a potential climax overstory dominated by red oak and red maple. Other species are white spruce and eastern white pine. The dominant ground flora includes brackenfern, trailing arbutus, wintergreen, lowbush blueberry, mosses, and Canada blueberry. The potential productivity is moderately low for aspen and moderate for red pine and jack pine.

**TM—Tsuga-Maianthemum habitat type.** This habitat type has a potential climax overstory dominated by eastern hemlock, sugar maple, and red maple. Other species include yellow birch, white spruce, balsam fir, eastern white pine, northern red oak, northern whitecedar, and American basswood. The dominant ground flora includes Canada mayflower, brackenfern, sedge, American starflower, and wild sarsaparilla. The potential productivity is moderate for northern hardwoods, moderately high for aspen, and high for red pine and jack pine.

**TMC—Tsuga-Maianthemum-Coptis habitat type.** This habitat type has a potential climax overstory dominated by eastern hemlock and red maple. Sugar maple and yellow birch are common. Other species include balsam fir, white spruce, and northern whitecedar. The dominant ground flora includes Canada mayflower, goldthread, yellow beadlily, bunchberry dogwood, American starflower, and spinulose woodfern. The potential productivity is moderate for northern hardwoods and aspen.

**TMC-D—Tsuga-Maianthemum-Coptis habitat type, Dryopteris phase.** This habitat type has a potential climax overstory dominated by eastern hemlock and red maple. Sugar maple and yellow birch are common. Other species include balsam fir, white spruce, and northern whitecedar. The dominant ground flora includes Canada mayflower, goldthread, yellow beadlily, bunchberry dogwood, American starflower, spinulose woodfern, long beechfern, oakfern, and Solomons seal. The potential productivity is moderate for northern hardwoods and aspen.

**TMC-V—Tsuga-Maianthemum-Coptis habitat type, Vaccinium phase.** This habitat type has a potential climax overstory dominated by eastern hemlock and red maple. Sugar maple and yellow birch are common. Other species include balsam fir, white spruce, and northern whitecedar. The dominant ground flora includes Canada mayflower, goldthread, yellow beadlily, bunchberry dogwood, American starflower, Canada blueberry, lowbush blueberry, and spinulose woodfern. The potential productivity is moderate for northern hardwoods and aspen.

**TMV—Tsuga-Maianthemum-Vaccinium habitat type.** This habitat type has a potential climax overstory dominated by eastern hemlock and red maple. Other species include sugar maple, eastern white pine, balsam fir, white spruce, and northern red oak. The dominant ground flora includes Canada blueberry, wild sarsaparilla, brackenfern, Canada mayflower, lowbush blueberry, yellow beadlily, and wood betony. The potential productivity is moderate for northern hardwoods, moderately high for aspen, and high for red pine and jack pine.

**TTM—Tsuga-Thuja-Mitella habitat type.** This habitat type has a potential climax overstory dominated by northern whitecedar and eastern hemlock. Other species include balsam fir and red maple. The dominant ground flora includes sphagnum, naked miterwort, twinflower, goldthread, bunchberry dogwood, sedge, Canada mayflower, American starflower, and fringed polygala.

**TTP—Tsuga-Thuja-Petasites habitat type.** This habitat type has a potential climax overstory dominated

by eastern hemlock and northern whitecedar. Other species include balsam fir, red maple, and sugar maple. The dominant ground flora includes palmate-leaved sweet coltsfoot, bigleaf aster, sedge, barren strawberry, northern dewberry, bunchberry dogwood, wild sarsaparilla, and black snakeroot. The potential productivity is moderately low for aspen.

**TTS—Tsuga-Thuja-Sphagnum habitat type.** This habitat type has a potential climax overstory dominated by eastern hemlock and northern whitecedar. Other species include balsam fir, black spruce, and red maple. The dominant ground flora includes sphagnum, goldthread, bunchberry dogwood, sedge, Canada mayflower, American starflower, and wood sorrel.

## Recreation

Mackinac County has many campgrounds along its Great Lakes shoreline, inland lakes, and rivers and has a few rustic campgrounds on its islands. The readily available water access and large acreage of public land allow for many outdoor activities. Popular activities are fishing, boating, swimming, hunting, hiking, cross-country skiing, and snowmobiling. Many rivers are noted for their trout fishing, and Lakes Michigan and Huron are noted for perch, pike, whitefish, trout, and salmon.

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that 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 a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

*Camp areas* require site preparation, such as shaping and leveling the 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 have gentle 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 campsites.

*Picnic areas* are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for 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 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 and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

*Paths and trails* for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

## Wildlife Habitat

Mackinac County has a large and varied population of fish and wildlife. White-tailed deer, black bear, snowshoe hare, coyote, bobcat, foxes, beaver, ducks, owls, hawks, ruffed grouse, and songbirds are common. The streams and lakes support many species of fish. The extensive Great Lakes shoreline supports many nesting waterfowl and shore birds. A number of endangered or protected species live or nest in the county. Among these are bald eagles, osprey, sandhill cranes, common loon, fishers, pine martens, and wolves.

Soils affect the kind and amount of vegetation that is

**Figure 12.—Regeneration of aspen in an area of Wallace sand, 0 to 6 percent slopes, as a result of clearcutting. Clearcutting helps to maintain habitat for ruffed grouse, white-tailed deer, and other wildlife.**

available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants (figs. 12 and 13).

In table 11, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in 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* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

**Figure 13.—A prescribed burn in an area of Spot-Finch complex, 0 to 3 percent slopes. Controlled fires are used to create openings for wildlife habitat and to reduce logging slash prior to planting.**

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

*Grain and seed crops* are domestic grains and seed-producing herbaceous plants. Soil properties and features 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 flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are rye, wheat, oats, and barley.

*Grasses and legumes* are domestic perennial grasses and herbaceous legumes. Soil properties and features 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, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, birdsfoot trefoil, orchardgrass, bromegrass, clover, and alfalfa.

*Wild herbaceous plants* are native or naturally established grasses and forbs, including weeds. Soil properties and features 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 flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are strawberry, bunchberry, ferns, wild leeks, cattails, and reed canarygrass.

*Hardwood trees* and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are poplar, sweetgum, apple, hawthorn,

dogwood, beech, blackberry, raspberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are American cranberrybush, autumn-olive, crabapple, and silky dogwood.

*Coniferous plants* furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover 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. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cattails, rushes, sedges, and reeds.

*Shallow water areas* have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

*Habitat for openland wildlife* consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, and shrubs. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include sharptail grouse, sandhill cranes, marsh hawks, field sparrow, woodchuck, and red fox.

*Habitat for woodland wildlife* consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, deer, and bear.

*Habitat for wetland wildlife* consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

## Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

*Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.*

*The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.*

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in

this survey, can be used to make additional interpretations.

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

**Building Site Development**

Table 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

*Shallow excavations* are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

*Dwellings* and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrinking and swelling, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

*Local roads and streets* have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

*Lawns and landscaping* require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, and the available water capacity in the upper 40 inches affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

**Sanitary Facilities**

Table 13 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for landfill. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

*Septic tank absorption fields* are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site

features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

*Sewage lagoons* are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the 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.

Table 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

*Sanitary landfills* are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

*Daily cover for landfill* is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as the final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

### Construction Materials

Table 14 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

*Roadfill* is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading.

Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet and have a water table at a depth of less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

*Sand* and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 14, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

*Topsoil* is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel or stones, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

**Water Management**

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and

diversions, and grassed waterways.

*Pond reservoir areas* hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

*Embankments, dikes, and levees* are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or organic matter. A high water table affects the amount of usable material. It also affects trafficability.

*Aquifer-fed excavated ponds* are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water. Depth to bedrock and the content of large stones affect the ease of excavation.

*Drainage* is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity. Availability of drainage outlets is not considered in the ratings.

*Irrigation* is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

*Terraces and diversions* are embankments or a combination of channels and ridges constructed across a slope to control water erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

*Grassed waterways* are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

# Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

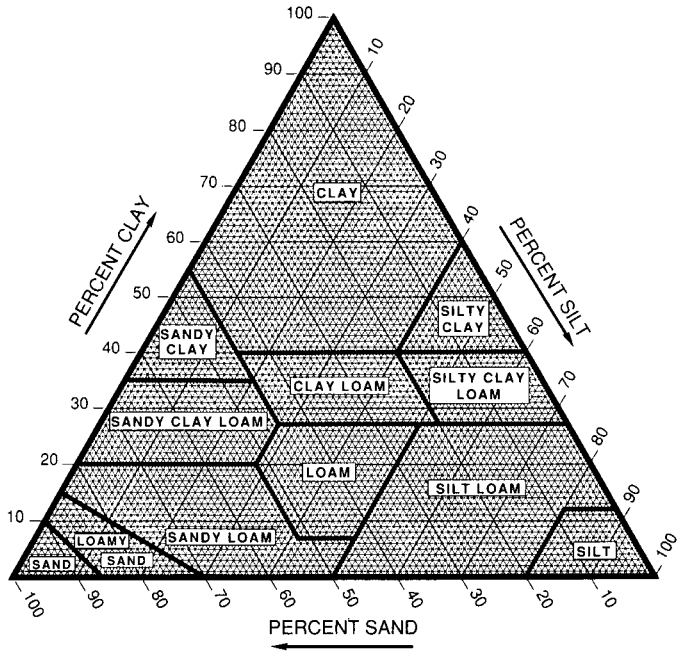


**Figure 14.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.**

## Engineering Index Properties

Table 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

*Depth* to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each taxonomic unit under the heading "Soil Series and Their Morphology."

*Texture* is given 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 the fraction of the soil that is less than 2 millimeters in diameter (fig. 14). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

*Classification* of the soils is determined according to the Unified soil classification system (ASTM, 1993) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 1986).

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 and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and

clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups 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 (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

*Rock fragments* larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

*Percentage (of soil particles) passing designated sieves* is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

*Liquid limit* and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

## Physical and Chemical Properties

Table 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

*Clay* as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

*Moist bulk density* is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓-bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

*Permeability* refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

*Available water capacity* refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

*Soil reaction* is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops

and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

*Shrink-swell potential* is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; *high*, more than 6 percent; and *very high*, greater than 9 percent.

*Erosion factor K* indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 to 0.64. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

*Erosion factor T* is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

*Wind erodibility groups* are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. The soils assigned to group 1 are the most susceptible to soil blowing, and those assigned to group 8 are the least susceptible. The groups are as follows:

1. Coarse sands, sands, fine sands, and very fine sands.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, ash material, and sapric soil material.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material.
8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

*Organic matter* is the plant and animal residue in the soil at various stages of decomposition. In table 17, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

## Soil and Water Features

Tables 18 and 19 give estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

*Hydrologic soil groups* are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive 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 mainly of deep, well drained to excessively drained sands or gravelly sands. 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 having a layer that impedes the downward movement of water or soils of 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 clays that have a high shrink-swell potential, soils that have a 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.

If a soil is assigned to two hydrologic groups in table 18, the first letter is for drained areas and the second is for undrained areas.

*Flooding*, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

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 (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of flooding is more than 50 percent in any year). Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

*High water table* (seasonal) is the highest level of a saturated zone in the soil in most years. The estimates are based mainly on observations of the water table at selected sites and on the evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. Indicated in table 18 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. A water table that is seasonally high for less than 1 month is not indicated in table 18.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Two numbers in the column showing depth to the water table indicate the normal range in depth to a saturated zone. Depth is given to the nearest half foot. The first numeral in the range indicates the highest water level. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. "More than 6.0" indicates that the water table is below a depth of 6 feet or that it is within a depth of 6 feet for less than a month.

In table 19, *depth to bedrock* is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

A *cemented pan* is a cemented or indurated subsurface layer within a depth of 5 feet. Such a pan causes difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

*Subsidence* is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 19 shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

*Potential frost action* is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in

evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

*Risk of corrosion* pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

## Characterization Data for Selected Soils

Some of the major soils in Mackinac County were sampled by the Soil Survey Laboratory in Lincoln, Nebraska, and the Soil Research Laboratory, Michigan Technological University, Houghton, Michigan. The laboratory data obtained from the soil samples included analyses of particle-size distribution, coarse fragments, bulk density, and moisture retention. Complete chemical analyses were also performed on each sample, and spodic horizon criteria were performed on the appropriate samples. Standard National Cooperative Soil Survey procedures were used for all analyses (USDA, 1991).

These data were used in classifying and correlating the soils and in evaluating their behavior, especially under forestry uses. Eight pedons were selected as representative of the respective series. These series and their laboratory identification numbers are as follows: Battydoe (S82MI-097-004 and S90MI-097-1), Graveraet (S90MI-097-005), Greylock (S79MI-097-2 and S82MI-097-005), Johnswood (S82MI-097-002), Satago (S82MI-097-003), and Springlake (S90MI-097-2).

In addition to the complete chemical analyses of these samples, several soil horizons of some major soils in the county were sampled for texture, spodic criteria, bulk density, and consistency (cementation) of ortstein. The soils for which texture samples were checked are Adams, Alcona, Battydoe, Graveraet, Greylock, Moltke, Satago, Search, Shelter, and Springlake. The soils for which spodic criteria tests were made are Battydoe, Greylock, and Springlake. The soils for which consistency of ortstein was tested are Finch, Paquin, Pullup, Spot, and Wallace. The soils for which bulk density tests were made are Greylock and Shelter. Information on all of these partial soil analyses is available from the Soil Research Laboratory, Michigan Technological University, Houghton, Michigan; the Soil Survey Laboratory in Lincoln, Nebraska; and the State Office of the Natural Resources Conservation Service, East Lansing, Michigan.

# Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (USDA, 1975; USDA, 1994). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 20 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Spodosol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Orthod (*Orth*, meaning the common ones, plus *od*, from Spodosol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplorthods (*Hapl*, meaning minimal horizonation, plus *orthod*, the suborder of the Spodosols that has a horizon characterized by an accumulation of aluminum, iron, and organic carbon in which no one of the elements dominates).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplorthods.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle size, mineral content, soil temperature regime, soil depth, and reaction. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is sandy, mixed, frigid Typic Haplorthods.

SERIES. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile.

## Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" (USDA, 1993). Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" (USDA, 1975) and in "Keys to Soil Taxonomy" (USDA, 1994). Unless otherwise indicated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series or other taxonomic unit are described in the section "Detailed Soil Map Units."

### Adams Series

The Adams series consists of very deep, somewhat excessively drained soils on outwash plains and ground

moraines. These soils formed in sandy glaciofluvial deposits. Permeability is moderately rapid in the upper part and rapid or very rapid in the lower part. Slopes range from 0 to 15 percent.

Typical pedon of Adams sandy loam, in an area of Greylock-Adams complex, 0 to 6 percent slopes; in an area where the slope is 1 percent; 2,200 feet west and 150 feet south of the northeast corner of sec. 22, T. 44 N., R. 12 W.

Oi—0 to 1 inch; slightly decomposed leaf litter.
A—1 to 4 inches; very dark gray (10YR 3/1) sandy loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; friable; many fine to coarse roots; about 1 percent gravel; moderately acid; abrupt wavy boundary.
E—4 to 5 inches; reddish gray (5YR 5/2) sandy loam; weak medium subangular blocky structure; friable; many fine to coarse roots; about 1 percent gravel; moderately acid; abrupt broken boundary.
Bhs—5 to 7 inches; dark reddish brown (5YR 3/3) sandy loam; weak medium subangular blocky structure; friable; many fine to coarse roots; about 1 percent gravel; strongly acid; clear wavy boundary.
Bs1—7 to 12 inches; reddish brown (5YR 4/4) loamy sand; weak medium subangular blocky structure; friable; many fine to coarse roots; about 1 percent gravel; moderately acid; clear wavy boundary.
Bs2—12 to 15 inches; strong brown (7.5YR 5/6) sand; weak medium subangular blocky structure; very friable; few fine to coarse roots; about 1 percent gravel; moderately acid; gradual wavy boundary.
BC—15 to 26 inches; brownish yellow (10YR 6/6) sand; very weak medium subangular blocky structure; very friable; few fine to coarse roots; about 1 percent gravel; moderately acid; gradual wavy boundary.
C—26 to 80 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; few thin yellowish brown (10YR 5/4) strata of loamy sand; slightly acid.

Thickness of the loamy cap ranges from 6 to 10 inches. The content of gravel ranges from 0 to 5 percent in the solum and from 0 to 10 percent in the substratum.

The A horizon has hue of 10YR or 7.5YR, value of 2 to 4, and chroma of 1 or 2. The E horizon has hue of 7.5YR or 5YR, value of 5 or 6, and chroma of 1 or 2. The A and E horizons are sandy loam or loamy sand.

The Bhs horizon has hue of 7.5YR or 5YR and value and chroma of 2 or 3. It is sandy loam or loamy sand.

The Bs horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 4 to 6. It is loamy sand or sand.

The C horizon has hue of 10YR or 7.5YR and value and chroma of 4 to 6. It is sand.

## Alcona Series

The Alcona series consists of very deep, well drained soils on lake plains and ground moraines. These soils formed in stratified, loamy and sandy glaciofluvial deposits. Permeability is moderate. Slopes range from 0 to 60 percent.

Typical pedon of Alcona fine sandy loam, in an area of Wallace-Alcona complex, 35 to 60 percent slopes; in an area where the slope is 42 percent; 1,450 feet east and 2,300 feet north of the southwest corner of sec. 17, T. 42 N., R. 5 W.

Oe—0 to 1 inch; partially decomposed leaf litter.
E—1 to 3 inches; pinkish gray (7.5YR 6/2) fine sandy loam, pinkish gray (7.5YR 7/2) dry; weak fine subangular blocky structure; friable; many fine to coarse roots; about 1 percent gravel; strongly acid; clear smooth boundary.
Bs1—3 to 6 inches; dark brown (7.5YR 3/4) fine sandy loam; weak fine subangular blocky structure; friable; many fine to coarse roots; about 1 percent gravel; strongly acid; clear smooth boundary.
Bs2—6 to 9 inches; dark yellowish brown (10YR 4/4) fine sandy loam; weak fine subangular blocky structure; friable; many fine to coarse roots; about 1 percent gravel; moderately acid; clear wavy boundary.
Bs3—9 to 17 inches; strong brown (7.5YR 5/6) fine sandy loam; weak fine subangular blocky structure; friable; many fine to coarse roots; about 1 percent gravel; moderately acid; clear wavy boundary.
B/E—17 to 23 inches; about 65 percent reddish brown (5YR 5/4) very fine sandy loam (Bt); few faint dark brown (7.5YR 4/4) clay films on faces of peds; surrounded by tongues of light pinkish gray (7.5YR 6/2) very fine sandy loam (E), pinkish gray (7.5YR 7/2) dry; moderate medium subangular blocky structure; firm; common fine and medium roots; about 1 percent gravel; moderately acid; clear wavy boundary.
E/B—23 to 54 inches; about 70 percent light reddish brown (5YR 6/3) loamy fine sand (E), pinkish gray (7.5YR 7/2) dry, surrounding peds of reddish brown (5YR 5/4) fine sandy loam (Bt); few faint reddish brown (5YR 5/4) clay flows on faces of peds; weak coarse subangular blocky structure; friable; common fine vesicular pores; few fine and medium roots; about 1 percent gravel; slightly acid; gradual wavy boundary.
C—54 to 80 inches; light brown (7.5YR 6/4) and brown (7.5YR 5/4), stratified loamy very fine sand, fine sandy loam, and very fine sandy loam; massive; friable; few fine and medium roots; about 1 percent

gravel; slightly effervescent; moderately alkaline.

The content of gravel ranges from 0 to 5 percent throughout the profile.

Some pedons have an A horizon. This horizon has hue of 7.5YR, value of 2 to 4, and chroma of 1 or 2. It is fine sandy loam, very fine sandy loam, or loamy very fine sand.

The E horizon has hue of 7.5YR or 5YR, value of 5 or 6, and chroma of 1 to 3. It is fine sandy loam, very fine sandy loam, or loamy very fine sand.

The Bs1 horizon has hue of 7.5YR or 5YR and value and chroma of 3 or 4. The Bs2 and Bs3 horizons have hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. The Bs horizons are fine sandy loam, very fine sandy loam, or loamy very fine sand.

The B part of the B/E and E/B horizons has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is very fine sandy loam, fine sandy loam, or silt loam. The E part of these horizons has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. It is loamy fine sand or loamy very fine sand.

The C horizon has hue of 5YR to 10YR, value of 4 to 7, and chroma of 2 to 4. Textures range from loamy fine sand to silt loam.

## Allendale Series

The Allendale series consists of very deep, somewhat poorly drained soils on lake plains, outwash plains, and ground moraines. These soils formed in sandy sediments and in the underlying clayey lacustrine or till deposits. Permeability is rapid in the upper sandy part and very slow in the lower clayey part. Slopes range from 0 to 3 percent.

Typical pedon of Allendale fine sand, 0 to 3 percent slopes, 540 feet east and 640 feet south of the northwest corner of sec. 20, T. 43 N., R. 2 W.

Oe—0 to 2 inches; partially decomposed leaf litter.

A—2 to 3 inches; black (10YR 2/1) fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; many fine and medium roots; very strongly acid; abrupt wavy boundary.

E—3 to 7 inches; brown (7.5YR 5/2) fine sand, pinkish gray (7.5YR 7/2) dry; single grain; loose; common fine roots; strongly acid; abrupt wavy boundary.

Bhs—7 to 9 inches; dark reddish brown (5YR 3/3) fine sand; single grain; loose; many fine roots; few fine distinct yellowish red (5YR 5/8) iron accumulations; ortstein makes up 25 percent of the horizon and occurs as weakly cemented chunks; strongly acid; clear wavy boundary.

Bs—9 to 23 inches; yellowish brown (10YR 5/6) fine sand; single grain; loose; common fine roots; common medium prominent yellowish red (5YR 5/8) iron accumulations; ortstein makes up 25 percent of the horizon and occurs as weakly cemented chunks; slightly acid; clear wavy boundary.

E'—23 to 29 inches; pale brown (10YR 6/3) fine sand, very pale brown (10YR 7/3) dry; single grain; loose; few fine roots; common fine distinct brownish yellow (10YR 6/6) iron accumulations; neutral; abrupt wavy boundary.

2Bt—29 to 37 inches; light reddish brown (5YR 6/3) silty clay; many reddish brown (5YR 5/3) clay flows on faces of peds; moderate very coarse angular blocky structure; firm; few fine roots; common fine faint yellowish red (5YR 5/6) iron accumulations; moderately alkaline; gradual wavy boundary.

2C—37 to 80 inches; light reddish brown (5YR 6/3) silty clay; moderate coarse angular blocky structure; firm; strongly effervescent; moderately alkaline.

The upper part of the profile is fine sand, sand, or loamy sand. The lower part is silty clay or clay.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 1 or 2.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. The Bs horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6.

The E' horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 2 or 3.

The 2Bt horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 3 or 4.

The 2C horizon has hue of 7.5YR to 2.5YR, value of 4 to 6, and chroma of 3 or 4.

## Alpena Series

The Alpena series consists of very deep, excessively drained soils on lake beaches. These soils formed in loamy and gravelly deposits. Permeability is very rapid. Slopes range from 0 to 15 percent.

Typical pedon of Alpena gravelly loam, 0 to 15 percent slopes, in an area where the slope is 2 percent; in an unsectionalized area 900 feet north of U.S. Highway 2 and 3,500 feet west of Interstate Highway 75, T. 40 N., R. 4 W.

A—0 to 5 inches; very dark grayish brown (10YR 3/2) gravelly loam, dark grayish brown (10YR 4/2) dry; strong medium granular structure; friable; many fine to coarse roots; about 15 percent gravel and 2 percent cobbles; slightly alkaline; gradual wavy boundary.

Bw—5 to 10 inches; dark yellowish brown (10YR 4/4) extremely gravelly loam; moderate fine granular structure; friable; common coarse to fine roots;

about 65 percent gravel and 2 percent cobbles; slightly alkaline; gradual wavy boundary.
C1—10 to 25 inches; light yellowish brown (10YR 6/4) very gravelly coarse sand; single grain; loose; few medium and fine roots; about 50 percent gravel and 10 percent cobbles; slightly alkaline; gradual wavy boundary.
C2—25 to 60 inches; very pale brown (10YR 7/3) very gravelly coarse sand; single grain; loose; about 50 percent gravel and 10 percent cobbles; slightly effervescent; slightly alkaline.

The content of gravel ranges from 10 to 75 percent in the solum and from 35 to 80 percent in the C horizon. The content of cobbles ranges from 0 to 10 percent throughout the profile.

Some pedons have a thin layer of leaf litter. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is sandy loam, loam, or the gravelly or very gravelly analogs of these textures.

The Bw horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is sandy loam, fine sandy loam, loam, or the gravelly, very gravelly, extremely gravelly, cobbly, or very cobbly analogs of these textures.

The C horizon has hue of 10YR, value of 5 to 7, and chroma of 3 or 4. It is stratified sand and coarse sand or the very gravelly or extremely gravelly analogs of these textures.

## Amadon Series

The Amadon series consists of shallow, well drained soils on bedrock-controlled ground moraines and bedrock benches. These soils formed in loamy glacial till deposits overlying limestone bedrock. Permeability is moderate. Slopes range from 0 to 45 percent.

Typical pedon of Amadon sandy loam, in an area of Amadon-Longrie sandy loams, 1 to 6 percent slopes, rocky; in an area where the slope is 1 percent; 1,800 feet south and 50 feet east of the northwest corner of sec. 27, T. 42 N., R. 11 W.

Oe—0 to 2 inches; partially decomposed leaf litter.
E—2 to 8 inches; pinkish gray (7.5YR 6/2) sandy loam, pinkish gray (10YR 7/2) dry; weak medium subangular blocky structure; very friable; many fine to coarse roots; about 2 percent gravel; moderately acid; clear smooth boundary.
Bhs—8 to 10 inches; dark reddish brown (5YR 3/2) fine sandy loam; moderate medium subangular blocky structure; friable; many fine to coarse roots; about 2 percent gravel; moderately acid; clear smooth boundary.
Bs—10 to 15 inches; dark brown (7.5YR 3/4) fine sandy loam; moderate medium subangular blocky structure; friable; many fine to coarse roots; about 2 percent gravel; moderately acid; clear smooth boundary.
2R—15 inches; fractured, hard limestone bedrock.

The depth to limestone ranges from 10 to 20 inches. The content of cobbles and channers ranges from 0 to 20 percent throughout the profile. The content of gravel ranges from 1 to 14 percent throughout the profile. The profile is sandy loam, fine sandy loam, silt loam, or the cobbly or channery analogs of these textures.

Some pedons have an A horizon. This horizon has hue of 10YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2.

The E horizon has hue of 7.5YR or 5YR, value of 5 or 6, and chroma of 1 or 2.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. The Bs horizon has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 3 to 6.

## Angelica Series

The Angelica series consists of very deep, poorly drained soils in depressional areas on ground moraines. These soils formed in loamy glacial till deposits. Permeability is moderately slow. Slopes range from 0 to 2 percent.

Typical pedon of Angelica muck, 2,475 feet east and 2,145 feet north of the southwest corner of sec. 29, T. 42 N., R. 4 W.

Oa—0 to 2 inches; black (10YR 2/1) muck; weak medium subangular blocky structure; friable; many fine to coarse roots; slightly acid; abrupt smooth boundary.
A—2 to 4 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; many fine to coarse roots; slightly acid; abrupt wavy boundary.
Bg—4 to 7 inches; dark gray (10YR 4/1) loam; moderate fine subangular blocky structure; friable; common fine and medium roots; few medium distinct dark brown (10YR 4/3) iron accumulations; about 5 percent gravel; neutral; abrupt wavy boundary.
Bw1—7 to 12 inches; brown (7.5YR 4/4) clay loam; moderate fine angular blocky structure parting to moderate thin platy; friable; few fine roots; many fine distinct strong brown (7.5YR 5/6) iron accumulations; about 5 percent gravel; neutral; clear wavy boundary.
Bw2—12 to 17 inches; reddish brown (5YR 5/4) clay loam; moderate fine subangular blocky structure parting to moderate thin platy; friable; few very fine

roots; many fine distinct yellowish red (5YR 5/6) iron accumulations; about 5 percent gravel; slightly alkaline; clear wavy boundary.

C—17 to 60 inches; light reddish brown (5YR 6/3) loam; moderate medium platy structure; friable; light greenish gray (5GY 7/1) silt coatings on faces of peds; about 5 percent gravel; slightly effervescent; moderately alkaline.

The content of gravel ranges from 0 to 10 percent in the solum and from 1 to 25 percent in the substratum.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or silt loam.

The Bg horizon has hue of 7.5YR, 10YR, or 5Y, value of 4 to 6, and chroma of 1 or 2. It is sandy loam or loam. The Bw horizon has hue of 7.5YR or 5YR, value of 4 to 6, and chroma of 3 or 4. It is loam, clay loam, or sandy clay loam.

The C horizon has hue of 7.5YR or 5YR, value of 5 or 6, and chroma of 2 to 4. It is loam or gravelly loam.

## Aquents

Aquents consist of very poorly drained soils on lake plains, outwash plains, and moraines. These soils formed in sandy to clayey glaciofluvial material. Permeability is rapid to slow. Slopes are 0 to 1 percent.

Typically, the surface layer is black (10YR 2/1) muck or mucky peat 3 to 16 inches thick. The upper part of the mineral layers has hue of 10YR, 2.5Y, or 5Y, value of 5 or 6, and chroma of 1 or 2. The lower part has hue of 5YR to 5Y, value of 5 or 6, and chroma of 1 to 3.

The mineral layers range from sand to clay.

## Battydoe Series

The Battydoe series consists of very deep, well drained soils on ground moraines and drumlins. These soils formed in loamy glacial till deposits. Permeability is moderate. Slopes range from 1 to 35 percent.

Typical pedon of Battydoe fine sandy loam, in an area of Longrie-Battydoe, stony, complex, 1 to 6 percent slopes; in an area where the slope is 1 percent; 1,200 feet south and 175 feet west of the northeast corner of sec. 28, T. 42 N., R. 11 W.

Oe—0 to 1 inch; black (5YR 2/1), partially decomposed leaf litter.

A—1 to 3 inches; black (5YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; many fine to coarse roots; about 3 percent gravel and 10 percent cobbles; strongly acid; abrupt smooth boundary.

E—3 to 5 inches; reddish gray (5YR 5/2) loamy sand, gray (5YR 6/1) dry; moderate medium and fine subangular blocky structure; friable; common fine to coarse roots; about 3 percent gravel and 10 percent cobbles; strongly acid; abrupt irregular boundary.

Bhs—5 to 11 inches; dark reddish brown (5YR 3/3) fine sandy loam; weak medium and fine subangular blocky structure; friable; common fine to coarse roots; ortstein makes up 30 percent of the horizon and occurs as weakly cemented chunks; about 3 percent gravel and 10 percent cobbles; strongly acid; clear irregular boundary.

Bs—11 to 20 inches; reddish brown (5YR 4/4) loamy sand; weak medium and fine subangular blocky structure; friable; common fine to coarse roots; about 3 percent gravel and 10 percent cobbles; slightly acid; clear wavy boundary.

BC—20 to 28 inches; brown (7.5YR 5/4) gravelly fine sandy loam; moderate medium subangular blocky structure; friable; few fine roots; about 10 percent gravel and 10 percent cobbles; strongly effervescent in places; neutral; clear irregular boundary.

C—28 to 80 inches; light brown (7.5YR 6/4) gravelly fine sandy loam; massive; friable; about 10 percent gravel and 10 percent cobbles; strongly effervescent; slightly alkaline.

The content of gravel ranges from 1 to 10 percent in the solum and from 10 to 35 percent in the substratum. The content of cobbles ranges from 5 to 15 percent throughout the profile, and the content of stones ranges from 0 to 10 percent.

The A horizon has hue of 5YR to 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 3. It is fine sandy loam, loam, sandy loam, or the cobbly analogs of these textures.

The E horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 2. It is loamy sand, sandy loam, fine sandy loam, or the cobbly analogs of these textures.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. It is fine sandy loam, sandy loam, or the cobbly analogs of these textures.

The Bs horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4. It is loamy sand, sandy loam, fine sandy loam, or the cobbly analogs of these textures.

The BC horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4. It is sandy loam, fine sandy loam, or the gravelly or cobbly analogs of these textures.

The C horizon has hue of 5YR or 7.5YR, value of 5 to 7, and chroma of 3 or 4. It is gravelly sandy loam or gravelly fine sandy loam.

## Beavertail Series

The Beavertail series consists of very deep, very poorly drained soils on ground moraines. These soils formed in very gravelly, loamy glacial till deposits and are shallow to dense till. Permeability is very slow. Slopes range from 0 to 2 percent.

Typical pedon of Beavertail muck, 1,450 feet east and 50 feet north of the southwest corner of sec. 7, T. 42 N., R. 1 E.

Oa—0 to 9 inches; muck, black (N 2/0) broken face and rubbed; 10 percent cobbles; slightly alkaline; clear smooth boundary.

Bw—9 to 13 inches; yellowish brown (10YR 5/4) very gravelly sandy loam; moderate medium subangular blocky structure; very friable; few fine to coarse roots; about 25 percent gravel and 10 percent cobbles; slightly effervescent; moderately alkaline; abrupt smooth boundary.

Cd1—13 to 28 inches; light brown (7.5YR 6/4) very gravelly sandy loam; moderate medium platy structure; firm; moderate medium distinct strong brown (7.5YR 5/8) iron accumulations; about 25 percent gravel and 10 percent cobbles; strongly effervescent; moderately alkaline; clear wavy boundary.

Cd2—28 to 60 inches; pinkish gray (7.5YR 6/2) very gravelly sandy loam; moderate medium platy structure; firm; about 30 percent gravel and 10 percent cobbles; strongly effervescent; moderately alkaline.

The thickness of the muck surface layer ranges from 8 to 10 inches. The surface layer has up to 10 percent rock fragments. The Bw and C horizons have 25 to 45 percent gravel and 5 to 15 percent cobbles and stones.

Some pedons have an A horizon. This horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is 2 to 4 inches thick.

The Bw and Cd horizons have hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 to 4. They are very gravelly sandy loam or very gravelly fine sandy loam.

## Borgstrom Series

The Borgstrom series consists of very deep, moderately well drained soils on outwash plains and lake plains. These soils formed in sandy outwash deposits underlain by loamy lacustrine material. Permeability is moderate or moderately rapid in the ortstein layer, rapid in the rest of the upper sandy part, and moderately slow in the lower loamy part. Slopes range from 0 to 6 percent.

Typical pedon of Borgstrom sand, 0 to 6 percent slopes, in an area where the slope is 2 percent, 2,640 feet north and 330 feet west of the southeast corner of sec. 19, T. 43 N., R. 8 W.

Oi—2 inches to 0; slightly decomposed leaf litter.

Oa—0 to 2 inches; black (N 2/0), well decomposed leaf litter; weak medium granular structure; friable; many fine to coarse roots; extremely acid; abrupt smooth boundary.

E—2 to 9 inches; pinkish gray (5YR 6/2) sand, pinkish gray (5YR 7/2) dry; weak fine subangular blocky structure; very friable; many fine to coarse roots; very strongly acid; abrupt wavy boundary.

Bhsm—9 to 11 inches; dark reddish brown (5YR 2/2 and 3/3) sand; massive; very hard; ortstein makes up 100 percent of the horizon and is strongly cemented; ortstein occurs as a continuous layer with tongues that extend to a depth of 20 inches; common fine to coarse roots; very strongly acid; clear wavy boundary.

Bsm—11 to 21 inches; mixed brown (7.5YR 4/4) (80 percent) and dark brown (7.5YR 3/3) sand; massive; very hard; ortstein makes up 100 percent of the horizon and is strongly cemented; ortstein occurs as a continuous layer; few fine roots; strongly acid; clear wavy boundary.

BC—21 to 29 inches; yellowish brown (10YR 5/6) sand; very weak fine subangular blocky structure; very friable; strongly acid; abrupt smooth boundary.

2C1—29 to 59 inches; stratified pale brown (10YR 6/3), reddish brown (5YR 4/4), and pinkish gray (5YR 6/2) fine sand, silt loam, and very fine sand; massive parting to weak thin platy fragments; friable; common coarse distinct brownish yellow (10YR 6/6) and common coarse prominent strong brown (7.5YR 5/6) iron accumulations; moderately acid; clear wavy boundary.

2C2—59 to 80 inches; brown (10YR 5/3) silt loam; massive parting to weak thin platy structure; friable; common coarse prominent strong brown (7.5YR 5/6) and reddish brown (5YR 5/4) iron accumulations; slightly effervescent; slightly alkaline.

Depth to the loamy substratum ranges from 20 to 40 inches. The content of coarse fragments ranges from 0 to 5 percent throughout the profile. The solum is sand or fine sand.

The E horizon has hue of 10YR to 5YR, value of 4 to 6, and chroma of 1 or 2. Some pedons have a thin A horizon.

The Bhsm horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. The Bsm horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6.

Pedons with 50 to 90 percent ortstein have Bhs and Bs horizons. The Bhs horizon has colors similar to those of the Bhsm horizon, and the Bs horizon has colors similar to those of the Bsm horizon.

The 2C horizon has hue of 10YR to 5YR, value of 4 to 6, and chroma of 2 to 6. Textures include fine sand, very fine sand, and silt loam and few strata of loamy fine sand, loamy very fine sand, fine sandy loam, very fine sandy loam, and silt.

## Bowers Series

The Bowers series consists of very deep, somewhat poorly drained soils on lake plains. These soils formed in stratified, loamy lacustrine deposits. Permeability is slow. Slopes range from 0 to 3 percent.

Typical pedon of Bowers silt loam, 0 to 3 percent slopes, in an area where the slope is 1 percent, 50 feet south and 275 feet west of the northeast corner of sec. 1, T. 43 N., R. 3 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; friable; many fine and medium roots; slightly acid; abrupt smooth boundary.

E—8 to 11 inches; grayish brown (10YR 5/2) silt loam, white (10YR 8/2) dry; moderate medium angular blocky structure; firm; common fine and medium roots; common medium distinct yellowish brown (10YR 5/6) iron accumulations; neutral; clear smooth boundary.

B/E—11 to 14 inches; 85 percent reddish brown (5YR 4/4) silty clay loam (Bt); surrounded by tongues of brown (7.5YR 5/2) silt loam (E), pinkish gray (7.5YR 7/2) dry; strong medium angular blocky structure; firm; few fine and medium roots; common medium distinct strong brown (7.5YR 5/6) iron accumulations; slightly alkaline; clear wavy boundary.

Bt—14 to 22 inches; reddish brown (5YR 4/4) silty clay loam; strong medium angular blocky structure; firm; few medium distinct brown (7.5YR 5/2) and common medium distinct strong brown (7.5YR 5/6) iron accumulations; slightly alkaline; clear smooth boundary.

C—22 to 80 inches; stratified, reddish brown (5YR 5/4) and light reddish brown (5YR 6/4) silt loam, silty clay loam, and silty clay; strong medium platy structure; firm; common medium distinct strong brown (7.5YR 5/6 and 5/8) iron accumulations; common thin gray (5GY 6/1) streaks of lime; strongly effervescent; moderately alkaline.

The Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. It is silt loam.

The E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2. It is silt loam.

The Bt part of the B/E horizon has hue of 5YR, value of 4 or 5, and chroma of 4. It is silty clay loam. The E part of the B/E horizon has colors and textures similar to those of the E horizon. The Bt horizon has colors and textures similar to those of the Bt part of the B/E horizon.

The C horizon has hue of 5YR, value of 5 or 6, and chroma of 2 to 4.

## Caffey Series

The Caffey series consists of very deep, poorly drained and very poorly drained soils on outwash plains, lake plains, and deltas. These soils formed in sandy glaciofluvial deposits and are underlain by loamy and sandy, stratified lacustrine sediments. Permeability is rapid or moderately rapid in the upper sandy part and moderately slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Caffey muck, 50 feet east and 1,650 feet south of the northwest corner of sec. 16, T. 43 N., R. 8 W.

Oa—0 to 6 inches; muck, black (10YR 2/1) broken face and rubbed; about 15 percent fibers, 2 percent rubbed; moderate medium granular structure; friable; many fine to coarse roots; neutral; abrupt smooth boundary.

Bw—6 to 12 inches; brown (10YR 5/3) sand; weak medium subangular blocky structure; very friable; few fine and medium roots; black (10YR 2/1) organic stains along root channels; common medium distinct (10YR 5/6) iron accumulations; slightly alkaline; clear smooth boundary.

Cg—12 to 21 inches; 60 percent grayish brown (10YR 5/2) and 40 percent dark yellowish brown (10YR 4/4), stratified medium and fine sand; massive; friable; common fine distinct yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/6) iron accumulations; moderately alkaline; clear smooth boundary.

2C—21 to 35 inches; brown (10YR 5/3), gray (10YR 5/1), grayish brown (2.5Y 5/2), and light olive brown (2.5Y 5/4), stratified very fine sandy loam and loamy very fine sand; massive; friable; common medium distinct yellowish brown (10YR 5/6) and many medium distinct light olive brown (2.5Y 5/6) iron accumulations; slightly effervescent; moderately alkaline; clear wavy boundary.

2Cg—35 to 80 inches; grayish brown (2.5Y 5/2) very fine sandy loam; massive; friable; violently effervescent; moderately alkaline.

The depth to the loamy stratified material ranges from 18 to 32 inches. The content of gravel ranges from 0 to 1 percent throughout the profile.

The Oa horizon has hue of 10YR or is neutral in hue. It has value of 2 and chroma of 0 or 1.

The Bw horizon has hue of 10YR, value of 4 to 6, and chroma of 2 to 4. It is sand, fine sand, loamy sand, or loamy fine sand.

The Cg horizon has hue of 10YR, value of 5 or 6, and chroma of 1 or 2. It is sand, fine sand, loamy sand, or loamy fine sand.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 4. It is stratified silt, silt loam, fine sandy loam, very fine sandy loam, very fine sand, loamy very fine sand, and loamy fine sand and some strata of fine sand, sand, and silty clay loam. The thickness and sequence of the strata vary widely.

## Carbondale Series

The Carbondale series consists of very deep, very poorly drained soils in depressions on lake plains, ground moraines, and outwash plains. These soils formed in organic material more than 51 inches thick. Permeability is moderately slow to moderately rapid. Slopes range from 0 to 2 percent.

Typical pedon of Carbondale muck, in an area of Markey and Carbondale mucks, 2,600 feet south and 1,250 feet east of the northwest corner of sec. 19, T. 43 N., R. 11 W.

Oa1—0 to 4 inches; muck, black (10YR 2/1) broken face and very dark brown (10YR 2/2) rubbed; about 15 percent fibers, about 5 percent rubbed; moderate medium granular structure; friable; primarily herbaceous material; common fine to coarse roots; moderately acid; clear smooth boundary.

Oa2—4 to 18 inches; muck, black (N 2/0) broken face and rubbed; about 10 percent fibers, about 1 percent rubbed; massive; friable; primarily herbaceous fibers; few medium and coarse roots; moderately acid; clear smooth boundary.

Oe—18 to 35 inches; mucky peat, black (10YR 2/1) broken face and very dark brown (10YR 2/2) rubbed; about 70 percent fibers, about 20 percent rubbed; massive; friable; primarily herbaceous fibers; few fine roots; slightly acid; clear smooth boundary.

O'a—35 to 65 inches; muck, black (N 2/0) broken face and rubbed; about 10 percent fibers, about 1 percent rubbed; massive; friable; primarily herbaceous fibers; neutral.

The thickness of the organic layers is more than 51 inches. The organic material has hue of 10YR, 7.5YR, or 5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. Wood fragments are throughout the profile. More than 10 inches of the subsurface and bottom tiers is hemic material.

## Cozy Series

The Cozy series consists of very deep, moderately well drained soils on ground moraines and drumlins. These soils formed in loamy glacial till deposits. Permeability is moderate in the solum and very slow in the substratum. Slopes range from 0 to 6 percent.

Typical pedon of Cozy cobbly fine sandy loam, 0 to 6 percent slopes, in an area where the slope is 6 percent, 1,100 feet north and 300 feet east of the southwest corner of sec. 10, T. 42 N., R. 11 W.

Oa—0 to 5 inches; black (N 2/0), well decomposed leaf litter; moderate medium granular structure; friable; many fine to coarse roots; about 15 percent cobbles; moderately acid; abrupt wavy boundary.

E—5 to 6 inches; brown (7.5YR 5/2) cobbly fine sandy loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; friable; many fine to coarse roots; about 2 percent gravel and 15 percent cobbles; moderately acid; abrupt broken boundary.

Bhs—6 to 10 inches; dark brown (7.5YR 3/2) cobbly fine sandy loam; weak medium subangular blocky structure; friable; many fine to coarse roots; about 2 percent gravel and 15 percent cobbles; moderately acid; clear irregular boundary.

Bs—10 to 14 inches; dark brown (7.5YR 3/4) cobbly sandy loam; weak fine subangular blocky structure; friable; common fine to coarse roots; about 2 percent gravel and 15 percent cobbles; slightly acid; abrupt irregular boundary.

Cd—14 to 60 inches; light brown (7.5YR 6/3) very gravelly sandy loam; strong thick platy structure; very firm; about 30 percent gravel and 15 percent cobbles; strongly effervescent; slightly alkaline.

Depth to the dense loamy till ranges from 12 to 24 inches. The content of gravel ranges from 1 to 10 percent in the solum and from 25 to 40 percent in the substratum. The content of cobbles ranges from 5 to 20 percent throughout the profile.

The E horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 1 or 2. It is sandy loam, fine sandy loam, loamy fine sand, or the cobbly analogs of these textures.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. It is sandy loam, fine sandy loam, or the cobbly analogs of these textures.

The Bs horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4. It is sandy loam, fine sandy

loam, loamy sand, or the cobbly analogs of these textures.

The Cd horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 3 or 4. It is the very gravelly analogs of sandy loam or fine sandy loam.

## Croswell Series

The Croswell series consists of very deep, moderately well drained soils on low dunes, lake plains, and outwash plains. These soils formed in sandy deposits. Permeability is rapid. Slopes range from 0 to 6 percent.

Typical pedon of Croswell sand, 0 to 6 percent slopes, in an area where the slope is 2 percent, 1,800 feet east and 950 feet north of the southwest corner of sec. 29, T. 44 N., R. 9 W.

Oe—0 to 2 inches; partially decomposed leaf litter.
E—2 to 6 inches; light brownish gray (10YR 6/2) sand, light gray (10YR 7/2) dry; weak fine subangular blocky structure; very friable; common fine and medium roots; very strongly acid; abrupt wavy boundary.
Bs1—6 to 8 inches; dark brown (7.5YR 4/4) sand; weak fine subangular blocky structure; very friable; many fine to coarse roots; strongly acid; clear irregular boundary.
Bs2—8 to 15 inches; strong brown (7.5YR 5/6) sand; weak medium subangular blocky structure; very friable; common medium and fine roots; strongly acid; clear irregular boundary.
BC—15 to 22 inches; brownish yellow (10YR 6/6) sand; single grain; loose; few fine roots; moderately acid; gradual wavy boundary.
C—22 to 80 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; common fine prominent strong brown (7.5YR 5/6) iron accumulations beginning at a depth of 27 inches; moderately acid.

The content of gravel ranges from 0 to 10 percent throughout the profile. The profile is sand throughout.

Some pedons have an A horizon. This horizon has hue of 10YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. The E horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 1 or 2.

The Bs1 horizon has hue of 7.5YR, value of 3 or 4, and chroma of 4. The Bs2 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6.

The C horizon has hue of 10YR, value of 4 to 6, and chroma of 2 to 4.

## Dawson Series

The Dawson series consists of very deep, very poorly drained soils in closed depressions on outwash plains, ground moraines, and lake plains. These soils formed in organic material 16 to 50 inches thick and in the underlying sandy deposits. Permeability is moderately slow to moderately rapid in the organic material and rapid in the sandy material. Slopes range from 0 to 2 percent.

Typical pedon of Dawson peat, in an area of Dawson and Loxley peats, 660 feet east and 660 feet north of the southwest corner of sec. 14, T. 44 N., R. 9 W.

Oi—0 to 5 inches; peat, yellowish brown (10YR 5/4) broken face and dark yellowish brown (10YR 3/4) rubbed; 95 percent sphagnum moss fibers, 30 percent rubbed; weak thick platy structure; friable; common fine and medium roots; extremely acid; abrupt smooth boundary.
Oa—5 to 32 inches; muck, black (5YR 2/1) broken face and rubbed; about 35 percent fibers, about 5 percent rubbed; weak thick platy structure; friable; primarily herbaceous fibers; common fine and medium roots; very strongly acid; abrupt smooth boundary.
2E—32 to 36 inches; grayish brown (10YR 5/2) sand, light gray (10YR 7/1) dry; weak fine subangular blocky structure; friable; strongly acid; abrupt wavy boundary.
2Bhs—36 to 48 inches; dark reddish brown (5YR 3/3) sand; massive; firm; ortstein makes up 40 percent of the horizon and occurs as weakly cemented chunks; very strongly acid; abrupt irregular boundary.
2Bs—48 to 54 inches; strong brown (7.5YR 4/6) sand; weak fine subangular blocky structure; friable; strongly acid; clear wavy boundary.
2C—54 to 60 inches; yellowish brown (10YR 5/6) sand; single grain; loose; strongly acid.

Depth to the sandy material ranges from 16 to 50 inches. Some pedons have thin hemic layers less than 5 inches thick. The mineral layers are sand or fine sand.

The organic material has hue of 10YR to 5YR, value of 2 to 6, and chroma of 1 to 4.

The 2E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3.

The 2Bhs horizon has hue of 7.5YR or 5YR and value and chroma of 2 or 3. The 2Bs horizon has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 4 to 6.

The 2C horizon has hue of 10YR or 7.5YR and value and chroma of 3 to 6.

## Dinkey Series

The Dinkey series consists of very deep, well drained soils on high stream terraces. These soils formed in stratified, sandy alluvium and organic material. Permeability is moderate or moderately rapid. Slopes range from 0 to 6 percent.

Typical pedon of Dinkey muck, 0 to 6 percent slopes, in an area where the slope is 4 percent, 1,300 feet south and 50 feet east of the northwest corner of sec. 12, T. 43 N., R. 6 W.

Oa1—0 to 7 inches; muck, dusky red (10R 3/3) broken face and rubbed; about 5 percent fibers, a trace rubbed; weak fine subangular blocky structure; very friable; many fine roots; strongly effervescent; slightly alkaline; abrupt smooth boundary.

Oa2—7 to 9 inches; muck, black (N 2/0) broken face and rubbed; about 75 percent fibers, 1 percent rubbed; weak thin platy structure; friable; many fine roots; slightly alkaline; abrupt smooth boundary.

C—9 to 28 inches; light yellowish brown (10YR 6/4) fine sand; strata of black (N 2/0) muck and yellowish red (5YR 5/6) mucky fine sand ⅛ to 1 inch thick; massive with weak thin bedding planes; very friable; common fine roots; slightly alkaline; abrupt smooth boundary.

O'a—28 to 33 inches; muck, black (N 2/0) broken face and rubbed; about 25 percent fibers, a trace rubbed; weak medium platy structure; friable; slightly alkaline; abrupt smooth boundary.

C'1—33 to 45 inches; brown (10YR 5/3) fine sand; strata of black (N 2/0) muck and strong brown (7.5YR 4/6) mucky fine sand ⅛ to 1 inch thick; massive with weak thin bedding planes; very friable; common fine prominent strong brown (7.5YR 5/6) iron accumulations (relict redoximorphic features); slightly alkaline; clear wavy boundary.

C'2—45 to 80 inches; brownish yellow (10YR 6/6) sand; strata of black (N 2/0) muck and mucky sand ⅛ to ¼ inch thick; massive with weak thin bedding planes; very friable; common fine prominent strong brown (7.5YR 5/6) iron accumulations (relict redoximorphic features); neutral.

Thickness of the surface organic layers is 8 to 15 inches. The characteristic red color of the surface muck is a result of past fires and oxidation. Ash in the surface layer also accounts for the effervescence and the higher pH.

The organic surface horizons have hue of 10R to 5YR or are neutral in hue. They have value of 2 to 4 and chroma of 0 to 6.

The C horizons have hue of 10YR, value of 5 or 6, and chroma of 3 to 6. They are sand, fine sand, loamy sand, loamy fine sand with thin strata of muck, or the mucky analogs of these textures.

## Dorval Series

The Dorval series consists of very deep, very poorly drained soils in depressional areas and drainageways on lake plains. These soils formed in organic material 16 to 50 inches thick overlying clayey lacustrine materials. Permeability is moderate or moderately rapid in the organic material and very slow in the underlying clayey deposits. Slopes range from 0 to 2 percent.

Typical pedon of Dorval muck, 1,700 feet north and 50 feet east of the southwest corner of sec. 10, T. 43 N., R. 1 W.

Oa1—0 to 4 inches; muck, black (N 2/0) broken face and rubbed and very dark brown (10YR 2/2) pressed; about 45 percent fibers, 5 percent rubbed; weak medium granular structure; friable; many fine and medium roots; neutral; clear wavy boundary.

Oa2—4 to 16 inches; muck, black (N 2/0) broken face, rubbed, and pressed; about 30 percent fibers, 1 percent rubbed; strong coarse subangular blocky structure; friable; common fine and medium roots; slightly alkaline; abrupt smooth boundary.

2Cg—16 to 18 inches; dark gray (10YR 4/1) clay; massive; firm; few fine distinct dark brown (10YR 4/3) iron accumulations; few medium roots; slightly alkaline; clear wavy boundary.

2C—18 to 60 inches; reddish brown (5YR 5/4) clay; massive; firm; few olive gray (5Y 5/2) streaks of lime; moderately alkaline.

Depth to the mineral layers is typically 16 to 30 inches but ranges to 50 inches. The organic material is dominantly sapric material. Some pedons have thin layers of hemic material. The organic layers have hue of 10YR to 5YR or are neutral in hue. They have value of 2 or 3 and chroma of 0 to 2.

The 2Cg horizon has hue of 10YR or 5Y, value of 4 to 6, and chroma of 1 or 2. The 2C horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 3 to 5. The C horizons are clay or silty clay.

## Eastport Series

The Eastport series consists of very deep, excessively drained soils on vegetated beach ridges or stabilized sand dunes. These soils formed in sandy eolian deposits. Permeability is rapid. Slopes range from 0 to 35 percent.

Typical pedon of Eastport sand, in an area of Eastport-Leafriver complex, 0 to 35 percent slopes; in an area where the slope is 10 percent; 1,800 feet north

and 400 feet east of the center of sec. 14, T. 41 N., R. 5 W.

Oi—1 inch to 0; slightly decomposed, mixed hardwood and conifer leaf litter.
A—0 to 3 inches; dark gray (10YR 4/1) sand, pale brown (10YR 6/2) dry; weak medium granular structure; very friable; many medium roots; strongly acid; abrupt smooth boundary.
E—3 to 14 inches; pale brown (10YR 6/3) sand, very pale brown (10YR 7/3) dry; single grain; loose; many medium roots; slightly acid; abrupt irregular boundary.
Bs1—14 to 24 inches; strong brown (7.5YR 5/6) sand; single grain; loose; ortstein makes up 10 percent of the horizon and occurs as weakly cemented chunks; common fine roots; slightly acid; clear wavy boundary.
Bs2—24 to 38 inches; brownish yellow (10YR 6/6) sand; single grain; loose; ortstein makes up 5 percent of the horizon and occurs as weakly cemented chunks; very few very fine roots; slightly acid; gradual wavy boundary.
C—38 to 60 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; neutral.

The content of gravel ranges from 0 to 15 percent. The profile is sand throughout.

The A horizon has hue of 10YR to 5YR or is neutral in hue. It has value of 2 to 4 and chroma of 0 to 2.

The E horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 2 or 3.

The Bs horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 4 to 8.

The C horizon has hue of 10YR or 7.5YR, value of 4 to 7, and chroma of 3 to 6.

## Engadine Series

The Engadine series consists of very deep, somewhat poorly drained soils on lake plains. These soils formed in loamy lacustrine deposits and in the underlying clayey lacustrine sediments. Permeability is moderate in the upper part and very slow in the lower part. Slopes range from 0 to 3 percent.

Typical pedon of Engadine fine sandy loam, 0 to 3 percent slopes, in an area where the slope is 1 percent, 500 feet north and 250 feet east of the southwest corner of sec. 5, T. 43 N., R. 10 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) fine sandy loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; friable; many fine roots; slightly acid; abrupt smooth boundary.
E—9 to 10 inches; grayish brown (10YR 5/2) fine sandy loam, light gray (10YR 7/2) dry; weak fine granular structure; friable; common fine roots; few medium prominent strong brown (7.5YR 5/6) iron accumulations; slightly acid; abrupt broken boundary.
Bhs—10 to 12 inches; dark brown (7.5YR 3/3) fine sandy loam; weak thick platy structure; friable; common fine roots; common medium prominent strong brown (7.5YR 4/6) iron accumulations; moderately acid; clear smooth boundary.
Bs—12 to 14 inches; brown (7.5YR 4/4) sandy loam; weak thick platy structure; friable; common fine roots; common medium distinct strong brown (7.5YR 5/6) iron accumulations; moderately acid; clear smooth boundary.
2B/E—14 to 18 inches; about 70 percent brown (7.5YR 5/4) silty clay loam (Bt); surrounded by brown (10YR 5/3) loamy fine sand (E), very pale brown (10YR 7/3) dry; moderate medium subangular blocky structure; firm; few fine roots; common medium distinct strong brown (7.5YR 5/6) iron accumulations; neutral; clear smooth boundary.
2Bt—18 to 25 inches; reddish brown (2.5YR 5/4) clay; strong medium angular structure; firm; many thin light reddish brown (2.5YR 6/4) clay films on faces of peds; common fine prominent gray (5Y 6/1) iron depletions; slightly alkaline; gradual wavy boundary.
2C—25 to 80 inches; brown (2.5YR 5/4) clay; strong coarse prismatic structure parting to strong medium angular fragments; firm; common thin light gray (10YR 7/1) coatings of calcium carbonate and few thin light reddish brown (2.5YR 6/4) clay films on prism faces; few fine prominent yellowish red (5YR 5/6) iron accumulations; strongly effervescent; moderately alkaline.

Depth to the clayey material ranges from 12 to 32 inches.

The Ap horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 2. The E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. The Ap and E horizons are sandy loam or fine sandy loam.

The Bhs horizon, if it occurs, has hue of 5YR or 7.5YR and value and chroma of 2 or 3. It is sandy loam, fine sandy loam, very fine sandy loam, or loamy fine sand.

The Bs horizon has hue of 7.5YR or 10YR, value of 3 or 4, and chroma of 4. In pedons that do not have a Bhs horizon, the Bs horizon has hue of 7.5YR, value of 3 or 4, and chroma of 4. It is sandy loam, fine sandy loam, very fine sandy loam, or loamy fine sand.

The Bt part of the 2B/E horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4. It has textures

similar to those of the 2Bt horizon. The E part of the 2B/E horizon has colors similar to those of the E horizon. It is loamy fine sand, fine sandy loam, or silt loam.

The 2Bt horizon has hue of 2.5YR to 7.5YR, value of 4 or 5, and chroma of 4. It is clay, silty clay loam, or silty clay.

The 2C horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 3 or 4. It is clay or silty clay.

## Ensign Series

The Ensign series consists of shallow, somewhat poorly drained soils on ground moraines and glacial lake benches. These soils formed in loamy glacial till deposits underlain by limestone bedrock. Permeability is moderate. Slopes range from 0 to 3 percent.

Typical pedon of Ensign fine sandy loam, 0 to 3 percent slopes, rocky, in an area where the slope is 1 percent, 1,750 feet east and 2,200 feet north of the southwest corner of sec. 28, T. 43 N., R. 5 W.

Oe—0 to 1 inch; partially decomposed leaf litter.
A—1 to 5 inches; very dark grayish brown (10YR 3/2) fine sandy loam, gray (10YR 5/1) dry; moderate medium granular structure; friable; many fine to coarse roots; slightly alkaline; clear smooth boundary.
B/A—5 to 8 inches; fine sandy loam, dark yellowish brown (10YR 4/4) (B) and very dark grayish brown (10YR 3/2) (A), light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; friable; many fine to coarse roots; few fine distinct yellowish brown (10YR 5/6) iron accumulations; about 2 percent gravel; slightly alkaline; clear smooth boundary.
Bw—8 to 15 inches; dark brown (10YR 4/3) sandy loam; moderate medium subangular blocky structure; friable; common fine to coarse roots; few medium distinct grayish brown (10YR 5/2) and few fine prominent strong brown (7.5YR 5/6) iron accumulations; about 2 percent gravel; slightly effervescent; slightly alkaline; abrupt smooth boundary.
2R—15 inches; fractured limestone bedrock.

The depth to bedrock ranges from 10 to 20 inches. The content of coarse fragments ranges from 0 to 25 percent throughout the profile. The profile is fine sandy loam, sandy loam, loam, or the gravelly, cobbly, or flaggy analogs of these textures.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2.

The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 3 to 6.

## Ermatinger Series

The Ermatinger series consists of very deep, poorly drained soils on the former flood plains along glacial rivers. These soils formed in stratified, loamy deposits. Permeability is moderate. Slopes range from 0 to 2 percent.

Typical pedon of Ermatinger silt loam, 1,700 feet east and 400 feet north of the southwest corner of sec. 26, T. 47 N., R. 1 E., in Chippewa County, Michigan:

Ap—0 to 8 inches; black (10YR 2/1) silt loam, light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; friable; common medium roots; neutral; clear smooth boundary.
Cg1—8 to 12 inches; grayish brown (2.5Y 5/2) silt loam; moderate medium subangular blocky structure; friable; many fine and medium roots; few fine prominent yellowish brown (10YR 5/6) iron accumulations; common worm channels and some mixing with material from the Ap horizon; neutral; abrupt wavy boundary.
Cg2—12 to 21 inches; gray (10YR 5/1) very fine sandy loam and loamy very fine sand; massive; friable; few fine prominent strong brown (7.5YR 4/6) and few fine prominent yellowish brown (10YR 5/8) iron accumulations in the matrix and in root channels; common fine and medium roots; few fine vesicular pores; common black (N 2/0) organic stains and charcoal fragments; slightly alkaline; clear smooth boundary.
Cg3—21 to 60 inches; brown (7.5YR 5/2) very fine sandy loam and loamy very fine sand; massive; friable; few fine roots in the upper 15 inches; common fine distinct strong brown (7.5YR 4/6) and many medium prominent yellowish brown (10YR 5/4) iron accumulations; few fine vesicular pores; common dark grayish brown (10YR 4/2) organic stains; slightly alkaline.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is silt loam.

The C horizon has hue of 7.5YR to 2.5Y, value of 4 to 6, and chroma of 1 to 4. It is silt loam, loamy very fine sand, or very fine sandy loam. It has organic layers and decaying logs in some pedons.

## Esau Series

The Esau series consists of very deep, somewhat poorly drained soils on low beach ridges. These soils formed in loamy and gravelly deposits. Permeability is very rapid. Slopes range from 0 to 3 percent.

Typical pedon of Esau extremely gravelly sandy loam, in an area of Esau-Zela complex, 0 to 3 percent

slopes; in an area where the slope is 3 percent; 1,800 feet south and 1,550 feet west of the northeast corner of sec. 26, T. 39 N., R. 1 W., on Bois Blanc Island:

Oe—0 to 2 inches; partially decomposed leaf litter.
A—2 to 6 inches; very dark gray (10YR 3/1) extremely gravelly sandy loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; very friable; many medium and coarse roots; about 75 percent gravel; slightly alkaline; clear smooth boundary.
2Bw—6 to 10 inches; yellowish brown (10YR 5/4) extremely gravelly coarse sand; single grain; loose; many fine and medium roots; about 65 percent gravel; slightly alkaline; clear smooth boundary.
2C—10 to 80 inches; brown (10YR 5/3) very gravelly coarse sand; single grain; loose; common coarse roots in the upper part; few fine faint grayish brown (10YR 5/2) iron depletions; about 45 percent gravel; slightly effervescent; moderately alkaline.

The content of rock fragments ranges from 45 to 80 percent throughout the profile.

The A horizon has hue of 10YR, value of 2 to 4, and chroma of 1 or 2. It is extremely gravelly sandy loam or very gravelly sandy loam.

The Bw horizon has hue of 10YR, value of 3 to 5, and chroma of 3 or 4. It is the very gravelly or extremely gravelly analogs of sand or coarse sand.

The C horizon has hue of 10YR, value of 5 to 7, and chroma of 3 to 6. It is the very gravelly or extremely gravelly analogs of sand or coarse sand.

## Finch Series

The Finch series consists of very deep, somewhat poorly drained soils on lake plains and outwash plains. These soils formed in sandy deposits. Permeability is moderate or moderately rapid in the ortstein layer and rapid in the rest of the profile. Slopes range from 0 to 3 percent.

Typical pedon of Finch sand, in an area of Spot-Finch complex, 0 to 3 percent slopes; in an area where the slope is 2 percent; 1,500 feet east of the center of sec. 8, T. 44 N., R. 7 W.

Oe—0 to 1 inch; partially decomposed leaf litter.
E—1 to 11 inches; pinkish gray (10YR 6/2) sand, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; very friable; few fine to coarse roots; strongly acid; clear irregular boundary.
Bsm1—11 to 18 inches; 60 percent dark brown (7.5YR 3/4) and dark reddish brown (7.5YR 3/2) sand; massive; very hard; ortstein makes up 100 percent of the horizon and is strongly cemented; ortstein occurs as a continuous layer and as tongues that extend to a depth of 21 inches; many medium distinct strong brown (7.5YR 5/6) iron accumulations; strongly acid; clear irregular boundary.
Bsm2—18 to 42 inches; splotchy pattern of dark brown (7.5YR 4/4) (60 percent), dark brown (7.5YR 3/4), and brown (7.5YR 5/4) sand; massive; very hard; ortstein makes up 90 percent of the horizon and is strongly cemented; ortstein occurs as a nearly continuous layer; common medium distinct strong brown (7.5YR 5/6) iron accumulations; strongly acid; gradual wavy boundary.
C—42 to 80 inches; yellowish brown (10YR 5/6) fine sand; single grain; loose; moderately acid.

The E horizon has hue of 7.5YR or 5YR, value of 5 to 7, and chroma of 1 or 2. It is sand.

The Bsm horizon has hue of 7.5YR, value of 3 to 5, and chroma of 2 to 6. It has at least 90 percent ortstein. It is sand. Pedons that have 50 to 90 percent ortstein have a Bs horizon, which has colors and textures similar to those of the Bsm horizon.

The C horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2 to 6. It is sand or fine sand.

## Furlong Series

The Furlong series consists of moderately deep, somewhat excessively drained soils on ground moraines and outwash plains. These soils formed in sandy material over limestone bedrock. Permeability is rapid. Slopes range from 0 to 6 percent.

Typical pedon of Furlong sand, 0 to 6 percent slopes, rocky, in an area where the slope is 1 percent, 165 feet east and 2,805 feet south of the northwest corner of sec. 34, T. 43 N., R. 4 W.

Oe—0 to 1 inch; partially decomposed leaf litter.
A—1 to 2 inches; black (10YR 2/1) sand, gray (10YR 5/1) dry; single grain; loose; many very fine and fine roots; very strongly acid; abrupt smooth boundary.
E—2 to 5 inches; pinkish gray (5YR 6/2) sand, pinkish gray (7.5YR 6/2) dry; single grain; loose; many fine to coarse roots; about 5 percent gravel; very strongly acid; abrupt wavy boundary.
Bhs—5 to 7 inches; dark reddish brown (5YR 3/3) sand; single grain; loose; many fine to coarse roots; ortstein makes up 15 percent of the horizon and occurs as weakly cemented chunks; about 5 percent gravel; very strongly acid; abrupt wavy boundary.
Bs1—7 to 13 inches; dark brown (7.5YR 3/4) sand; single grain; loose; common fine and medium roots; ortstein makes up 15 percent of the horizon and occurs as weakly cemented chunks; about 5

percent gravel; very strongly acid; abrupt wavy boundary.
Bs2—13 to 19 inches; reddish brown (5YR 4/3) sand; single grain; loose; few fine roots; ortstein makes up 2 percent of the horizon and occurs as strongly cemented chunks; moderately acid; abrupt wavy boundary.
C—19 to 22 inches; brown (7.5YR 5/4) sand; single grain; loose; very few fine roots; about 5 percent gravel; slightly alkaline; abrupt smooth boundary.
2R—22 inches; fractured, hard limestone bedrock.

The depth to limestone bedrock ranges from 20 to 40 inches. The solum is sand or loamy sand. The content of gravel ranges from 0 to 10 percent.

The A horizon has hue of 10YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 3.

The E horizon has hue of 5YR to 10YR, value of 5 to 7, and chroma of 1 to 3.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 4 to 6.

The C horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 3 to 5.

## Glawe Series

The Glawe series consists of very deep, poorly drained soils on lake plains. These soils formed in stratified, loamy glacial lacustrine deposits. Permeability is moderate. Slopes range from 0 to 2 percent.

Typical pedon of Glawe silt loam, 200 feet east and 2,350 feet south of the northwest corner of sec. 30, T. 43 N., R. 10 W.

Ap—0 to 9 inches; black (N 2/0) silt loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; common fine and medium roots; strong effervescence; moderately alkaline; clear smooth boundary.
Cg—9 to 14 inches; grayish brown (10YR 5/2) silt loam; moderate medium platy structure; friable; few medium and fine roots; common medium distinct yellowish brown (10YR 5/6) iron accumulations; common worm mixings; slightly effervescent; moderately alkaline; abrupt smooth boundary.
C—14 to 80 inches; brown (10YR 5/3) silt loam; strong medium platy structure; friable; many coarse distinct brownish yellow (10YR 6/6) and yellowish brown (10YR 5/8) iron accumulations; strongly effervescent; moderately alkaline.

Textures throughout the profile are very fine sandy loam and silt loam with some strata of loamy very fine sand or silty clay loam.

The Ap horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. Some pedons have an A horizon, which has colors similar to those of the Ap horizon.

The Cg horizon has hue of 10YR, value of 5 or 6, and chroma of 1 or 2. The C horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2 to 4.

## Gogomain Series

The Gogomain series consists of very deep, poorly drained soils on lake plains. These soils formed in loamy and sandy glaciofluvial deposits underlain by clayey lacustrine material. Permeability is moderately rapid in the upper part and very slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Gogomain very fine sandy loam, 1,600 feet north and 1,800 feet west of the southeast corner of sec. 30, T. 44 N., R. 10 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) very fine sandy loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; friable; many fine and medium roots; neutral; abrupt smooth boundary.
Bg—10 to 11 inches; grayish brown (10YR 5/2) loamy very fine sand; moderate medium platy structure; friable; common medium distinct reddish yellow (7.5YR 6/6) iron accumulations; few fine roots; slightly alkaline; abrupt broken boundary.
Bw—11 to 18 inches; brown (10YR 5/3 and 7.5YR 5/4), stratified very fine sandy loam and fine sandy loam; moderate medium platy structure; friable; few fine roots; common medium distinct brownish yellow (10YR 6/6) and many coarse distinct reddish yellow (7.5YR 6/6) iron accumulations; slightly alkaline; abrupt smooth boundary.
2C1—18 to 57 inches; reddish brown (2.5YR 4/4) clay; strong medium prismatic structure parting to strong fine angular blocky; firm; common pinkish gray (5YR 7/2) streaks of lime along ped faces; about 1 percent gravel; strongly effervescent; moderately alkaline; clear smooth boundary.
2C2—57 to 80 inches; reddish brown (5YR 5/3) clay; strong medium platy structure; firm; common greenish gray (5GY 6/1) streaks of lime along ped faces; strongly effervescent; moderately alkaline.

Depth to the clayey material ranges from 18 to 24 inches.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. Some pedons have an A horizon, which has colors similar to those of the Ap horizon. The

A or Ap horizon is very fine sandy loam or silt loam.

The Bg horizon has hue of 10YR, value of 4 to 6, and chroma of 1 or 2. It is loamy very fine sand or very fine sandy loam.

The Bw horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 or 4. It is stratified very fine sandy loam and fine sandy loam.

The 2C horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 2 to 4. It is silty clay or clay.

## Graveraet Series

The Graveraet series consists of very deep, moderately well drained soils on drumlins and ground moraines. These soils formed in loamy glacial till deposits. Permeability is moderate in the upper part of the solum, very slow in the fragipan, slow in the lower part of the solum, and moderate in the substratum. Slopes range from 1 to 15 percent.

Typical pedon of Graveraet fine sandy loam, 1 to 6 percent slopes, 145 feet north and 2,150 feet east of the southwest corner of sec. 27, T. 44 N., R. 12 W.

Oi—1 inch to 0; slightly decomposed leaf litter.

A—0 to 3 inches; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 5/1) dry; moderate coarse granular structure; friable; many fine to coarse roots; strongly acid; abrupt smooth boundary.

E—3 to 6 inches; brown (7.5YR 5/3) fine sandy loam, pinkish gray (7.5YR 6/2) dry; moderate medium subangular blocky structure; friable; common fine to coarse roots; strongly acid; abrupt wavy boundary.

Bhs—6 to 9 inches; dark reddish brown (5YR 3/2) fine sandy loam; weak fine subangular blocky structure; friable; common fine to coarse roots; strongly acid; clear wavy boundary.

Bs—9 to 16 inches; dark brown (7.5YR 4/4) fine sandy loam; moderate thick platy structure; firm; few fine to coarse roots; few fine vesicular pores; few fine distinct strong brown (7.5YR 5/6) iron accumulations; strongly acid; abrupt wavy boundary.

(E/B)x—16 to 32 inches; about 80 percent brown (7.5YR 5/3) loamy sand (Ex), pinkish gray (7.5YR 6/2) dry; surrounding remnants of reddish brown (5YR 5/4) loam (Bt); moderate thick platy structure; firm in place, friable when disturbed; few fine roots; few fine vesicular pores; common faint reddish brown (5YR 4/4) clay films on faces of peds; few fine distinct strong brown (7.5YR 5/6) iron accumulations; about 2 percent gravel; moderately acid; gradual wavy boundary.

B/E—32 to 47 inches; about 80 percent reddish brown (5YR 5/4) sandy clay loam (Bt); common faint reddish brown (5YR 4/4) clay films on faces of peds; surrounded by tongues of brown (7.5YR 5/3) loamy sand (E), pinkish gray (7.5YR 6/2) dry; moderate thick platy structure; firm; few fine roots; about 2 percent gravel; moderately acid; gradual wavy boundary.

Bt—47 to 67 inches; reddish brown (5YR 5/4) sandy clay loam; moderate medium subangular blocky structure; friable; few faint reddish brown (5YR 4/4) clay films on faces of peds; about 5 percent gravel; neutral; gradual wavy boundary.

C—67 to 80 inches; reddish brown (5YR 5/4) sandy loam; massive; friable; about 10 percent gravel; slightly effervescent; slightly alkaline.

The content of cobbles ranges from 0 to 10 percent throughout the profile. The content of gravel ranges from 0 to 10 percent in the solum and from 2 to 15 percent in the substratum.

The A horizon has hue of 7.5YR or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is sandy loam or fine sandy loam.

The E horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 2 or 3. It is sandy loam or fine sandy loam.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. It is fine sandy loam or sandy loam.

The Bs horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4 to 6. It is fine sandy loam or sandy loam.

The E part of the (E/B)x horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. It is loamy sand, loamy fine sand, or sandy loam. The B part has hue of 5YR, value of 4 or 5, and chroma of 4. It is sandy clay loam or loam.

The B part of the B/E horizon has colors and textures similar to those of the B part of the (E/B)x horizon. The E part of the B/E horizon has colors and textures similar to those of the E part of the (E/B)x horizon. Some pedons have a (B/E)x horizon or an E/B horizon.

The Bt horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 4. It is dominantly sandy clay loam or loam, but the range includes sandy loam or fine sandy loam.

The C horizon has hue of 2.5YR or 5YR, value of 5 or 6, and chroma of 3 or 4. It is sandy loam, fine sandy loam, or the gravelly analogs of these textures.

## Greylock Series

The Greylock series consists of very deep, well drained soils on ground moraines, end moraines, and drumlins. These soils formed in loamy glacial till deposits. Permeability is moderate. Slopes range from 1 to 60 percent.

Typical pedon of Greylock fine sandy loam, 1 to 6 percent slopes, in an area where the slope is 6 percent, 100 feet west and 700 feet north of the southeast corner of sec. 10, T. 43 N., R. 4 W.

Oe—0 to 1 inch; partially decomposed leaf litter.
A—1 to 6 inches; black (10YR 2/1) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; friable; many fine to coarse roots; about 2 percent gravel and 1 percent cobbles; moderately acid; clear smooth boundary.
E—6 to 7 inches; reddish gray (5YR 5/2) sandy loam, gray (10YR 6/1) dry; moderate medium subangular blocky structure; friable; many fine to coarse roots; about 2 percent gravel and 1 percent cobbles; moderately acid; abrupt wavy boundary.
Bhs—7 to 9 inches; dark reddish brown (5YR 3/2) fine sandy loam; moderate medium subangular blocky structure; friable; many fine to coarse roots; about 2 percent gravel and 1 percent cobbles; moderately acid; clear wavy boundary.
Bs—9 to 19 inches; dark brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; common fine to coarse roots; about 5 percent gravel and 1 percent cobbles; moderately acid; clear wavy boundary.
E/B—19 to 26 inches; about 70 percent brown (7.5YR 5/2) loamy sand (E), light brownish gray (10YR 6/2) dry; surrounding peds of reddish brown (5YR 4/3) sandy loam (Bt); moderate medium subangular blocky structure; firm; few medium and coarse roots; about 5 percent gravel; slightly acid; gradual wavy boundary.
B/E—26 to 34 inches; about 85 percent reddish brown (5YR 4/3) sandy loam (Bt); few fine reddish brown (5YR 4/3) clay films on faces of peds; surrounded by tongues of reddish brown (5YR 5/3) loamy sand (E), pinkish gray (7.5YR 6/2) dry; moderate medium subangular blocky structure; friable; few fine vesicular pores; few fine roots; about 5 percent gravel; neutral; gradual wavy boundary.
C—34 to 80 inches; brown (7.5YR 5/3) sandy loam; massive; friable; about 10 percent gravel; slightly effervescent; slightly alkaline.

The content of gravel ranges from 2 to 10 percent in the solum and from 5 to 15 percent in the substratum. The content of cobbles ranges from 0 to 10 percent throughout the profile.

The A horizon has hue of 10YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is fine sandy loam or sandy loam. Some pedons have an Ap horizon, which has colors similar to those of the A horizon.

The E horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 1 to 3. It is sandy loam, fine sandy loam, or loamy sand.

The Bhs horizon, if it occurs, has hue of 7.5YR or 5YR and value and chroma of 2 or 3. It is fine sandy loam or sandy loam.

In pedons that do not have a Bhs horizon, the Bs horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4. In pedons that have a Bhs horizon, the Bs horizon has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 4 to 6. It is sandy loam or fine sandy loam.

The E part of the B/E and E/B horizons has hue of 10YR to 5YR, value of 5 or 6, and chroma of 2 or 3. It is loamy sand or sandy loam. The B part of the B/E and E/B horizons has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or fine sandy loam. Some pedons have a Bt horizon.

The C horizon has hue of 7.5YR or 5YR, value of 5 or 6, and chroma of 3 or 4. It is sandy loam, fine sandy loam, or the gravelly analogs of these textures.

## Guardlake Series

The Guardlake series consists of very deep, well drained soils on outwash plains. These soils formed in shallow, loamy glaciofluvial deposits underlain by sand and gravel outwash. Permeability is moderate in the loamy part and very rapid in the substratum. Slopes range from 0 to 35 percent.

Typical pedon of Guardlake fine sandy loam, 0 to 6 percent slopes, in an area where the slope is 4 percent, 340 feet west and 1,540 feet north of the southeast corner of sec. 20, T. 43 N., R. 3 W.

Oi—1 inch to 0; slightly decomposed leaf litter.
A—0 to 1 inch; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; many fine roots; about 2 percent gravel; strongly acid; abrupt wavy boundary.
E—1 to 3 inches; brown (7.5YR 5/2) fine sandy loam, pinkish gray (7.5YR 6/2) dry; weak medium and coarse granular structure; friable; many fine and medium roots; about 5 percent gravel; strongly acid; abrupt wavy boundary.
Bhs—3 to 12 inches; dark reddish brown (5YR 3/3) fine sandy loam; weak medium granular and weak fine subangular blocky structure; very friable; common medium roots; ortstein makes up 30 percent of the horizon and occurs as weakly cemented chunks; about 5 percent gravel and 1 percent cobbles; moderately acid; abrupt irregular boundary.
2C—12 to 60 inches; light yellowish brown (10YR 6/4) and yellow (10YR 7/6) very gravelly sand; single grain; loose; few fine roots; about 20 percent gravel and 20 percent cobbles; slightly effervescent; moderately alkaline.

Thickness of the loamy cap ranges from 8 to 12 inches. The content of gravel ranges from 0 to 25 percent in the solum and from 30 to 50 percent in the substratum. The content of cobbles ranges from 0 to 7 percent in the solum and from 10 to 30 percent in the substratum.

The A horizon has hue of 10YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is sandy loam, fine sandy loam, loam, or the gravelly analogs of these textures.

The E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2. It is sandy loam, fine sandy loam, loam, or the gravelly analogs of these textures.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. It is sandy loam, fine sandy loam, loam, or the gravelly analogs of these textures. Some pedons have a Bs horizon, which has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4.

The 2C horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 3 to 6. It is the very gravelly or very cobbly analogs of sand or coarse sand.

## Heinz Series

The Heinz series consists of very deep, moderately well drained soils on outwash plains and ground moraines. These soils formed in loamy glaciofluvial deposits underlain by glacial outwash. Permeability is moderately rapid in the loamy upper part and very rapid in the lower part. Slopes range from 0 to 6 percent.

Typical pedon of Heinz sandy loam, 0 to 6 percent slopes, in an area where the slope is 2 percent, 1,800 feet east and 50 feet south of the northwest corner of sec. 30, T. 43 N., R. 12 W.

Oa—0 to 1 inch; black (10YR 2/1), well decomposed leaf litter; moderate medium granular structure; friable; many fine to coarse roots; abrupt smooth boundary.

A—1 to 5 inches; black (10YR 2/1) sandy loam, gray (10YR 5/1) dry; moderate medium granular structure; friable; many fine to coarse roots; about 2 percent gravel; strongly acid; clear smooth boundary.

E—5 to 6 inches; pinkish gray (7.5YR 6/2) sandy loam, pinkish gray (7.5YR 7/2) dry; weak medium granular structure; friable; many fine to coarse roots; about 2 percent gravel; strongly acid; abrupt broken boundary.

Bhs—6 to 8 inches; dark reddish brown (5YR 3/2) sandy loam; weak fine subangular blocky structure; friable; many fine to coarse roots; about 2 percent gravel; moderately acid; clear wavy boundary.

Bs1—8 to 18 inches; dark brown (7.5YR 3/4) loamy sand; weak fine subangular blocky structure; very friable; many fine to coarse roots; about 2 percent gravel; moderately acid; clear wavy boundary.

Bs2—18 to 25 inches; dark brown (7.5YR 4/4) sand; weak fine subangular blocky structure; very friable; common fine to medium roots; about 10 percent gravel; slightly acid; clear wavy boundary.

2C1—25 to 31 inches; brown (10YR 5/3) gravelly sand; single grain; loose; about 18 percent gravel and 2 percent cobbles; slightly effervescent; slightly alkaline; clear wavy boundary.

2C2—31 to 80 inches; pale brown (10YR 6/3) very gravelly sand; single grain; loose; about 40 percent gravel and 2 percent cobbles; strongly effervescent; slightly alkaline.

Thickness of the loamy cap ranges from 5 to 15 inches. The content of gravel ranges from 0 to 15 percent in the solum and from 25 to 50 percent in the substratum. The content of cobbles ranges from 0 to 5 percent in the solum and from 1 to 10 percent in the substratum.

The A horizon has hue of 10YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is sandy loam or fine sandy loam.

The E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. It is sandy loam or loamy sand.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. It is sandy loam or fine sandy loam.

The Bs horizon has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 3 or 4. It is loamy sand, sand, or the gravelly analogs of these textures.

The 2C horizon has hue of 10YR, value of 5 or 6, and chroma of 3 or 4. It is gravelly sand or very gravelly sand.

## Histosols

Histosols consist of very poorly drained soils on lake plains, outwash plains, and moraines. These soils formed in organic material. Permeability ranges from moderately rapid to moderately slow. Slopes are 0 to 1 percent.

The thickness of the organic material ranges from 16 to more than 50 inches. The surface horizons are dominantly muck or mucky peat, but the range includes peat. The subsurface horizons are dominantly muck, but in some pedons they are mucky peat.

The organic material typically has hue of 5YR, 7.5YR, or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 3.

The mineral horizons range from sand to clay. They have hue of 5YR to 5Y, value of 5 or 6, and chroma of 1 to 3.

## Ingalls Series

The Ingalls series consists of very deep, somewhat poorly drained soils on lake plains and outwash plains. These soils formed in sandy outwash deposits underlain by stratified, loamy lacustrine sediments. Permeability is rapid in the upper sandy material and moderately slow in the underlying deposits. Slopes range from 0 to 3 percent.

Typical pedon of Ingalls fine sand, 0 to 3 percent slopes, in an area where the slope is 1 percent, 1,485 feet south and 1,320 feet east of the northwest corner of sec. 20, T. 43 N., R. 8 W.

Oa—0 to 2 inches; black (N 2/0), well decomposed leaf litter; abrupt smooth boundary.
E—2 to 8 inches; grayish brown (10YR 5/2) fine sand, gray (10YR 6/1) dry; weak medium subangular blocky structure; very friable; many fine to coarse roots; strongly acid; abrupt wavy boundary.
Bhs—8 to 10 inches; dark brown (7.5YR 3/3) fine sand; common weak medium subangular blocky structure; very friable; ortstein makes up 35 percent of the horizon and occurs as weakly cemented chunks; common fine to coarse roots; medium distinct strong brown (7.5YR 4/6) iron accumulations; moderately acid; clear smooth boundary.
Bs—10 to 20 inches; dark brown (7.5YR 4/4) fine sand; weak medium subangular blocky structure; very friable; common fine and medium roots; common medium faint strong brown (7.5YR 5/6) iron accumulations; moderately acid; clear wavy boundary.
2C1—20 to 27 inches; light yellowish brown (10YR 6/4), stratified loamy very fine sand, silt loam, and very fine sand; massive; friable; common coarse distinct yellowish brown (10YR 5/8) iron accumulations; neutral; gradual wavy boundary.
2C2—27 to 60 inches; pale brown (10YR 6/3) and light brown (7.5YR 6/3), stratified silt loam, loamy very fine sand, and very fine sand; massive; friable; yellowish brown (10YR 5/6) iron accumulations; strongly effervescent; moderately alkaline.

Depth to the loamy material ranges from 18 to 30 inches. The solum is fine sand, sand, or loamy sand.

The E horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 1 to 3. Some pedons have a thin A horizon.

The Bhs horizon has hue of 7.5YR and value and chroma of 2 or 3. The Bs horizon has hue of 7.5YR, value of 3 to 5, and chroma of 4 to 6.

The 2C horizon has hue of 10YR to 5YR, value of 5 to 7, and chroma of 2 to 4.

## Iosco Series

The Iosco series consists of very deep, somewhat poorly drained soils on outwash plains and ground moraines. These soils formed in sandy lacustrine or outwash deposits and in the underlying loamy lacustrine or glacial till material. Permeability is rapid in the sandy upper part and moderate in the loamy lower part. Slopes range from 0 to 3 percent.

Typical pedon of Iosco sand, 0 to 3 percent slopes, 660 feet south and 825 feet west of the northeast corner of sec. 27, T. 42 N., R. 5 W.

Oe—0 to 2 inches; partially decomposed leaf litter.
Oa—2 to 6 inches; black (N 2/0), well decomposed leaf litter; weak medium and fine granular structure; very friable; many medium and fine roots; strongly acid; clear wavy boundary.
E1—6 to 9 inches; dark grayish brown (10YR 4/2) sand, light brownish gray (10YR 6/2) dry; weak fine granular structure; very friable; few fine and medium roots; very few fine distinct yellowish brown (10YR 5/4) iron accumulations; strongly acid; clear wavy boundary.
E2—9 to 11 inches; brown (10YR 4/3) sand, pale brown (10YR 6/3) dry; weak fine granular structure; very friable; few fine and medium roots; very few fine faint brown (10YR 5/3) iron accumulations; moderately acid; clear wavy boundary.
Bs1—11 to 25 inches; dark brown (7.5YR 4/4) loamy sand; weak fine subangular blocky structure; friable; ortstein makes up 35 percent of horizon and occurs as weakly cemented chunks; few fine roots; moderately acid; gradual wavy boundary.
Bs2—25 to 27 inches; yellowish brown (10YR 5/4) sand; single grain; loose; few fine roots; fine distinct dark yellowish brown (10YR 4/6) iron accumulations; slightly acid; abrupt wavy boundary.
2Bt—27 to 38 inches; reddish brown (5YR 5/3) loam; moderate medium subangular blocky structure; friable; common thin clay films on faces of peds; few fine distinct reddish yellow (5YR 6/6) iron accumulations; about 10 percent gravel and less than 5 percent cobbles; slightly alkaline; gradual wavy boundary.
2C—38 to 60 inches; light brown (7.5YR 6/4) loam; massive; friable; about 3 percent gravel and 3 percent cobbles; slightly effervescent; moderately alkaline.

Depth to the loamy material ranges from 21 to 36 inches. The content of gravel ranges from 0 to 15 percent throughout the profile, and the content of cobbles ranges from 0 to 5 percent.

Some pedons have an A horizon, which has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 or 3. The Bs1 horizon has hue of 7.5YR, value of 3 or 4, and chroma of 4. The Bs2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. The A, E, and Bs horizons are sand, fine sand, or loamy sand.

The 2Bt horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 to 5. It is loam, sandy loam, or the gravelly analogs of these textures.

The 2C horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 3 or 4. It is loam, fine sandy loam, or the gravelly analogs of these textures.

## Johnswood Series

The Johnswood series consists of very deep, moderately well drained soils on ground moraines. These soils formed in loamy deposits and are shallow to dense glacial till. Permeability is slow. Slopes range from 2 to 6 percent.

Typical pedon of Johnswood cobbly silt loam, 2 to 6 percent slopes, 2,000 feet north and 1,900 feet east of the southwest corner of sec. 24, T. 42 N., R. 2 W.

Oi—0 to 1 inch; slightly decomposed leaf litter.
A1—1 to 3 inches; black (10YR 2/1) cobbly silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; friable; many fine and medium roots; about 3 percent gravel and 15 percent cobbles; neutral; clear wavy boundary.
A2—3 to 7 inches; dark brown (7.5YR 3/2) cobbly silt loam, dark brown (10YR 4/2) dry; moderate medium subangular blocky structure; friable; many fine and medium roots; about 3 percent gravel and 15 percent cobbles; slightly acid; gradual wavy boundary.
Bt—7 to 13 inches; brown (7.5YR 4/4) very cobbly silt loam; moderate medium subangular blocky structure; friable; common medium and fine roots; few faint clay films on faces of peds; about 20 percent gravel and 25 percent cobbles; slightly alkaline; clear wavy boundary.
Cd—13 to 60 inches; pale brown (10YR 6/3) very gravelly loam; moderate thick platy structure; firm; about 35 percent gravel and 10 percent cobbles; slightly effervescent; moderately alkaline.

Depth to the dense till ranges from 12 to 18 inches. The content of gravel ranges from 5 to 15 percent in the A horizon and from 5 to 35 percent in the rest of the profile. The content of cobbles ranges from 15 to 35 percent in the A or A/B horizon and from 5 to 25 percent in the rest of the pedon.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. It is cobbly loam or cobbly silt loam.

The Bt horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 4 to 6. It is the very cobbly or very gravelly analogs of loam or silt loam.

The Cd horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 or 4. It is the very gravelly or very cobbly analogs of loam or fine sandy loam.

## Kalkaska Series

The Kalkaska series consists of very deep, somewhat excessively drained soils on outwash plains and ground moraines. These soils formed in sandy deposits. Permeability is rapid. Slopes range from 0 to 60 percent.

Typical pedon of Kalkaska sand, 0 to 6 percent slopes, in an area where the slope is 1 percent, 1,320 feet west and 2,145 feet south of the northeast corner of sec. 9, T. 43 N., R. 7 W.

Oe—0 to 1 inch; partially decomposed leaf litter.
E—1 to 6 inches; brown (7.5YR 5/2) sand, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; very friable; common fine to coarse roots; very strongly acid; abrupt irregular boundary.
Bhs—6 to 9 inches; dark reddish brown (5YR 3/2) sand; very weak fine subangular blocky structure; very friable; common fine to coarse roots; very strongly acid; abrupt irregular boundary.
Bs—9 to 18 inches; dark brown (7.5YR 3/4) sand; weak fine subangular blocky structure; very friable; ortstein makes up 20 percent of the horizon and occurs as weakly cemented chunks; common fine to coarse roots; strongly acid; clear wavy boundary.
BC—18 to 38 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; few fine and medium roots; strongly acid; about 2 percent gravel; clear wavy boundary.
C—38 to 80 inches; yellowish brown (10YR 5/4) sand; single grain; loose; slightly acid.

The content of gravel ranges from 0 to 10 percent throughout the profile. The profile is sand throughout.

The E horizon has hue of 7.5YR or 5YR, value of 5 or 6, and chroma of 1 or 2.

The Bhs horizon has hue of 7.5YR or 5YR and value and chroma of 2 or 3. The Bs horizon has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 4 to 6.

The C horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 3 to 6.

## Leafriver Series

The Leafriver series consists of very deep, very poorly drained soils on outwash plains and lake plains. These soils formed in a thin organic mantle and sandy outwash or lacustrine deposits. Permeability is moderate or moderately rapid in the organic material and rapid in the sandy sediments. Slopes range from 0 to 2 percent.

Typical pedon of Leafriver mucky peat, 3,135 feet south and 990 feet west of the northeast corner of sec. 9, T. 42 N., R. 3 W.

Oe—0 to 2 inches; black (N 2/0) mucky peat; massive; friable; slightly acid; clear smooth boundary.
Oa—2 to 8 inches; black (5YR 2/1) muck; massive; friable; many fine to coarse roots; slightly acid; clear smooth boundary.
A—8 to 10 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; many fine to coarse roots; few fine prominent yellowish brown (10YR 5/6) iron accumulations; slightly acid; abrupt wavy boundary.
Cg1—10 to 23 inches; grayish brown (10YR 5/2) fine sand; single grain; loose; common coarse to fine roots; few fine distinct brownish yellow (10YR 6/8) iron accumulations; neutral; gradual wavy boundary.
Cg2—23 to 39 inches; grayish brown (10YR 5/2) fine sand; single grain; loose; few fine roots; few fine distinct yellowish brown (10YR 5/8) iron accumulations; neutral; gradual smooth boundary.
Cg3—39 to 60 inches; dark grayish brown (10YR 4/2) fine sand; single grain; loose; few fine distinct dark yellowish brown (10YR 4/6) iron accumulations; 5 percent gravel; neutral.

The O horizons have hue of 10YR or are neutral in hue. They have value of 2 and chroma of 0 to 2.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is loamy fine sand, fine sand, or the mucky analogs of these textures.

The Cg horizon has hue of 10YR, value of 4 to 6, and chroma of 1 or 2. It is fine sand, sand, loamy sand, or coarse sand. The content of gravel ranges from 0 to 10 percent.

## Longrie Series

The Longrie series consists of moderately deep, well drained soils on bedrock-controlled ground moraines and lake benches. These soils formed in loamy glacial till deposits underlain by limestone bedrock. Permeability is moderate. Slopes range from 0 to 15 percent.

Typical pedon of Longrie sandy loam, in an area of Amadon-Longrie sandy loams, 1 to 6 percent slopes; in an area where the slope is 1 percent; 1,550 feet south and 150 feet west of the northeast corner of sec. 28, T. 42 N., R. 11 W.

Oe—0 to 1 inch; partially decomposed leaf litter.
Oa—1 to 2 inches; well decomposed leaf litter.
E—2 to 6 inches; reddish gray (5YR 5/2) sandy loam, light gray (5YR 7/1) dry; moderate medium subangular blocky structure; friable; common fine to coarse roots; about 2 percent gravel and 3 percent cobbles; moderately acid; abrupt irregular boundary.
Bhs—6 to 8 inches; dark reddish brown (5YR 3/3) fine sandy loam; weak medium subangular blocky structure; friable; many fine to coarse roots; ortstein makes up about 30 percent of the horizon and occurs as moderately cemented chunks; about 2 percent gravel and 3 percent cobbles; moderately acid; clear irregular boundary.
Bs—8 to 23 inches; dark brown (7.5YR 4/4) fine sandy loam; weak medium subangular blocky structure; friable; common fine to coarse roots; ortstein makes up about 30 percent of the horizon and occurs as moderately cemented chunks; about 2 percent gravel and 3 percent cobbles; slightly acid; clear wavy boundary.
C—23 to 36 inches; brown (7.5YR 5/4) sandy loam; moderate medium subangular blocky structure; friable; few fine roots; about 10 percent gravel and 3 percent cobbles; slightly effervescent; slightly alkaline; abrupt smooth boundary.
2R—36 inches; fractured, hard limestone bedrock.

The depth to bedrock ranges from 20 to 40 inches. The content of gravel ranges from 0 to 15 percent throughout the profile, and the content of cobbles ranges from 0 to 10 percent.

Some pedons have an A horizon. This horizon has hue of 5YR to 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. The E horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2. The E horizon and the A horizon, if it occurs, are sandy loam, fine sandy loam, or silt loam.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. It is fine sandy loam, sandy loam, or silt loam. The Bs horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is fine sandy loam, sandy loam, or silt loam.

The C horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 3 or 4. It is sandy loam, fine sandy loam, or the gravelly analogs of these textures. Some pedons do not have a C horizon.

## Loxley Series

The Loxley series consists of very deep, very poorly drained soils in closed depressions on outwash plains, ground moraines, and lake plains. These soils formed in organic material more than 51 inches thick. Permeability is moderately slow to moderately rapid.

Typical pedon of Loxley peat, in an area of Dawson and Loxley peats, 1,320 feet east and 50 feet south of the northwest corner of sec. 14, T. 44 N., R. 9 W.

Oi—0 to 8 inches; peat, dark yellowish brown (10YR 4/4) broken face and yellowish brown (10YR 5/4) rubbed; 100 percent sphagnum moss fibers, 95 percent rubbed; weak thick platy structure; friable; common fine and medium roots; extremely acid; abrupt smooth boundary.

Oa1—8 to 15 inches; muck, black (5YR 2/1) broken face and rubbed; about 45 percent fibers, about 5 percent rubbed; weak thick platy structure; friable; primarily herbaceous fibers; common fine and medium roots; very strongly acid; clear smooth boundary.

Oa2—15 to 45 inches; muck, dark reddish brown (5YR 2/2) broken face and rubbed; about 45 percent fibers, about 5 percent rubbed; massive; friable; primarily herbaceous fibers; very strongly acid; clear smooth boundary.

Oa3—45 to 60 inches; muck, dark reddish brown (5YR 2/2) broken face and rubbed; about 55 percent fibers, about 5 percent rubbed; massive; friable; primarily herbaceous fibers; very strongly acid.

The thickness of the organic layers is more than 51 inches. Layers within the control section have hue of 5YR to 10YR, value of 2 to 5, and chroma of 1 to 4. The colors commonly become darker when the soil is exposed to air.

## Manistee Series

The Manistee series consists of very deep, well drained soils on lake plains. These soils formed in sandy lacustrine and outwash deposits and in the underlying clayey lacustrine deposits. Permeability is rapid in the upper sandy part and very slow in the lower clayey part. Slopes range from 0 to 6 percent.

Typical pedon of Manistee sand, 0 to 6 percent slopes, in an area where the slope is 1 percent, 100 feet west of the center of sec. 18, T. 43 N., R. 10 W.

Oe—0 to 1 inch; partially decomposed leaf litter.

E—1 to 10 inches; pinkish gray (7.5YR 6/2) sand, light gray (10YR 7/2) dry; weak medium subangular blocky structure; very friable; few fine to coarse roots; strongly acid; abrupt irregular boundary.

Bs1—10 to 18 inches; dark brown (7.5YR 3/4) sand; weak coarse subangular blocky structure; very friable; ortstein makes up 45 percent of the horizon and occurs as moderately cemented chunks; common fine to coarse roots; moderately acid; gradual wavy boundary.

Bs2—18 to 26 inches; strong brown (7.5YR 4/6) sand; moderate coarse subangular blocky structure; friable; ortstein makes up 45 percent of the horizon and occurs as weakly or moderately cemented chunks; common fine and medium roots; slightly acid; clear smooth boundary.

2B/E—26 to 30 inches; about 55 percent reddish brown (2.5YR 4/4) clay (Bt); surrounded by tongues of dark reddish gray (5YR 4/2) silty clay loam (E), pinkish gray (7.5YR 6/2) dry; common fine reddish brown (2.5YR 4/4) clay films on faces of peds; coarse medium subangular blocky structure; firm; common fine vesicular pores; common fine and medium roots; slightly acid; clear smooth boundary.

2Bt—30 to 36 inches; reddish brown (2.5YR 4/4) clay; strong coarse angular blocky structure; firm; many fine reddish brown (2.5YR 4/4) clay skins on faces of peds; common fine and medium roots; neutral; clear wavy boundary.

2C—36 to 64 inches; reddish brown (2.5YR 5/4) clay that has thin strata of light brown (7.5YR 6/3) silty clay loam and silt loam; massive; firm; few medium roots; strongly effervescent; moderately alkaline.

Depth to the clayey material ranges from 18 to 30 inches. The upper part of the solum is sand, fine sand, or loamy sand.

The E horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. Some pedons have an A horizon.

The Bs1 horizon has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 4. The Bs2 horizon has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 4 to 6.

The B part of the 2B/E horizon has hue of 2.5YR or 5YR and value and chroma of 4 or 5. The E part has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 2 or 3. It is silt loam or silty clay loam.

The 2Bt horizon has colors similar to those of the B part of the 2B/E horizon. The 2Bt horizon is clay.

The 2C horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 3 or 4. It is clay that has thin strata of silty clay loam or silt loam.

## Markey Series

The Markey series consists of very deep, very poorly drained soils in depressions on lake plains, outwash plains, and ground moraines. These soils formed in organic material 16 to 50 inches thick over sandy

deposits. Permeability is moderately slow to moderately rapid in the organic material and rapid in the underlying sandy material.

Typical pedon of Markey muck, in an area of Markey and Carbondale mucks, 914 feet west and 100 feet north of the southeast corner of sec. 13, T. 42 N., R. 6 W.

Oa1—0 to 4 inches; muck, black (N 2/0) broken face and rubbed; about 20 percent fiber, 5 percent rubbed; moderate medium granular structure; very friable; common fine and medium roots throughout; primarily herbaceous fibers; slightly acid; clear smooth boundary.

Oa2—4 to 18 inches; muck, black (10YR 2/1) broken face and rubbed; about 20 percent fibers, about 5 percent rubbed; massive; very friable; common medium and coarse roots throughout; primarily herbaceous fibers; slightly acid; clear wavy boundary.

Oe—18 to 23 inches; mucky peat, very dark brown (10YR 2/2) broken face and rubbed; about 45 percent fibers, about 20 percent rubbed; massive; very friable; primarily woody fibers; slightly acid; clear wavy boundary.

O'a—23 to 27 inches; muck, very dark grayish brown (10YR 3/2) broken face and rubbed; about 10 percent fibers, about 2 percent rubbed; massive; very friable; primarily herbaceous fibers; slightly acid; abrupt smooth boundary.

Cg1—27 to 30 inches; dark gray (10YR 4/1) sand; single grain; loose; few black (N 2/0) organic stains; neutral; clear wavy boundary.

2Cg2—30 to 60 inches; dark grayish brown (10YR 4/2) sand; single grain; loose; thin layer of dark brown (7.5YR 3/2) muck about 2 inches thick; neutral.

Depth to the sandy material ranges from 16 to 50 inches. The organic material is primarily herbaceous but has some woody fragments or layers. Some pedons have a layer of sphagnum moss 1 to 4 inches thick at the surface.

The organic material has hue of 10YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 3. The organic layers are dominantly sapric material with thin layers of hemic material.

The C horizon has hue of 2.5Y to 7.5YR, value of 4 to 6, and chroma of 1 to 4. It is sand, but in some pedons it has thin layers of loamy material overlying the sand.

## Mattix Series

The Mattix series consists of very deep, somewhat poorly drained soils on outwash plains and ground moraines. These soils formed in shallow, loamy glaciofluvial deposits overlying sand and gravel outwash. Permeability is moderately rapid in the loamy part and very rapid in the substratum. Slopes range from 0 to 3 percent.

Typical pedon of Mattix sandy loam, 0 to 3 percent slopes, in an area where the slope is 1 percent, 2,150 feet east and 900 feet north of the southwest corner of sec. 19, T. 43 N., R. 12 W.

Oa—0 to 3 inches; black (N 2/0), well decomposed leaf litter; moderate medium granular structure; very friable; many fine to coarse roots; very strongly acid; abrupt smooth boundary.

E—3 to 5 inches; pinkish gray (7.5YR 6/2) sandy loam, pinkish gray (7.5YR 7/2) dry; weak medium subangular blocky structure; friable; many fine to coarse roots; about 1 percent gravel; very strongly acid; abrupt irregular boundary.

Bhs—5 to 11 inches; dark reddish brown (5YR 3/2) sandy loam; weak medium subangular blocky structure; friable; many fine to coarse roots; about 2 percent gravel; very strongly acid; clear wavy boundary.

Bs—11 to 24 inches; dark brown (7.5YR 3/4) loamy sand; weak fine subangular blocky structure; very friable; common fine to coarse roots; about 3 percent gravel and 1 percent cobbles; strongly acid; clear wavy boundary.

2C1—24 to 30 inches; light yellowish brown (10YR 6/4) gravelly sand; single grain; loose; few fine roots; about 25 percent gravel and 5 percent cobbles; slightly effervescent; slightly alkaline; clear wavy boundary.

2C2—30 to 80 inches; pale brown (10YR 6/3) very gravelly sand; single grain; loose; about 40 percent gravel and 5 percent cobbles; strongly effervescent; slightly alkaline.

Thickness of the loamy cap ranges from 5 to 15 inches. The content of gravel ranges from 0 to 15 percent in the solum and from 20 to 45 percent in the substratum. The content of cobbles ranges from 0 to 5 percent in the solum and from 1 to 10 percent in the substratum.

Some pedons have an A horizon. This horizon has hue of 10YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. The E horizon has hue of 7.5YR or 5YR, value of 5 or 6, and chroma of 2 or 3. The A and E horizons are sandy loam or loamy sand.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. It is sandy loam or loamy sand. The Bs horizon has hue of 7.5YR, value of 3 or 4, and chroma of 4 to 6. It is loamy sand or sand.

The C horizon has hue of 10YR, value of 5 or 6, and

chroma of 3 or 4. It is gravelly sand or very gravelly sand.

## Menominee Series

The Menominee series consists of very deep, well drained soils on ground moraines and outwash plains. These soils formed in sandy outwash material and in the underlying glacial till. Permeability is rapid in the upper sandy part and moderate in the lower loamy part. Slopes range from 0 to 15 percent.

Typical pedon of Menominee loamy sand, 6 to 15 percent slopes, in an area where the slope is 8 percent, 575 feet west and 1,200 feet north of the southeast corner of sec. 4, T. 43 N., R. 5 W.

Oa—0 to 2 inches; well decomposed leaf litter.
E—2 to 7 inches; reddish gray (5YR 5/2) loamy sand, gray (5YR 6/1) dry; weak medium subangular blocky structure; friable; many fine to coarse roots; very strongly acid; abrupt wavy boundary.
Bhs—7 to 10 inches; dark reddish brown (5YR 3/2) loamy sand; weak medium subangular blocky structure; friable; many fine to coarse roots; strongly acid; clear wavy boundary.
Bs1—10 to 23 inches; dark brown (7.5YR 3/4) loamy sand; weak medium subangular blocky structure; friable; common fine and medium roots; strongly acid; clear wavy boundary.
Bs2—23 to 28 inches; dark brown (7.5YR 4/4) loamy sand; weak medium subangular blocky structure; friable; few fine and medium roots; strongly acid; clear smooth boundary.
2E/B—28 to 38 inches; about 80 percent brown (7.5YR 5/2) loamy sand (E), light brownish gray (10YR 6/2) dry; surrounding peds of reddish brown (5YR 4/4) sandy loam (Bt); moderate medium subangular blocky structure; friable; about 2 percent gravel; moderately acid; clear wavy boundary.
2B/E—38 to 45 inches; about 80 percent dark reddish brown (2.5YR 3/4) sandy clay loam (Bt); surrounded by reddish gray (5YR 5/2) (E) sandy loam, pinkish gray (7.5YR 6/2) dry; moderate medium subangular blocky structure; friable; about 2 percent gravel; moderately acid; clear wavy boundary.
2C—45 to 80 inches; reddish brown (2.5YR 4/4) loam; massive; friable; about 10 percent gravel; slightly effervescent; slightly alkaline.

Depth to the loamy material ranges from 20 to 30 inches. The upper part of the profile is sand or loamy sand. The content of gravel ranges from 0 to 10 percent in the sandy layers and from 2 to 10 percent in the substratum.

The E horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. Some pedons have an A horizon.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4 to 6.

The E part of the 2B/E and 2E/B horizons has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. It is loamy sand or sandy loam. The B part has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 4. It is sandy loam, loam, or sandy clay loam.

The 2C horizon has hue of 2.5YR to 7.5YR and value and chroma of 4 or 5. It is loam or sandy loam.

## Millecoquins Series

The Millecoquins series consists of very deep, moderately well drained soils on lake plains and deltas. These soils formed in loamy, stratified glaciolacustrine deposits. Permeability is moderate in the upper part of the solum and moderately slow in the lower part of the solum and in the substratum. Slopes range from 0 to 15 percent.

Typical pedon of Millecoquins very fine sandy loam, 1 to 6 percent slopes, 2,100 feet west and 2,200 feet south of the northeast corner of sec. 20, T. 44 N., R. 10 W.

A—0 to 4 inches; black (N 2/0) very fine sandy loam, gray (10YR 5/1) dry; moderate coarse granular structure; friable; many fine to coarse roots; moderately acid; abrupt wavy boundary.
E—4 to 6 inches; reddish gray (5YR 5/2) very fine sandy loam, pinkish gray (7.5YR 6/2) dry; moderate fine subangular blocky structure; friable; many fine to coarse roots; moderately acid; abrupt wavy boundary.
Bhs—6 to 11 inches; dark brown (7.5YR 3/3) very fine sandy loam; moderate fine subangular blocky structure; friable; many fine to coarse roots; moderately acid; clear wavy boundary.
Bs—11 to 17 inches; brown (7.5YR 4/3) very fine sandy loam; moderate fine subangular blocky structure; friable; common fine to coarse roots; moderately acid; clear wavy boundary.
B/E—17 to 28 inches; about 70 percent reddish brown (5YR 4/4) silty clay loam (Bt); many faint reddish brown (5YR 5/4) clay films on faces of peds; surrounded by tongues of brown (7.5YR 5/3) silt loam (E), light brown (7.5YR 6/3) dry; strong medium subangular blocky structure; friable; few medium and coarse roots; few fine vesicular pores; common medium distinct strong brown (7.5YR 4/6) iron accumulations in the lower part; moderately acid; clear wavy boundary.
BC—28 to 37 inches; reddish brown (5YR 4/4), dark

brown (7.5YR 4/4), and pale brown (10YR 6/3), stratified fine sandy loam, silt loam, and silty clay loam; medium thick platy structure; friable; few medium and coarse roots; common medium distinct strong brown (7.5YR 4/6) iron accumulations; neutral; gradual wavy boundary.

C—37 to 80 inches; stratified yellowish brown (10YR 5/4) silt loam and reddish brown (5YR 5/4) silty clay loam; massive parting to coarse plates; friable; common coarse distinct yellowish brown (10YR 5/6) iron accumulations; strongly effervescent; slightly alkaline.

Depth to the argillic horizon ranges from 15 to 20 inches.

The A horizon has hue of 7.5YR or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is very fine sandy loam or fine sandy loam.

The E horizon has hue of 7.5YR or 5YR, value of 5 or 6, and chroma of 2 or 3. It is very fine sandy loam or fine sandy loam.

The Bhs horizon, if it occurs, has hue of 5YR or 7.5YR and value and chroma of 2 or 3. It is very fine sandy loam or fine sandy loam.

The Bs horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. In pedons that do not have a Bhs horizon, the Bs horizon has hue of 7.5YR or 5YR, value of 4, and chroma of 3 or 4. It is very fine sandy loam or fine sandy loam.

The Bt part of the B/E horizon has hue of 5YR to 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is silty clay loam. The E part has hue of 5YR to 10YR, value of 5 or 6, and chroma of 2 or 3. It is very fine sandy loam or silt loam.

The C horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 3 to 6. It is stratified fine sandy loam, very fine sandy loam, silt loam, loam, or silty clay loam.

## Moltke Series

The Moltke series consists of very deep, somewhat poorly drained soils on lake plains and outwash plains. These soils formed in loamy glaciolacustrine deposits. Permeability is moderate. Slopes range from 0 to 3 percent.

Typical pedon of Moltke loam, 0 to 3 percent slopes, in an area where the slope is 2 percent, 520 feet east and 350 feet north of the southwest corner of sec. 20, T. 44 N., R. 10 W.

A—0 to 6 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; common fine and medium roots; moderately acid; clear smooth boundary.

E—6 to 11 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/1) dry; moderate medium platy structure parting to moderate fine subangular blocky; friable; few fine roots; moderately acid; clear irregular boundary.

B/E—11 to 17 inches; about 70 percent reddish brown (5YR 4/4) silt loam (Bt); common clay flows on faces of peds; surrounded by brown (10YR 5/3) silt loam (E), light gray (10YR 7/2) dry; strong coarse subangular blocky structure; friable; many fine pores; many coarse distinct yellowish red (5YR 5/8) and prominent strong brown (7.5YR 5/6) iron accumulations and dark grayish brown (10YR 4/2) iron depletions; moderately acid; clear wavy boundary.

BC—17 to 25 inches; stratified, reddish brown (5YR 5/4) and brown (7.5YR 5/2) silt loam; strong thick platy structure; friable; many fine pores; many coarse distinct strong brown (7.5YR 5/6) and prominent yellowish brown (10YR 5/6) iron accumulations; neutral; clear wavy boundary.

C1—25 to 37 inches; stratified, brown (7.5YR 5/4) and grayish brown (10YR 5/2) silt loam; massive; friable; many coarse distinct strong brown (7.5YR 5/6) iron accumulations; slightly alkaline; gradual wavy boundary.

C2—37 to 60 inches; grayish brown (10YR 5/2) silt loam; massive; friable; many coarse distinct yellowish brown (10YR 5/6) iron accumulations; slightly effervescent; moderately alkaline.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. Some pedons have an Ap horizon, which has colors similar to those of the A horizon. The A horizon is loam, silt loam, or very fine sandy loam.

The E horizon has hue of 10YR, value of 4 to 6, and chroma of 2 or 3. It is silt loam.

The B part of the B/E horizon has hue of 5YR or 7.5YR and value and chroma of 4 or 5. The E part has colors similar to those of the E horizon. The B/E horizon is very fine sandy loam or silt loam and has some thin bands of silty clay loam.

The C horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 or 4. It is very fine sandy loam or silt loam. The textures and colors are stratified in the BC and C horizons.

## Ontonagon Series

The Ontonagon series consists of very deep, well drained soils on lake plains. These soils formed in clayey lacustrine deposits. Permeability is very slow. Slopes range from 6 to 50 percent.

Typical pedon of Ontonagon silt loam, 25 to 50 percent slopes, in an area where the slope is 35

percent, 2,400 feet north and 300 feet east of the southwest corner of sec. 9, T. 43 N., R. 10 W.

A—0 to 7 inches; dark reddish brown (5YR 3/2) silt loam, pinkish gray (7.5YR 6/2) dry; moderate medium granular structure; friable; common fine and medium roots; slightly acid; abrupt smooth boundary.
B/E—7 to 10 inches; about 90 percent reddish brown (2.5YR 4/4) clay (Bt); surrounded by tongues of reddish gray (5YR 5/2) silty clay (E), pinkish gray (7.5YR 6/2) dry; strong coarse subangular blocky structure; firm; few fine and medium roots; slightly acid; clear smooth boundary.
Bt1—10 to 16 inches; reddish brown (2.5YR 4/4) clay; strong fine angular blocky structure; firm; many faint reddish brown (2.5YR 4/4) clay films on faces of peds; few fine to coarse roots; neutral; clear smooth boundary.
Bt2—16 to 21 inches; reddish brown (2.5YR 4/4) clay; strong fine angular blocky structure; firm; slightly alkaline; gradual smooth boundary.
C—21 to 80 inches; reddish brown (2.5YR 5/4) clay; moderate fine to thick platy fragments; firm; brown (10YR 5/3) varved layers; violently effervescent; moderately alkaline.

The A horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 2. It is silt loam.

The B part of the B/E horizon has colors and textures similar to those of the Bt horizon. The E part of the B/E horizon has hue of 7.5YR or 5YR, value of 5 or 6, and chroma of 2 or 3. It is clay, silty clay loam, or silty clay.

The Bt horizon has hue of 5YR or 2.5YR, value of 4 or 5, and chroma of 3 or 4. It is clay.

The C horizon has hue of 5YR or 2.5YR, value of 4 or 5, and chroma of 2 to 4. It is clay.

## Paquin Series

The Paquin series consists of very deep, moderately well drained soils on outwash plains and lake plains. These soils formed in sandy glaciofluvial deposits. Permeability is moderate or moderately rapid in the ortstein layer and rapid in the rest of the profile. Slopes range from 0 to 6 percent.

Typical pedon of Paquin sand, 0 to 6 percent slopes, in an area where the slope is 1 percent, 900 feet south and 75 feet east of the northwest corner of sec. 7, T. 44 N., R. 7 W.

Oe—0 to 2 inches; partially decomposed leaf litter.
E—2 to 12 inches; brown (7.5YR 5/2) sand, pinkish gray (7.5YR 6/2) dry; weak medium subangular blocky structure; very friable; many fine to coarse roots; strongly acid; clear smooth boundary.
Bhs—12 to 14 inches; very dark brown (7.5YR 2/2) sand; weak fine subangular blocky structure; very friable; many fine to coarse roots; strongly acid; clear wavy boundary.
Bhsm—14 to 17 inches; very dark brown (7.5YR 2/2) sand; massive; very hard; ortstein makes up 100 percent of the horizon and is strongly cemented; ortstein occurs as a continuous layer and as tongues that extend to a depth of 22 inches; few fine roots; strongly acid; clear irregular boundary.
Bsm—17 to 27 inches; dark brown (7.5YR 3/4) sand; massive; hard; ortstein makes up 100 percent of the horizon and is strongly cemented; ortstein occurs as a continuous layer and as tongues that extend to a depth of 31 inches; strongly acid; clear irregular boundary.
BC—27 to 34 inches; strong brown (7.5YR 4/6) sand; single grain; loose; common fine distinct strong brown (7.5YR 5/8) iron accumulations in the lower 2 inches; strongly acid; gradual wavy boundary.
C—34 to 80 inches; yellowish brown (10YR 5/4) sand; single grain; loose; common coarse distinct strong brown (7.5YR 5/6) iron accumulations; moderately acid.

The content of gravel ranges from 0 to 5 percent. The texture is sand or fine sand throughout the profile.

The E horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 2. Some pedons have an A horizon.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. The Bhsm horizon has hue of 7.5YR or 5YR and value and chroma of 2 or 3. The Bsm horizon has hue of 7.5YR, value of 3 to 5, and chroma of 4 to 6. Pedons that contain 50 to 90 percent ortstein have Bhs and Bs horizons having colors and textures similar to those of the Bhsm and Bsm horizons.

The C horizon has hue of 10YR, value of 5 or 6, and chroma of 4.

## Pickford Series

The Pickford series consists of very deep, poorly drained soils on lake plains. These soils formed in clayey lacustrine deposits. Permeability is very slow. Slopes range from 0 to 2 percent.

Typical pedon of Pickford silty clay loam, 2,500 feet north and 50 feet east of the southwest corner of sec. 2, T. 43 N., R. 1 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silty clay loam, gray (10YR 5/1) dry; strong medium granular structure; friable; many fine and medium roots; moderately acid; abrupt smooth boundary.

Eg—6 to 9 inches; dark gray (10YR 4/1) clay, gray (10YR 5/1) dry; many coarse prominent yellowish brown (10YR 5/6) iron accumulations; strong coarse angular blocky structure; firm; many fine and medium roots; slightly acid; clear wavy boundary.
Bw—9 to 14 inches; reddish brown (5YR 4/4) clay; strong coarse angular blocky structure; firm; few fine roots; few fine distinct yellowish red (5YR 4/6) iron accumulations and common fine prominent gray (10YR 5/1) iron depletions; neutral; clear wavy boundary.
BC—14 to 19 inches; reddish brown (5YR 4/4) clay; strong thick platy structure parting to strong coarse angular blocky; firm; few fine roots; common fine prominent gray (10YR 5/1) iron depletions along root channels; slightly alkaline; clear wavy boundary.
C—19 to 60 inches; reddish brown (2.5YR 4/4) clay; strong thick platy structure; firm; light brownish gray (10YR 6/2) varved layers; olive gray (5Y 5/2) streaks of lime; strongly effervescent; moderately alkaline.

Pedons in wooded areas commonly have an O horizon, which ranges to 6 inches in thickness. The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. Pedons in undisturbed areas have an A horizon, which has the same colors as the Ap horizon. The A horizon is silty clay loam or silt loam.

The Eg horizon has hue of 10YR or 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay, silty clay, or silty clay loam.

The Bw horizon has hue of 5YR or 2.5YR and value and chroma of 4. It is clay.

The C horizon has hue of 5YR or 2.5YR and value and chroma of 4. It is clay.

## Pullup Series

The Pullup series consists of very deep, somewhat excessively drained soils on dunes, beach ridges, and bars. These soils formed in sandy eolian and lacustrine deposits. Permeability is moderate or moderately rapid in the ortstein layer and rapid in the rest of the profile. Slopes range from 0 to 35 percent.

Typical pedon of Pullup fine sand, 0 to 6 percent slopes, 2,145 feet south of the center of sec. 11, T. 44 N., R. 9 W.

Oi—2 inches to 0; slightly decomposed leaf litter.
E—0 to 8 inches; light brownish gray (10YR 6/2) fine sand, light gray (10YR 7/2) dry; weak medium subangular blocky structure; very friable; common fine to coarse roots; strongly acid; abrupt wavy boundary.
Bs—8 to 12 inches; dark brown (7.5YR 4/4) fine sand; weak fine subangular blocky structure; very friable; common fine to coarse roots; moderately acid; clear wavy boundary.
Bsm—12 to 22 inches; dark brown (7.5YR 4/4), strong brown (7.5YR 5/8), and pinkish gray (7.5YR 6/2) fine sand; massive; very hard; ortstein makes up 90 percent of the horizon and is strongly cemented; ortstein occurs as a nearly continuous layer and as tongues that extend to a depth of 38 inches; few fine and medium roots; moderately acid; clear irregular boundary.
C—22 to 80 inches; very pale brown (10YR 7/4) fine sand; single grain; loose; slightly acid.

The texture is dominantly fine sand throughout, but the range includes medium sand or a combination of fine and medium sand.

The E horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 2. Some pedons have an A horizon.

The Bs horizon has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 4. The Bsm horizon has hue of 7.5YR, value of 4 to 6, and chroma of 2 to 8. More than 50 percent of the color has value of 3 or 4 and chroma of 4.

The C horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 4 to 6.

## Rubicon Series

The Rubicon series consists of very deep, excessively drained soils on outwash plains and lake plains. These soils formed in sandy deposits. Permeability is rapid. Slopes range from 0 to 60 percent.

Typical pedon of Rubicon sand, 0 to 6 percent slopes, in an area where the slope is 3 percent, 20 feet west and 1,400 feet north of the southeast corner of sec. 21, T. 44 N., R. 9 W.

Oe—0 to 2 inches; partially decomposed leaf litter.
E—2 to 4 inches; grayish brown (10YR 5/2) sand, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; very friable; many fine and coarse roots; very strongly acid; clear wavy boundary.
Bs1—4 to 8 inches; dark brown (7.5YR 4/4) sand; weak fine subangular blocky structure; very friable; many fine and coarse roots; ortstein makes up 25 percent of the horizon and occurs as weakly cemented chunks; about 3 percent gravel; strongly acid; clear wavy boundary.
Bs2—8 to 17 inches; strong brown (7.5YR 5/6) sand; weak fine subangular blocky structure; very friable;

many fine to coarse roots; strongly acid; gradual irregular boundary.
BC—17 to 32 inches; reddish yellow (7.5YR 6/6) sand; single grain; loose; few fine and medium roots; about 2 percent gravel; moderately acid; gradual irregular boundary.
C1—32 to 65 inches; brownish yellow (10YR 6/6) sand; single grain; loose; about 2 percent gravel; moderately acid; clear smooth boundary.
C2—65 to 80 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; few thin yellowish red (10YR 6/8) strata; about 2 percent gravel; moderately acid.

The content of gravel ranges from 0 to 10 percent throughout the profile. The soils are sand throughout.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 1 to 3.

The Bs1 horizon has hue of 7.5YR, value of 3 or 4, and chroma of 4. The Bs2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6.

The C horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 to 5.

## Rudyard Series

The Rudyard series consists of very deep, somewhat poorly drained soils on lake plains. These soils formed in clayey lacustrine deposits. Permeability is very slow. Slopes range from 0 to 3 percent.

Typical pedon of Rudyard silty clay loam, 0 to 3 percent slopes, in an area where the slope is 1 percent, 1,100 feet south and 50 feet east of the northwest corner of sec. 10, T. 43 N., R. 1 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) silty clay loam, pale brown (10YR 6/2) dry; strong medium granular structure; friable; common fine and medium roots; neutral; abrupt smooth boundary.
Bt1—10 to 14 inches; reddish brown (5YR 4/4) clay; common distinct reddish brown (2.5YR 5/4) clay flows on faces of peds; strong fine angular blocky structure; firm; common fine and medium roots; few fine distinct reddish gray (5YR 5/2) iron depletions and common fine distinct yellowish red (5YR 4/6) iron accumulations; slightly alkaline; clear smooth boundary.
Bt2—14 to 19 inches; reddish brown (2.5YR 4/4) clay; common distinct reddish brown (2.5YR 5/4) clay flows on faces of peds; strong fine angular blocky structure; firm; few medium roots; few fine prominent yellowish red (5YR 4/6) iron accumulations; slightly alkaline; clear smooth boundary.
C1—19 to 23 inches; reddish brown (2.5YR 4/4) clay; strong fine angular blocky structure; firm; few fine prominent dark brown (7.5YR 4/4) iron accumulations; slightly effervescent; moderately alkaline; clear smooth boundary.
C2—23 to 60 inches; reddish brown (2.5YR 5/4) clay; strong thick platy structure parting to strong fine angular blocky; firm; few fine prominent dark brown (7.5YR 4/4) iron accumulations; brown (7.5YR 5/2) varved layers; strongly effervescent; moderately alkaline.

The Ap horizon has hue of 10YR, value of 2 to 4, and chroma of 2 or 3. It is silty clay loam or silt loam. Some pedons have an A horizon, which has colors and textures similar to those of the Ap horizon.

The Bt horizon has hue of 5YR or 2.5YR, value of 3 or 4, and chroma of 4. It is clay.

The C horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. It is clay.

## Ruse Series

The Ruse series consists of shallow, poorly drained soils on ground moraines. These soils formed in loamy glacial till deposits. Permeability is moderate or moderately rapid. Slopes range from 0 to 2 percent.

Typical pedon of Ruse mucky loam, 2,000 feet east and 1,500 feet south of the northwest corner of sec. 19, T. 43 N., R. 10 W.

A—0 to 7 inches; black (10YR 2/1) mucky loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; many fine to coarse roots; neutral; abrupt smooth boundary.
Bg—7 to 11 inches; grayish brown (10YR 5/2) sandy loam; weak medium subangular blocky structure; friable; many fine faint gray (10YR 6/1) iron depletions; common fine to coarse roots; slightly alkaline; abrupt smooth boundary.
Bw—11 to 15 inches; pale brown (10YR 6/3) sandy loam; weak thick platy structure; friable; common fine prominent yellowish brown (7.5YR 5/6) iron accumulations and common fine distinct light brownish gray (2.5Y 6/2) iron depletions throughout; few fine roots; slightly alkaline; abrupt smooth boundary.
R—15 inches; fractured limestone bedrock.

The depth to limestone bedrock ranges from 10 to 20 inches. The content of gravel ranges from 0 to 15 percent throughout the profile, and the content of cobbles and flagstones ranges from 0 to 10 percent. Some pedons have a thin surface layer of muck.

The A horizon has hue of 10YR, value of 2 or 3, and

chroma of 1 or 2. It is sandy loam, fine sandy loam, or the mucky or gravelly analogs of these textures.

The Bg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is sandy loam or fine sandy loam.

The Bw horizon has hue of 5YR to 2.5Y, value of 4 to 6, and chroma of 3 or 4. It is fine sandy loam, sandy loam, or the gravelly analogs of these textures.

## Satago Series

The Satago series consists of deep, well drained soils on ground moraines. These soils formed in loamy deposits underlain by soft shale bedrock. Permeability is moderate. Slopes range from 0 to 6 percent.

Typical pedon of Satago silt loam, 1 to 6 percent slopes, in an area where the slope is 4 percent, 150 feet west and 200 feet south of the northeast corner of sec. 23, T. 42 N., R. 4 W.

Oi—2 inches to 0; slightly decomposed leaf litter.
A—0 to 4 inches; dark brown (7.5YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; friable; many fine and medium roots; about 1 percent gravel; neutral; clear wavy boundary.
BA—4 to 8 inches; brown (7.5YR 4/4) and reddish brown (5YR 4/3) silt loam; moderate medium subangular blocky structure; friable; many fine and medium roots; about 7 percent gravel; neutral; gradual wavy boundary.
Bw—8 to 12 inches; reddish brown (5YR 4/4) silt loam; moderate medium subangular blocky structure; friable; common fine roots; about 30 percent grayish brown (2.5Y 5/2), weathered shale fragments that are easily crushed; about 3 percent gravel; slightly effervescent; moderately alkaline; gradual wavy boundary.
C—12 to 46 inches; reddish brown (5YR 4/3) silt loam; weak medium subangular blocky structure; firm; about 20 percent grayish brown (2.5Y 5/2), weathered shale fragments that are easily crushed; about 3 percent gravel; slightly effervescent; moderately alkaline; abrupt smooth boundary.
Cr—46 to 60 inches; soft shale bedrock.

The depth to paralithic contact ranges from 40 to 50 inches. The content of gravel ranges from 0 to 10 percent. The content of weathered shale fragments, which can be easily crushed, ranges from 0 to 12 percent in the A and Bw1 horizons and from 3 to 30 percent in the lower horizons.

The A horizon has hue of 10YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is silt loam, loam, silty clay loam, or very fine sandy loam.

The BA and Bw horizons have hue of 5YR to 2.5Y, value of 3 to 5, and chroma of 2 to 4. They are silt loam, loam, or silty clay loam.

The C horizon has hue of 5YR to 2.5Y, value of 3 to 6, and chroma of 2 to 6. It is silt loam, loam, or silty clay loam.

## Search Series

The Search series consists of moderately deep, somewhat poorly drained soils on ground moraines and end moraines. These soils formed in loamy glacial till overlying calcareous, soft shale bedrock. Permeability is moderately slow. Slopes range from 0 to 3 percent.

Typical pedon of Search very fine sandy loam, 0 to 3 percent slopes, in an area where the slope is 1 percent, 2,200 feet east and 1,100 feet south of the northwes corner of sec. 29, T. 41 N., R. 3 W.

A—0 to 8 inches; black (10YR 2/1) very fine sandy loam, dark gray (10YR 4/1) dry; strong medium granular structure; friable; many fine to coarse roots; slightly alkaline; clear smooth boundary.
BA—8 to 10 inches; 70 percent yellowish brown (10YR 5/4) (B) and very dark grayish brown (10YR 3/2) (A) very fine sandy loam; moderate medium subangular blocky structure; friable; many fine and medium roots; about 10 percent gravel; few fine faint dark grayish brown (10YR 4/2) iron depletions; strongly effervescent; moderately alkaline; clear smooth boundary.
C1—10 to 15 inches; light yellowish brown (10YR 6/4) gravelly very fine sandy loam; massive; firm; few fine roots; about 10 percent soft shale fragments that are easily crushed; about 15 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.
C2—15 to 24 inches; light brown (7.5YR 6/4) very gravelly very fine sandy loam; massive; firm; about 10 percent soft shale fragments that are easily crushed; about 35 percent gravel; strongly effervescent; moderately alkaline; clear smooth boundary.
Cr—24 to 60 inches; layered weak red (10R 5/2 and 4/3) and pale olive (5Y 6/4), calcareous, soft shale bedrock.

The depth to paralithic contact ranges from 20 to 30 inches. The content of gravel ranges from 0 to 10 percent in the surface horizons and from 10 to 35 percent in the substratum. The content of soft shale channers ranges from 0 to 15 percent.

The A horizon has hue of 10YR or is neutral in hue.

It has value of 2 or 3 and chroma of 0 to 2. It is very fine sandy loam, silt loam, or loam.

The B part of the BA horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. The A part has colors similar to those of the A horizon and has the same textures as the A horizon.

The C horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 3 or 4. It is very gravelly very fine sandy loam or very gravelly silt loam.

## Shelter Series

The Shelter series consists of very deep, somewhat poorly drained soils on ground moraines, drumlins, and glacial lake benches. These soils formed in loamy glacial till deposits and are shallow to dense till. Permeability is very slow. Slopes range from 0 to 15 percent.

Typical pedon of Shelter very cobbly loam, 6 to 15 percent slopes, cobbly, in an area where the slope is 8 percent, 2,020 feet west and 2,000 feet south of the northeast corner of sec. 34, T. 42 N., R. 1 E.

Oa—0 to 2 inches; black (N 2/0), well decomposed leaf litter; about 15 percent gravel and 40 percent stones and cobbles; many fine to coarse roots; neutral; abrupt smooth boundary.

A—2 to 8 inches; black (10YR 2/1) very cobbly loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; many fine to coarse roots; about 15 percent gravel and 40 percent cobbles and stones; slightly alkaline; abrupt smooth boundary.

AB—8 to 10 inches; very dark grayish brown (10YR 3/2) (A) and dark yellowish brown (10YR 4/4) (B) very cobbly fine sandy loam; moderate medium subangular blocky structure; friable; many coarse to fine roots; about 25 percent gravel and 40 percent cobbles and stones; slightly effervescent; moderately alkaline; abrupt wavy boundary.

Bw—10 to 14 inches; dark yellowish brown (10YR 4/4) very cobbly fine sandy loam; moderate medium subangular blocky structure; friable; common fine to coarse roots; about 15 percent gravel and 35 percent cobbles and stones; strongly effervescent; moderately alkaline; clear wavy boundary.

Cd—14 to 60 inches; light brown (7.5YR 6/4) very gravelly fine sandy loam; strong very thick platy structure parting to strong medium subangular blocky; firm; few fine vesicular pores; common medium distinct strong brown (7.5YR 5/6) iron accumulations; about 20 percent gravel and 20 percent cobbles and stones; strongly effervescent; moderately alkaline.

Depth to the dense till ranges from 8 to 16 inches. The content of gravel in the surface horizons ranges from 5 to 25 percent, and the content of cobbles and stones ranges from 15 to 40 percent. The content of gravel in the subsoil and the substratum ranges from 15 to 40 percent, and the content of cobbles and stones ranges from 20 to 40 percent.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The A part of the AB horizon has colors similar to those of the A horizon. The B part of the AB horizon has hue of 10YR and value and chroma of 3 or 4. The A and AB horizons are the cobbly, gravelly, stony, very cobbly, very gravelly, or very stony analogs of loam, fine sandy loam, or silt loam.

The Bw horizon has value of 4 to 6 and chroma of 3 or 4. It is the very cobbly or very gravelly analogs of fine sandy loam, loam, or silt loam.

The Cd horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 2 to 4. It is the very gravelly or very cobbly analogs of fine sandy loam or loam.

## Solona Series

The Solona series consists of very deep, somewhat poorly drained soils on ground moraines. These soils formed in loamy glacial till deposits. Permeability is moderate. Slopes range from 0 to 3 percent.

Typical pedon of Solona loam, 0 to 3 percent slopes, 495 feet east and 2,145 feet south of the northwest corner of sec. 34, T. 43 N., R. 3 W.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) loam, gray (10YR 5/1) dry; weak medium granular structure; very friable; many fine to coarse roots; less than 5 percent gravel; neutral; abrupt wavy boundary.

E—3 to 11 inches; brown (10YR 5/3) loam; moderate medium subangular blocky structure; friable; many fine to coarse roots; few fine faint grayish brown (10YR 5/2) iron accumulations; about 5 percent gravel; slightly acid; abrupt wavy boundary.

Bt1—11 to 18 inches; brown (7.5YR 5/4) sandy loam; many thin clay films on faces of peds; weak medium subangular blocky structure; friable; common fine pores; common fine and medium roots; common fine distinct brown (7.5YR 5/2) iron accumulations; about 13 percent gravel; slightly alkaline; clear smooth boundary.

Bt2—18 to 27 inches; reddish brown (5YR 5/4) sandy loam; many thick clay films on faces of peds; moderate medium subangular blocky structure; friable; few fine and medium roots; common fine distinct yellowish red (5YR 5/8) iron accumulations; common fine pores; about 13 percent gravel; slightly alkaline; gradual smooth boundary.

C—27 to 60 inches; light reddish brown (5YR 6/4) gravelly sandy loam; weak medium subangular blocky structure; friable; very few medium and fine roots; many medium distinct yellowish red (5YR 5/6) iron accumulations; about 15 percent gravel; strongly effervescent; slightly alkaline.

The content of gravel ranges from 0 to 15 percent in the solum and from 0 to 25 percent in the substratum. The content of cobbles ranges from 0 to 2 percent.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. The A and E horizons are sandy loam, fine sandy loam, or loam.

The Bt horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 3 to 6. It is sandy loam, fine sandy loam, or loam.

The C horizon has hue of 7.5YR or 5YR and value and chroma of 4 to 6. It is gravelly sandy loam or gravelly fine sandy loam.

## Soo Series

The Soo series consists of very deep, poorly drained soils on lake plains. These soils formed in loamy lacustrine deposits. Permeability is slow. Slopes range from 0 to 2 percent.

Typical pedon of Soo silty clay loam, 450 feet south and 2,200 feet west of the northeast corner of sec. 22, T. 44 N., R. 3 W., in Chippewa County, Michigan:

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 6/1) dry; moderate medium subangular blocky structure parting to moderate medium granular; friable; many fine to coarse roots; common medium prominent brownish yellow (10YR 6/8) and strong brown (7.5YR 5/8) iron accumulations; slightly acid; clear smooth boundary.

Bw—7 to 17 inches; dark brown (7.5YR 4/4) silty clay loam; very coarse angular blocky structure; very firm; common fine and few coarse roots; common medium distinct strong brown (7.5YR 5/6) iron accumulations and common fine prominent gray (5YR 5/1) iron depletions; slightly alkaline; clear wavy boundary.

C1—17 to 26 inches; reddish brown (5YR 5/3) silty clay loam that has thin bands of pinkish gray (5YR 7/2) silt loam; weak thick platy fragments; firm; few fine roots; common medium prominent strong brown (7.5YR 5/8) and yellowish brown (10YR 5/6) iron accumulations; greenish gray (5GY 6/1) clay films in root channels; violently effervescent; moderately alkaline; clear smooth boundary.

C2—26 to 60 inches; reddish brown (5YR 5/3) silty clay loam that has thin bands of pinkish gray (5YR 7/2) silt loam; massive; firm; few fine roots in the upper 20 inches; greenish gray (5GY 6/1) silt coatings in root channels; few medium prominent brownish yellow (10YR 6/6) iron accumulations; violently effervescent; moderately alkaline.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. It is silty clay loam or silt loam. Some pedons have an A horizon. This horizon has colors similar to those of the Ap horizon.

The Bw horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4.

The C horizon has hue of 5YR or 7.5YR, value of 4 to 7, and chroma of 2 to 6.

## Spot Series

The Spot series consists of very deep, poorly drained soils on outwash plains, lake plains, and ground moraines. These soils formed in sandy glaciofluvial deposits. Permeability is moderate or moderately rapid in the ortstein layer and rapid in the rest of the profile. Slopes range from 0 to 2 percent.

Typical pedon of Spot muck, 1,550 feet west and 600 feet north of the southeast corner of sec. 27, T. 44 N., R. 9 W.

Oi—0 to 1 inch; slightly decomposed organic matter.

Oa—1 to 2 inches; muck, black (N 2/0) rubbed and broken face; medium granular structure; friable; many fine to coarse roots; very strongly acid; abrupt smooth boundary.

E—2 to 8 inches; light brownish gray (10YR 6/2) sand, light gray (10YR 7/1) dry; weak medium subangular blocky structure; friable; common fine and medium roots; common fine prominent strong brown (7.5YR 5/6) iron accumulations; very strongly acid; clear wavy boundary.

Bhsm—8 to 10 inches; dark reddish brown (5YR 3/3 and 3/2) sand; massive; very hard; ortstein makes up 90 percent of the horizon and is strongly cemented; ortstein occurs as a nearly continuous layer and as tongues that extend to a depth of 20 inches; common fine and medium roots; very strongly acid; clear irregular boundary.

Bs1—10 to 12 inches; dark brown (7.5YR 4/4) sand; weak fine subangular blocky structure; friable; ortstein makes up 70 percent of the horizon and is moderately cemented; dark brown (7.5YR 4/4) ortstein occurs as a nearly continuous layer with tongues to a depth of 22 inches; strongly acid; clear irregular boundary.

Bs2—12 to 18 inches; strong brown (7.5YR 4/6) sand; weak fine subangular blocky structure; friable;

ortstein makes up 30 percent of the horizon and is weakly cemented; strong brown (7.5YR 4/4) ortstein occurs as tongues 2 to 6 inches wide that extend to a depth of 25 inches; ortstein tongues are 16 to 30 inches apart; strongly acid; gradual wavy boundary.
C1—18 to 41 inches; light brown (7.5YR 6/4) sand; single grain; loose; strongly acid; gradual wavy boundary.
C2—41 to 80 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; moderately acid.

The profile is fine sand or medium sand throughout.

The E horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 1 to 3.

The Bhsm horizon has hue of 5YR to 10YR and value and chroma of 2 or 3. Pedons that contain 50 to 90 percent ortstein have a Bhs horizon, which has colors similar to those of the Bhsm horizon.

The Bs horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 4 to 6. Pedons that contain more than 90 percent ortstein have a Bsm horizon, which has colors similar to those of the Bs horizon.

The C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4.

## Springlake Series

The Springlake series consists of very deep, somewhat excessively drained soils on outwash plains, ground moraines, and beach ridges. These soils formed in sandy and gravelly deposits. Permeability is very rapid. Slopes range from 0 to 35 percent.

Typical pedon of Springlake loamy coarse sand, 0 to 6 percent slopes, 3,000 feet north and 200 feet west of the southeast corner of sec. 30, T. 44 N., R. 7 W.

Oi—1 inch to 0; slightly decomposed leaf litter.
A—0 to 6 inches; very dark grayish brown (10YR 3/2) loamy coarse sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; many fine to coarse roots; some mixing of material from the E and B horizons; moderately acid; clear irregular boundary.
E—6 to 8 inches; grayish brown (10YR 5/2) loamy coarse sand, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; very friable; many fine to coarse roots; moderately acid; clear smooth boundary.
Bhs—8 to 13 inches; dark brown (7.5YR 3/3) loamy coarse sand; weak fine subangular blocky structure; very friable; common fine and medium roots; moderately acid; clear wavy boundary.
Bs—13 to 22 inches; strong brown (7.5YR 4/6) loamy coarse sand; single grain; loose; common fine roots; about 5 percent gravel; neutral; clear wavy boundary.
2BC—22 to 25 inches; strong brown (7.5YR 5/6) gravelly coarse sand; single grain; loose; about 15 percent gravel; slightly alkaline; clear wavy boundary.
2C—25 to 80 inches; light yellowish brown (10YR 6/4) gravelly coarse sand; single grain; loose; about 15 percent gravel; strongly effervescent; moderately alkaline.

The content of gravel ranges from 0 to 15 percent in the solum and from 5 to 35 percent in the substratum.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. The E horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2. The A and E horizons are loamy sand, loamy coarse sand, or sand.

The Bhs horizon has hue of 7.5YR or 5YR and value and chroma of 2 or 3. It is sand, loamy sand, or loamy coarse sand.

The Bs horizon has hue of 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is loamy sand, loamy coarse sand, or sand.

The 2C horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 4 to 6. It is sand, coarse sand, or the gravelly analogs of these textures.

## St. Ignace Series

The St. Ignace series consists of shallow, well drained soils on bedrock-controlled ground moraines and lake benches. These soils formed in loamy materials underlain by limestone breccia. Permeability is moderate or moderately rapid. Slopes range from 0 to 70 percent.

Typical pedon of St. Ignace silt loam, 0 to 6 percent slopes, in an area where the slope is 5 percent, in an unsectionalized area 100 yards west of Park Avenue on the south side of Mackinac Island, T. 40 N., R. 3 W.

A—0 to 5 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; strong medium granular structure; friable; many fine to coarse roots; about 10 percent gravel; moderately alkaline; clear wavy boundary.
Bw—5 to 15 inches; yellowish brown (10YR 5/4) gravelly silt loam; moderate medium granular structure; friable; common fine and medium roots; about 30 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.
2Cr—15 inches; fractured limestone breccia.

The depth to bedrock ranges from 10 to 20 inches. The content of gravel ranges from 2 to 35 percent throughout the profile, and the content of cobbles

ranges from 0 to 20 percent. The total content of rock fragments ranges from 5 to 35 percent. The soils are silt loam, loam, or the gravelly and cobbly analogs of these textures.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2.

The Bw horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. Some pedons have a BA horizon.

## Superior Series

The Superior series consists of very deep, well drained soils on ground moraines and lake plains. These soils formed in loamy water-laid deposits and in the underlying clayey lacustrine deposits and glacial till. Permeability is moderate in the loamy upper part and slow or very slow in the underlying material. Slopes range from 0 to 15 percent.

Typical pedon of Superior fine sandy loam, till substratum, 1 to 6 percent slopes, in an area where the slope is 3 percent, 1,900 feet east and 450 feet north of the southwest corner of sec. 34, T. 44 N., R. 10 W.

A—0 to 4 inches; black (N 2/0) fine sandy loam, gray (7.5YR 5/1) dry; moderate coarse granular structure; friable; many fine to coarse roots; about 2 percent gravel; strongly acid; clear wavy boundary.

E—4 to 7 inches; brown (7.5YR 4/2) fine sandy loam, gray (5YR 6/1) dry; moderate medium subangular blocky structure; friable; many fine to coarse roots; about 2 percent gravel; moderately acid; clear irregular boundary.

Bhs1—7 to 9 inches; dark reddish brown (5YR 3/2) fine sandy loam; moderate medium subangular blocky structure; friable; many fine to coarse roots; about 2 percent gravel; moderately acid; clear wavy boundary.

Bhs2—9 to 16 inches; dark reddish brown (5YR 3/3) fine sandy loam; moderate medium subangular blocky structure; friable; common fine to coarse roots; about 2 percent gravel; moderately acid; abrupt smooth boundary.

2B/E—16 to 28 inches; about 55 percent reddish brown (2.5YR 4/4) clay (Bt); surrounded by tongues of brown (7.5YR 5/2) loam (E), light gray (10YR 7/2) dry; strong very coarse subangular blocky structure; very firm; few fine and medium roots; common fine vesicular pores; moderately acid; clear wavy boundary.

2Bt—28 to 34 inches; reddish brown (2.5YR 4/4) clay; many fine reddish brown (2.5YR 4/4) clay films on faces of peds; moderate coarse angular blocky structure; very firm; few fine and medium roots; slightly acid; clear smooth boundary.

2C1—34 to 74 inches; reddish brown (2.5YR 4/4) clay that has thin strata of dark brown (7.5YR 4/4) silt loam; massive; very firm; few fine roots; slightly effervescent; slightly alkaline; clear wavy boundary.

3C2—74 to 80 inches; mixed grayish brown (2.5Y 5/2) and reddish brown (5YR 4/4) sandy clay loam; massive; firm; about 5 percent gravel; strongly effervescent; slightly alkaline.

Depth to the clayey material ranges from 10 to 20 inches. The content of gravel ranges from 0 to 5 percent in the loamy cap.

The A horizon is neutral in hue. It has value of 2 or 3 and chroma of 0. It is fine sandy loam or sandy loam.

The E horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. It is fine sandy loam or sandy loam.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. Some pedons have a Bs horizon, which has hue of 5YR, value of 3 or 4, and chroma of 4 to 6. The Bhs and Bs horizons are fine sandy loam or sandy loam.

The B part of the 2B/E horizon has hue of 2.5YR and value and chroma of 4 or 5. The E part has hue of 7.5YR, value of 5, and chroma of 2 or 3. It is fine sandy loam or loam.

The 2Bt horizon has colors similar to those of the B part of the 2B/E horizon. The 2Bt horizon is clay.

The 2C horizon has hue of 2.5YR and value and chroma of 4 or 5. It is clay and has thin strata of silt loam.

The 3C horizon has hue of 7.5YR to 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is sandy loam or sandy clay loam.

## Wainola Series

The Wainola series consists of very deep, somewhat poorly drained soils on lake plains and outwash plains. These soils formed in sandy glaciofluvial deposits. Permeability is rapid. Slopes range from 0 to 3 percent.

Typical pedon of Wainola fine sand, 0 to 3 percent slopes, 1,050 feet north and 1,600 feet east of the southwest corner of sec. 18, T. 43 N., R. 9 W.

Oe—0 to 3 inches; partially decomposed leaf litter.

E—3 to 14 inches; pinkish gray (10YR 6/2) fine sand, light gray (10YR 7/2) dry; weak fine subangular blocky structure; very friable; common fine to coarse roots; very strongly acid; abrupt irregular boundary.

Bs1—14 to 17 inches; 70 percent dark brown (7.5YR 3/4) fine sand; weak medium subangular blocky structure; very friable; dark reddish brown (7.5YR 3/2) ortstein makes up 30 percent of the horizon and occurs as moderately cemented chunks; many

fine to coarse roots; many medium distinct strong brown (7.5YR 4/6) iron accumulations; very strongly acid; clear wavy boundary.

Bs2—17 to 26 inches; strong brown (7.5YR 4/6) fine sand; weak medium subangular blocky structure; very friable; few fine roots; few medium faint strong brown (7.5YR 5/6) iron accumulations; very strongly acid; clear wavy boundary.

BC—26 to 30 inches; yellowish brown (10YR 5/6) fine sand; single grain; loose; strongly acid; gradual wavy boundary.

C—30 to 80 inches; light yellowish brown (10YR 6/4) fine sand; single grain; loose; moderately acid.

The E horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 2 or 3. It is fine sand.

The Bs1 horizon has hue of 7.5YR, value of 3 or 4, and chroma of 2 to 4. The Bs2 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. These horizons are fine sand.

The C horizon has hue of 10YR, value of 5 or 6, and chroma of 3 or 4. It is fine sand.

## Wakeley Series

The Wakeley series consists of very deep, poorly drained soils on lake plains and outwash plains. These soils formed in sandy outwash deposits underlain by clayey lacustrine deposits. Permeability is rapid in the upper sandy part and very slow in the lower clayey part. Slopes range from 0 to 2 percent.

Typical pedon of Wakeley muck, 228 feet north and 2,376 feet west of the southeast corner of sec. 23, T. 42 N., R. 5 W.

Oa—0 to 4 inches; black (N 2/0) muck; weak fine granular structure; very friable; many fine to coarse roots; moderately acid; abrupt wavy boundary.

A—4 to 5 inches; black (10YR 2/1) loamy fine sand, very dark grayish brown (10YR 3/2) dry; massive; loose; many fine to coarse roots; slightly acid; abrupt broken boundary.

Cg—5 to 7 inches; dark grayish brown (10YR 4/2) loamy fine sand; massive; loose; few fine roots; common fine prominent brown (10YR 4/3) iron accumulations; neutral; abrupt smooth boundary.

C1—7 to 24 inches; pale brown (10YR 4/3) fine sand; massive; loose; very few fine roots; common medium distinct yellowish brown (10YR 5/6) iron accumulations; slightly alkaline; abrupt smooth boundary.

2C2—24 to 60 inches; reddish brown (5YR 5/3) silty clay; massive; very firm; common coarse distinct yellowish brown (10YR 5/6) iron accumulations; slightly effervescent; moderately alkaline.

Depth to the clayey material ranges from 20 to 34 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loamy fine sand, sand, loamy sand, or the mucky analogs of these textures.

The Cg horizon has hue of 10YR, value of 4 to 6, and chroma of 1 or 2. The C horizon has hue of 10YR, value of 4 to 6, and chroma of 3 or 4. The Cg and C horizons are sand or fine sand.

The 2C horizon has hue of 5YR, value of 4 or 5, and chroma of 3 or 4. It is clay or silty clay.

## Wallace Series

The Wallace series consists of very deep, well drained soils on dunes, lake plains, and outwash plains. These soils formed in sandy deposits. Permeability is moderate or moderately rapid in the ortstein layer and rapid in the rest of the profile. Slopes range from 0 to 60 percent.

Typical pedon of Wallace sand, 0 to 6 percent slopes, in an area where the slope is 2 percent, 100 feet west and 950 north of the southeast corner of sec. 12, T. 43 N., R. 9 W.

Oe—0 to 2 inches; partially decomposed leaf litter.

E—2 to 10 inches; light brownish gray (10YR 6/2) sand, light gray (10YR 7/2) dry; weak medium subangular blocky structure; very friable; many fine to coarse roots; very strongly acid; abrupt wavy boundary.

Bhs—10 to 11 inches; dark reddish brown (5YR 3/2) sand; weak fine subangular blocky structure; very friable; many fine to coarse roots; very strongly acid; abrupt irregular boundary.

Bhsm—11 to 21 inches; dark brown (7.5YR 3/3) sand; massive; very hard; ortstein makes up 95 percent of horizon and is strongly cemented; ortstein occurs as a nearly continuous layer and as tongues that extend to a depth of 52 inches; few fine and medium roots; strongly acid; clear irregular boundary.

Bsm—21 to 26 inches; dark brown (7.5YR 4/4) sand; massive; hard; ortstein makes up 95 percent of the horizon and is moderately cemented; ortstein occurs as a nearly continuous layer and as tongues that extend to a depth of 55 inches; few fine and medium roots; strongly acid; clear irregular boundary.

BC—26 to 59 inches; brownish yellow (10YR 6/6) sand; single grain; loose; few fine roots; moderately acid; gradual wavy boundary.

C—59 to 80 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; moderately acid.

Textures are sand and fine sand throughout the

profile. The content of gravel ranges from 0 to 5 percent.

The E horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 1 or 2.

The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. The Bhsm horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. The Bsm horizon has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 4 to 6. Pedons that contain 50 to 90 percent ortstein have a Bs horizon, which has colors similar to those of the Bsm horizon.

The C horizon has hue of 10YR, value of 5 or 6, and chroma of 4 to 6.

## Zela Series

The Zela series consists of very deep, poorly drained soils on beach ridges. These soils formed in gravelly and sandy water-laid deposits. Permeability is very rapid. Slopes range from 0 to 2 percent.

Typical pedon of Zela muck, 3,270 feet south and 2,000 feet west of the far northeast corner of sec. 28, T. 39 N., R. 1 W., on Bois Blanc Island:

Oa—0 to 9 inches; black (N 2/0) muck; weak fine granular structure; very friable; many fine to coarse roots; very strongly acid; gradual wavy boundary.

A—9 to 12 inches; black (10YR 2/1) extremely gravelly loam, dark grayish brown (10YR 4/2) dry; single grain; loose; many fine to coarse roots; about 85 percent gravel; slightly alkaline; clear wavy boundary.

Cg—12 to 35 inches; grayish brown (10YR 5/2) very gravelly sand; single grain; loose; few fine roots; common coarse prominent brownish yellow (10YR 6/8) iron accumulations in the lower part; about 55 percent gravel; strongly effervescent; moderately alkaline; gradual wavy boundary.

C—35 to 60 inches; yellowish brown (10YR 5/4) very gravelly sand; single grain; loose; about 60 percent gravel; violently effervescent; moderately alkaline.

The content of gravel ranges from 35 to 90 percent throughout the profile. The gravel is dominantly limestone.

The Oa horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 3. It is 8 to 12 inches thick.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 3. It is the very gravelly or extremely gravelly analogs of loam or sandy loam.

The C horizons have hue of 10YR, value of 4 to 6, and chroma of 2 to 4. They are the very gravelly or extremely gravelly analogs of sand or coarse sand.

# Formation of the Soils

This section relates the five major factors of soil formation to the soils in the survey area. It also explains the processes of soil formation.

## Factors of Soil Formation

Soil forms through the interaction of five major factors—the physical, chemical, and mineralogical composition of the parent material; the climate under which the soil material has accumulated and has 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 that the processes of soil formation have acted on the parent material (Jenny, 1941).

Climate and plant and animal life are the active forces of 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 affects the kind of soil profile that forms and, in some extreme cases, determines it almost entirely. Finally, time is needed for the differentiation of soil horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

### Parent Material

Parent material is the unconsolidated mass in which a soil forms. It affects the limits of the chemical and mineralogical composition of the soil. In this survey, nearly all of the parent materials were deposited by glaciers or glacial meltwater that covered the area about 10,000 years ago. Although most of the parent materials in Mackinac 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 Mackinac County were deposited as glacial till, lacustrine material, outwash material, eolian material, or organic material. The soil mantle ranges from a few inches to more than 100 feet in thickness. In many areas of the county, limestone bedrock is at a shallow depth or is exposed. In the Straits area, calcareous shale bedrock and limestone breccia are at a shallow depth or are exposed.

Glacial till was deposited directly by glaciers with minimal 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 water. Battydoe, Cozy, and Greylock soils are examples of soils that formed in glacial till on ground moraines and drumlins.

Lacustrine material was deposited from still, or ponded, glacial meltwater. It consists of fine soil particles, such as very fine sand, silt, and clay, that settled out in still water. Glawe soils are lacustrine soils that formed in deposits of very fine sand and silt, and Pickford soils are lacustrine soils that formed in deposits of clay.

Outwash material was deposited by running water from melting glaciers. The size of the particles depends on the speed of the stream that carried the material. The water deposited the coarser particles as it slowed down. Slowly moving water carried the finer particles, such as very fine sand, silt, and clay. Outwash deposits generally occur as layers of particles of similar size, such as sand, gravel, or other coarse particles. Kalkaska and Guardlake soils formed in deposits of outwash material.

Eolian material was deposited by wind action. In Mackinac County, it consists of sand deposited on dunes. Pullup soils are examples of soils that formed in eolian material.

Organic material occurs as deposits of plant residue. After the glaciers withdrew from an area, water remained standing in depressions on outwash plains, flood plains, till plains, and lake plains. Grasses and sedges grew around the edges of these lakes. When these plants died, the residue did not decompose because the areas were wet. Later, water-tolerant trees grew in these areas. After these trees died, their residue became part of the organic accumulation.

Eventually, the lakes were filled with organic material and developed into areas of muck. Carbondale and Loxley soils formed in organic material.

### Plant and Animal Life

Plants, animals, insects, bacteria, and fungi are important in the formation of soils. Additions of organic matter and nitrogen in the soil, gains or losses in plant nutrients, and alterations of soil structure and porosity are among the changes caused by living organisms. In this survey area, vegetation, dominantly hardwood and coniferous trees, has had a stronger effect than other living organisms on soil formation.

### Climate

Climate determines the kind of plant and animal life on and in the soil and the amount of water available for the weathering of minerals and the translocation of soil material. Through its influence on soil temperature, climate also determines the rate of chemical reaction in the soil.

The climate in Mackinac County is cool and humid. It is presumed to be similar to that under which the soils formed. The climate generally is uniform in all areas, except for areas near the shorelines of Lake Michigan and Lake Huron. Only minor differences among the soils in the county result from differences in climate.

### Relief

Relief affects soil formation through its influence on runoff, erosion, drainage, soil temperature, and plant cover. It causes erosional and depositional changes and thus alters the influence of the parent material and of time (Jenny, 1941). It alters the effects of climate through its influence on runoff, the water table, aspect, and vegetation.

### Time

Generally, a long time is needed for the development of distinct horizons in a soil profile. The degree of profile development commonly reflects the length of time that the parent material has been in place. Some soils form rapidly; others form slowly.

The soils in Mackinac County range from young to mature. Most of the soils that formed in glacial deposits have been exposed to the soil-forming factors long enough for the development of distinct horizons. Graveraet soils are examples. The soils that formed in recent alluvial material, however, such as Dinkey soils, have not been in place long enough for the development of distinct horizons.

## Processes of Soil Formation

The processes responsible for the development of soil horizons in the unconsolidated parent material are referred to as soil genesis. The physical, chemical, and biological properties of the horizons are known as soil morphology.

Several processes were involved in the development of horizons in the soils of Mackinac County. These are the accumulation of organic matter, the leaching of lime and other bases, the reduction and transfer of iron, and the formation and translocation of silicate clay minerals. More than one of these processes have helped to differentiate horizons in most of the soils.

As organic matter accumulates at the surface, an A horizon forms. The A and E horizons are mixed into a plow layer, or Ap horizon, if the soil is cultivated. The surface layer of the soils in Mackinac County ranges from high to low in organic matter content. The content is high, for example, in Glawe soils and is low in Eastport soils.

Carbonates and other bases have been leached from most of the soils. The leaching of bases generally precedes the translocation of silicate clay minerals. Several of the soils are moderately leached or strongly leached. Graveraet soils, for example, are leached of carbonates to a depth of more than 60 inches, and Ontonagon soils are leached to a depth of 21 inches.

Gleying, or the reduction and transfer of iron, is evident in somewhat poorly drained, poorly drained, and very poorly drained soils. Caffey soils are examples. A gray subsoil indicates the reduction and loss of iron.

The translocation of clay minerals has contributed to horizon development in some soils. An eluviated, or leached, E horizon typically is lower in content of clay and lighter in color than the illuviated B horizon below it. The B horizon typically has an accumulation of clay, or clay films, in pores and on the faces of peds. The soils in which this process has taken place were probably leached of carbonates and soluble salts to a considerable extent before the translocation of silicate clay minerals. Millecoquins soils are examples of soils in which translocated silicate clay minerals in the form of clay films have accumulated in the B horizon.

In many soils in Mackinac County, iron, aluminum, and humus have been transferred from the surface layer to the B horizon. The B horizon in these soils is dark brown. Kalkaska and Spot soils are examples.

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# Glossary

**ABC soil.** A soil having an A, a B, and a C horizon.

**AC soil.** A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

**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.

**Alpha,alpha-dipyridyl.** A dye that when dissolved in 1N ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction indicates a type of redoximorphic feature.

**Aquic conditions.** Current soil wetness characterized by saturation, reduction, and redoximorphic features.

**Area reclaim** (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

**Argillic horizon.** A subsoil horizon characterized by an accumulation of illuvial clay.

**Association, soil.** A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

**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:

| | |
|---|---|
| Very low | 0 to 3 |
| Low | 3 to 6 |
| Moderate | 6 to 9 |
| High | 9 to 12 |
| Very high | more than 12 |

**Basal area.** The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

**Basal till.** Compact glacial till deposited beneath the ice.

**Base saturation.** The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

**Bedding planes.** Fine strata, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediment.

**Bedrock.** The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

**Bedrock-controlled topography.** A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

**Bisequum.** Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

**Boulders.** Rock fragments larger than 2 feet (60 centimeters) in diameter.

**Breast height.** An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

**Cable yarding.** A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

**Calcareous soil.** A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

**Canopy.** The leafy crown of trees or shrubs. (See Crown.)

**Capillary water.** Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

**Catena.** A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

**Cation.** An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

**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.

**Channery soil material.** Soil material that is, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches (15 centimeters) along the longest axis. A single piece is called a channer.

**Chemical treatment.** Control of unwanted vegetation through the use of chemicals.

**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 depletions.** Low-chroma zones having a low content of iron, manganese, and clay because of the chemical reduction of iron and manganese and the removal of iron, manganese, and clay. A type of redoximorphic depletion.

**Clay film.** A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

**Climax plant community.** 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 textured soil.** Sand or loamy sand.

**Cobble (or cobblestone).** A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

**Cobbly soil material.** Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

**Complex slope.** Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

**Complex, soil.** A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

**Concretions.** Cemented bodies with crude internal symmetry organized around a point, a line, or a plane. They typically take the form of concentric layers visible to the naked eye. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up concretions. If formed in place, concretions of iron oxide or manganese oxide are generally considered a type of redoximorphic concentration.

**Conglomerate.** A coarse grained, clastic rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

**Conservation cropping system.** Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

**Conservation tillage.** A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

**Consistence, soil.** Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the "Soil Survey Manual."

**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 that

part of the soil profile between depths of 10 inches and 40 or 80 inches.

**Coprogenous earth (sedimentary peat).** Fecal material deposited in water by aquatic organisms.

**Corrosion.** Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

**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.

**Cropping system.** Growing crops according to a planned system of rotation and management practices.

**Crop residue management.** Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

**Cross-slope farming.** Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

**Crown.** The upper part of a tree or shrub, including the living branches and their foliage.

**Culmination of the mean annual increment (CMAI).** The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

**Cutbanks cave** (in tables). The walls of excavations tend to cave in or slough.

**Depth, soil.** Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

**Depth to rock** (in tables). Bedrock is too near the surface for the specified use.

**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 wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained.* These classes are defined in the "Soil Survey Manual."

**Drainage, surface.** Runoff, or surface flow of water, from an area.

**Draw.** A small stream valley that generally is more open and has broader bottom land than a ravine or gulch.

**Drumlin.** A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

**Duff.** A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

**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.

**Endosaturation.** A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

**Eolian soil material.** Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

**Ephemeral stream.** A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

**Episaturation.** A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of the surface.

**Erosion.** The wearing away of the land surface by 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 human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

**Escarpment.** A relatively continuous and steep slope or

cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Synonym: scarp.

**Excess fines** (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

**Fast intake** (in tables). The rapid movement of water into the soil.

**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.

**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.

**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.*

**Fine textured soil.** Sandy clay, silty clay, or clay.

**Flaggy soil material.** Material that is, by volume, 15 to 35 percent flagstones. Very flaggy soil material has 35 to 60 percent flagstones, and extremely flaggy soil material has more than 60 percent flagstones.

**Flagstone.** A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

**Flat.** A general term for a level or nearly level surface, or a small area of land marked by little or no relief.

**Flood plain.** A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

**Forb.** Any herbaceous plant not a grass or a sedge.

**Forest cover.** All trees and other woody plants (underbrush) covering the ground in a forest.

**Forest type.** A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

**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** (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other 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.** Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

**Glacial outwash.** Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

**Glacial till.** Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

**Glaciofluvial deposits.** 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.

**Glaciolacustrine deposits.** Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

**Gleyed soil.** Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

**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 as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

**Gravelly soil material.** Material that is 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

**Green manure crop** (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

**Ground water.** Water filling all the unblocked pores of the material below the water table.

**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.

**Hard bedrock.** Bedrock that cannot be excavated except by blasting or by the use of special

equipment that is not commonly used in construction.

**Hemic soil material (mucky peat).** Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

**Hill.** A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline; hillsides generally have slopes of more than 15 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

**Horizon, soil.** A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the "Soil Survey Manual." The major horizons of mineral soil are as follows:
*O horizon.*—An organic layer of fresh and decaying plant residue.
*A horizon.*—The mineral horizon 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.
*E horizon.*—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.
*B horizon.*—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.
*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 overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.
*Cr horizon.*—Soft, consolidated bedrock beneath the soil.
*R layer.*—Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

**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 potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties are depth to a seasonal high water table, the infiltration rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

**Illuviation.** The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

**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.

**Intermittent stream.** A stream, or reach of a stream, that flows for prolonged periods only when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

**Iron depletions.** Low-chroma zones having a low content of iron and manganese oxide because of chemical reduction and removal, but having a clay content similar to that of the adjacent matrix. A type of redoximorphic depletion.

**Karst** (topography). The relief of an area underlain by limestone that dissolves in differing degrees, thus forming numerous depressions or small basins.

**Knoll.** A small, low, rounded hill rising above adjacent landforms.

**Lacustrine deposit.** Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

**Lake plain** (geology). A nearly level surface marking the floor of an extinct lake filled in by well sorted, coarse textured to fine textured, stratified sediments.

**Landslide.** The rapid downhill movement of a mass of

soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

**Large stones** (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

**Leaching.** The removal of soluble material from soil or other material by percolating water.

**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.

**Loess.** Fine grained material, dominantly of silt-sized particles, deposited by wind.

**Low-residue crops.** Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

**Low strength.** The soil is not strong enough to support loads.

**Marl.** An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal amounts.

**Masses.** Concentrations of substances in the soil matrix that do not have a clearly defined boundary with the surrounding soil material and cannot be removed as a discrete unit. Common compounds making up masses are calcium carbonate, gypsum or other soluble salts, iron oxide, and manganese oxide. Masses consisting of iron oxide or manganese oxide generally are considered a type of redoximorphic concentration.

**Mechanical treatment.** Use of mechanical equipment for seeding, brush management, and other management practices.

**Medium textured soil.** Very fine sandy loam, loam, silt loam, or silt.

**Metamorphic rock.** Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

**Mineral soil.** Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

**Minimum tillage.** Only the tillage essential to crop production and prevention of soil damage.

**Miscellaneous area.** An area that has little or no natural soil and supports little or no vegetation.

**Moderately coarse textured soil.** Coarse sandy loam, sandy loam, or fine sandy loam.

**Moderately fine textured soil.** Clay loam, sandy clay loam, or silty clay loam.

**Mollic epipedon.** A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

**Moraine.** An accumulation of earth, stones, and other debris deposited by a glacier. Some 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. 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, finely divided, well decomposed organic soil material. (See Sapric soil material.)

**Mucky peat.** Organic soil material intermediate in degree of decomposition between the less decomposed peat and the more decomposed muck.

**Munsell notation.** A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

**Neutral soil.** A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

**Nodules.** Cemented bodies lacking visible internal structure. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up nodules. If formed in place, nodules of iron oxide or manganese oxide are considered types of redoximorphic concentrations.

**Nutrient, plant.** Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

**Organic mat.** A zone of accumulation of organic material, such as leaves, twigs, and grasses, in various stages of decomposition, that lies above the mineral soil. Often described in forested

regions; commonly called a duff layer.

**Organic matter.** Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

| | |
|---|---|
| Very low | less than 0.5 percent |
| Low | 0.5 to 1.0 percent |
| Moderately low | 1.0 to 2.0 percent |
| Moderate | 2.0 to 4.0 percent |
| High | 4.0 to 8.0 percent |
| Very high | more than 8.0 percent |

**Ortstein.** A hardened mass or layer in the soil in which the cementing material consists of illuviated compounds of iron and aluminum and organic matter.

**Outwash plain.** A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it generally is low in relief.

**Pan.** A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

**Parent material.** The unconsolidated organic and mineral material in which soil forms.

**Peat.** Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

**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 movement of water through the soil.

**Percs slowly** (in tables). The slow movement of water through the soil adversely affects the specified use.

**Permeability.** The quality of the soil that enables water or air to move downward through the profile. The rate at which a saturated soil transmits water is accepted as a measure of this quality. In soil physics, the rate is referred to as "saturated hydraulic conductivity," which is defined in the "Soil Survey Manual." In line with conventional usage in the engineering profession and with traditional usage in published soil surveys, this rate of flow continues to be expressed as "permeability." Terms describing permeability, measured in inches per hour, are as follows:

| | |
|---|---|
| Extremely slow | 0.0 to 0.01 inch |
| Very slow | 0.01 to 0.06 inch |
| Slow | 0.06 to 0.2 inch |
| Moderately slow | 0.2 to 0.6 inch |
| Moderate | 0.6 inch to 2.0 inches |
| Moderately rapid | 2.0 to 6.0 inches |
| Rapid | 6.0 to 20 inches |
| Very rapid | more than 20 inches |

**Phase, soil.** A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

**pH value.** A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

**Piping** (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through 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 semisolid to plastic.

**Ponding.** Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

**Poor filter** (in tables). Because of rapid or very rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

**Poorly graded.** Refers to a coarse grained soil or 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.

**Potential native plant community.** See Climax plant community.

**Potential rooting depth (effective rooting depth).** Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

**Prescribed burning.** Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.

**Productivity, soil.** The capability of a soil for producing a specified plant or sequence of plants under specific management.

**Profile, soil.** A vertical section of the soil extending through all its horizons and into the parent material.

**Proper grazing use.** Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction capacity of the key plants and promotes the accumulation of litter and mulch

necessary to conserve soil and water.

**Reaction, soil.** A measure 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 degrees of acidity or alkalinity, expressed as pH values, are:

| | |
|---|---|
| Ultra acid | less than 3.5 |
| Extremely acid | 3.5 to 4.4 |
| Very strongly acid | 4.5 to 5.0 |
| Strongly acid | 5.1 to 5.5 |
| Moderately acid | 5.6 to 6.0 |
| Slightly acid | 6.1 to 6.5 |
| Neutral | 6.6 to 7.3 |
| Slightly 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 |

**Red beds.** Sedimentary strata that are mainly red and are made up largely of sandstone and shale.

**Redoximorphic concentrations.** Nodules, concretions, soft masses, pore linings, and other features resulting from the accumulation of iron or manganese oxide. An indication of chemical reduction and oxidation resulting from saturation.

**Redoximorphic depletions.** Low-chroma zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay has been removed. These zones are indications of the chemical reduction of iron resulting from saturation.

**Redoximorphic features.** Redoximorphic concentrations, redoximorphic depletions, reduced matrices, a positive reaction to alpha,alpha-dipyridyl, and other features indicating the chemical reduction and oxidation of iron and manganese compounds resulting from saturation.

**Reduced matrix.** A soil matrix that has low chroma in situ because of chemically reduced iron (Fe II). The chemical reduction results from nearly continuous wetness. The matrix undergoes a change in hue or chroma within 30 minutes after exposure to air as the iron is oxidized (Fe III). A type of redoximorphic feature.

**Regolith.** The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

**Relief.** The elevations or inequalities of a land surface, considered collectively.

**Residuum (residual soil material).** Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

**Ridge.** A long, narrow elevation of the land surface, generally sharp crested with steep sides and forming an extended upland between valleys.

**Road cut.** A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

**Rock fragments.** Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

**Rooting depth** (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

**Root zone.** The part of the soil that can be penetrated by plant roots.

**Runoff.** The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil 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.

**Sandstone.** Sedimentary rock containing dominantly sand-sized particles.

**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.

**Saturation.** Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

**Sedimentary rock.** Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

**Seepage** (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

**Sequum.** A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

**Series, soil.** A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

**Shale.** Sedimentary rock formed by the hardening of a clay deposit.

**Shrink-swell** (in tables). 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.

**Silica-sesquioxide ratio.** The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

**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.

**Similar soils.** Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

**Sinkhole.** A depression in the landscape where limestone has been dissolved.

**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.

**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. The slope classes used in this survey are as follows:

| | |
|---|---|
| Level or nearly level | 0 to 3 percent |
| Nearly level and undulating | 0 to 6 percent |
| Gently rolling and rolling | 6 to 15 percent |
| Rolling to steep | 15 to 35 percent |
| Very steep | 35 percent and higher |

**Slope** (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

**Slow refill** (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

**Small stones** (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

**Soft bedrock.** Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

**Soil.** A natural, three-dimensional body at the earth's surface. It 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, in millimeters, of separates recognized in the United States are as follows:

| | |
|---|---|
| Very coarse sand | 2.0 to 1.0 |
| Coarse sand | 1.0 to 0.5 |
| Medium sand | 0.5 to 0.25 |
| Fine sand | 0.25 to 0.10 |
| Very fine sand | 0.10 to 0.05 |
| Silt | 0.05 to 0.002 |
| Clay | less than 0.002 |

**Solum.** The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

**Stone line.** A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

**Stones.** Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

**Stony.** Refers to a soil containing stones in numbers that interfere with or prevent tillage.

**Structure, soil.** The arrangement of primary soil particles into compound particles or 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 grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

**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 E horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

**Surface layer.** 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."

**Surface soil.** The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

**Terminal moraine.** A belt of thick glacial drift that generally marks the termination of important glacial advances.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

**Thin layer** (in tables). Otherwise suitable soil material that is too thin for the specified use.

**Till plain.** An extensive area of nearly level to undulating soils underlain by glacial till.

**Tilth, soil.** The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

**Toe slope.** The outermost inclined surface at the base of a hill; part of a foot slope.

**Topsoil.** The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

**Trace elements.** Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

**Upland.** Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

**Variegation.** Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

**Varve.** A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

**Water bars.** Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

**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 soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such 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 a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

**Windthrow.** The uprooting and tipping over of trees by the wind.

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