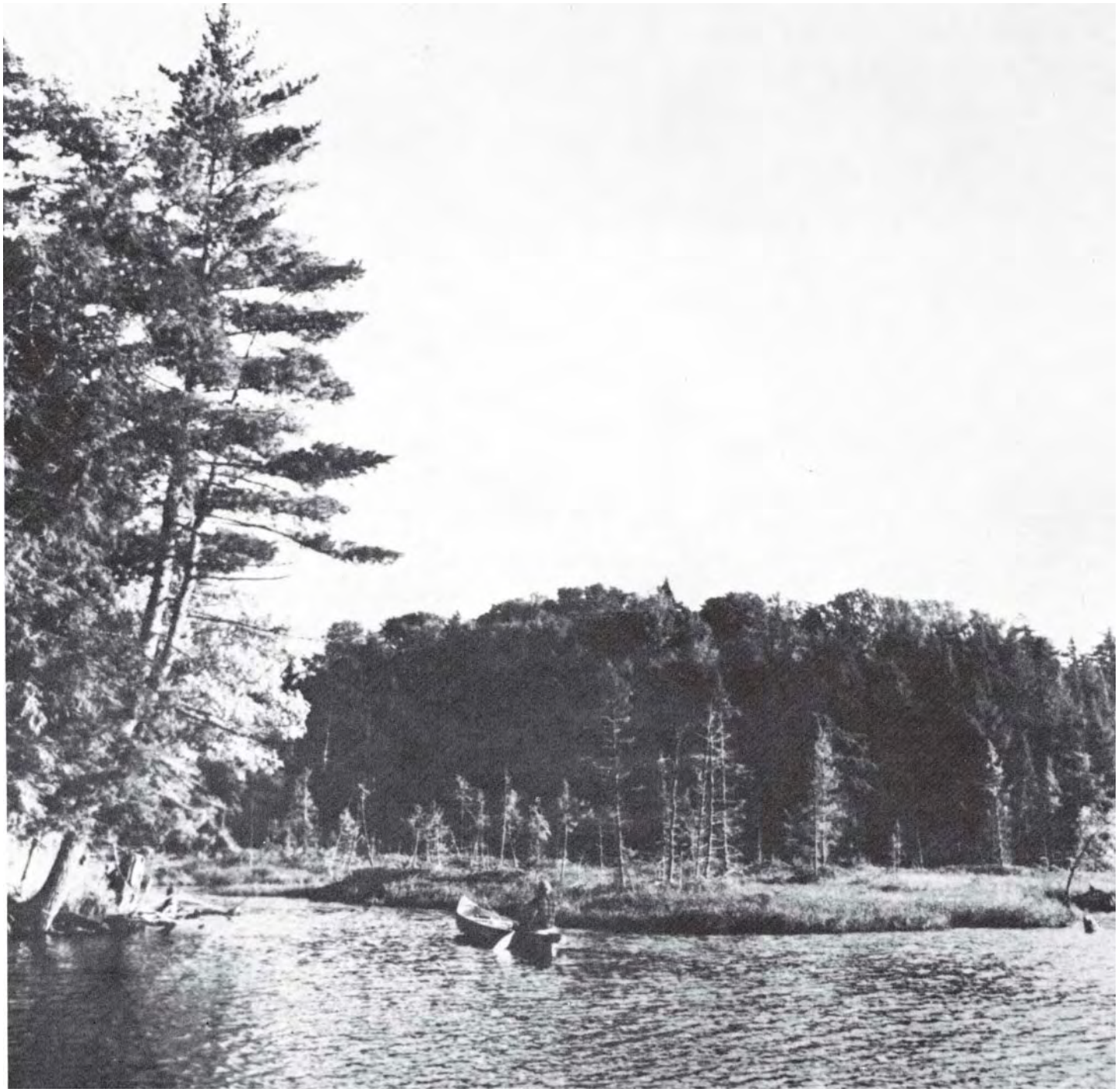
United States Department of Agriculture

Soil Conservation Service

In cooperation with United States Department of Agriculture, Forest Service, and Minnesota Agricultural Experiment Station

Soil Survey of Itasca County, Minnesota



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How To Use This Soil Survey

General Soil Map

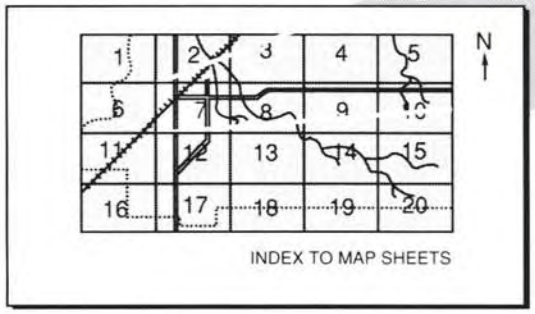
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

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.

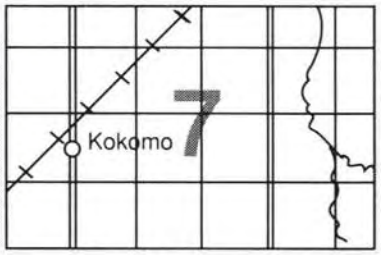
Detailed Soil Maps

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.



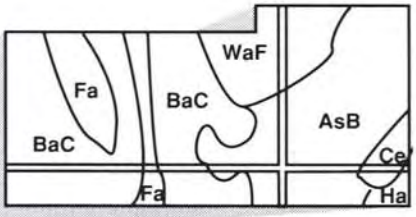
INDEX TO MAP SHEETS



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 Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1980. Soil names and descriptions were approved in 1981. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1981. This survey was made cooperatively by the Soil Conservation Service, the Forest Service, and the Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Itasca County Soil and Water Conservation District.

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.

Cover: A forested area of Warba soils adjacent to a small lake in the northern part of Itasca County.

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Soil Series

Issued August 1987

Reviewed and Approved for Reprinting—December 1990

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Summary of Tables

Foreword

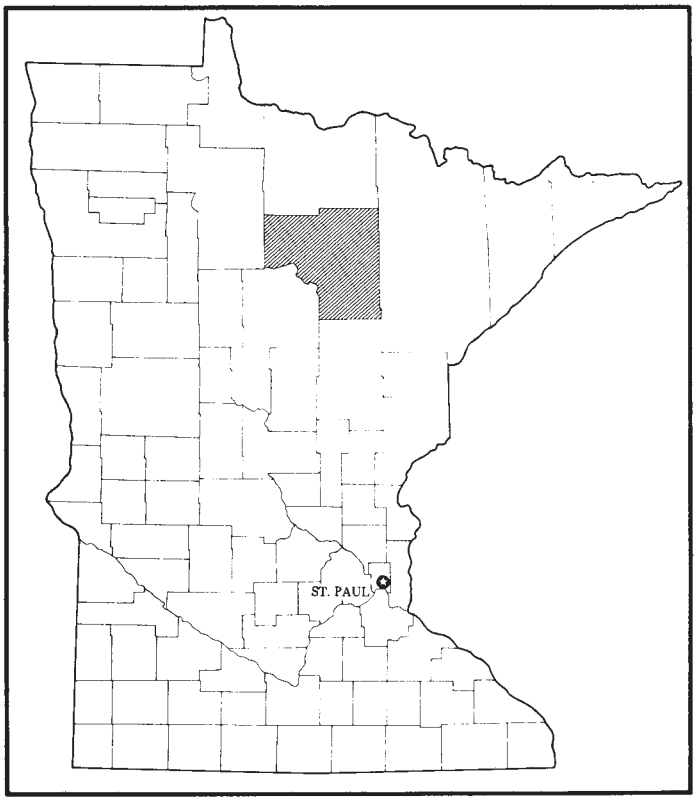
This soil survey contains information that can be used in land-planning programs in Itasca County, Minnesota. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Foresters, farmers, 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.

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 Soil Conservation Service or the Cooperative Extension Service.

Donald G. Ferren
State Conservationist
Soil Conservation Service



Location of Itasca County in Minnesota.

Soil Survey of Itasca County, Minnesota

By Paul R. Nyberg, Soil Conservation Service

Fieldwork by Paul R. Nyberg, Jerry A. Sharp, Alan E. Jacobson, and Brandt L. Heikel, Soil Conservation Service; Grant L. Goltz, Forest Service; and Jeffrey N. Bilkert and Timothy N. Richardson, Minnesota Agricultural Experiment Station

United States Department of Agriculture, Soil Conservation Service and Forest Service, in cooperation with the Minnesota Agricultural Experiment Station

General Nature of the County

Itasca County is in the north-central part of Minnesota. It has a total land area of 1,856,000 acres, or 2,900 square miles, of which 1,685,300 acres, or 2,633 square miles, is land and about 170,700 acres, or 267 square miles, is water. Grand Rapids is the county seat.

About 1,331,600 acres in the county is forest land. About 121,000 acres is farmland. About 74,000 acres of the farmland is cultivated. Mining, recreation enterprises, and agriculture contribute significantly to the economy of the county.

The upland soils in the county are mainly light colored and formed in glacial material under forest vegetation. About one-fourth of the county consists of organic soils that formed mainly in plant material in bogs and swamps.

Itasca County was named after a lake near the source of the Mississippi River. Previously, the name Itasca applied to a significantly larger area. This area extended from just north of Mille Lacs Lake to the Canadian border. It included lands east of the Mississippi River. Parts of the present Aitkin and Cass Counties and all of the present Carlton, Cook, Itasca, Koochiching, Lake, and St. Louis Counties were in the original area.

Itasca County was officially organized by an act of the state legislature on March 7, 1891. Early settlement began in the 1860's, principally by people who came to harvest the timber in the vast pine forests. In 1870, the population was only 96. By 1872, the county had 17 lumber camps, which employed 400 people. Mining exploration began in the 1880's. In the 1890's, several iron mines were opened. As mining expanded, the Iron Range communities were established.

Farming began in the late 1800's. The number of farms increased significantly in the early 1900's. In 1890, the county had only 18 farms. By 1920, it had 1,436 farms, which made up 168,976 acres, or nearly 10 percent of the total area. The extent of mining and farming has decreased in recent years.

The population of Itasca County was 32,996 in 1940. In 1980, it was 43,069. The county has 14 incorporated cities—Bigfork, Bovey, Calumet, Coleraine, Deer River, Effie, Grand Rapids, Keewatin, Marble, Nashwauk, Squaw Lake, Taconite, Warba, and Zemple. The largest of these is Grand Rapids, which had a population of 7,934 in 1980.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

In Itasca County, winters are very cold and summers are short and fairly warm. The short freeze-free period during the summer limits cropping mainly to forage, small grains, and adapted vegetables. Precipitation is fairly well distributed throughout the year, reaching a slight peak in summer. Snow covers the ground much of the time from late fall through early spring.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Grand Rapids,

Minnesota, in the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 11 degrees F, and the average daily minimum temperature is 0 degrees. The lowest temperature on record, which occurred at Grand Rapids on January 15, 1972, is -43 degrees. In summer the average temperature is 65 degrees, and the average daily maximum temperature is 77 degrees. The highest recorded temperature, which occurred at Grand Rapids on June 10, 1956, is 94 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 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 about 26 inches. Of this, 19 inches, or 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 16 inches. The heaviest 1-day rainfall during the period of record was 4.44 inches at Grand Rapids on October 9, 1973. Data gathered since the period of record show that the heaviest rainfall recorded in a 24-hour period was 7.41 inches on July 2 and 3, 1979, near Spider Lake, about 18 miles north of Grand Rapids. Thunderstorms occur on about 35 days each year.

The average seasonal snowfall is 57 inches. The greatest snow depth at any one time during the period of record was 35 inches. On the average, 65 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 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 65 percent of the time possible in summer and 45 percent in winter. The prevailing wind is from the west-northwest. Average windspeed is highest, 13 miles per hour, in spring.

Soils occasionally freeze to a depth of several feet when very cold temperatures occur before the ground is appreciably covered with snow. Usually, the soils are frozen in only the top few inches or to a depth of about 1 foot, except where the snow cover has been removed.

Transportation Facilities

One railway crosses the southern part of the county, generally parallel to U.S. Highway 2. Another railway crosses the northwestern part of the county. No railroad passenger service is available. The railways are used mostly by the forestry and mining industries.

The major routes in Itasca County are U.S. Highway 2, 71, and 169 and Minnesota Highways 1, 6, 46, 65, and 38. Minnesota Highway 38 is a scenic route entirely within Itasca County. A significant network of other highways provides ready access to most parts of the county. The major airport is at Grand Rapids.

Water Supply

The water for human consumption in Itasca County is drawn from two major sources. These are glacial drift and Precambrian rock, including the iron formations of the Mesabi Range. The glacial drift is the most common water source for domestic uses. It also supplies some of the water for city and industrial uses. It is less than 50 feet thick in the vicinity of the Iron Range and near rock outcrops. The maximum thickness is about 450 feet. Water from the glacial drift commonly has a high content of dissolved solids, mainly calcium and magnesium carbonates and bicarbonates. Some wells also have a high content of iron and manganese.

Wells in the vicinity of the Iron Range commonly extend into the Precambrian rock and iron formations. Municipal wells in these formations commonly are about 500 to 600 feet deep. They typically supply water that has a high content of iron and manganese.

In some areas in the northeastern part of the county, the glacial drift is too shallow over bedrock to be an adequate water supply. Many wells in these areas are drilled into the rock, commonly to a depth of more than 100 feet. They provide an adequate water supply for farms and rural residences.

A few areas have an artesian water supply that generally is quite highly mineralized. Pits and ponds provide water for livestock. They are commonly filled by collecting surface runoff or by horizontal subsurface flow in areas that have a high water table.

Forestry

The large pine trees that attracted the early settlers have been cut, except for a few scattered trees. The major land use in Itasca County, however, is still forestry. In 1977, the county had 1,331,600 acres of forest land. Of this, about 49,000 acres was classified as nonproductive. Of the productive commercial forest, which makes up 1,281,000 acres, about 734,000 acres is in public ownership. Of this publicly owned land, 264,900 acres is national forest, 233,600 acres is in state ownership, and 235,900 acres is in county and municipal ownership. Farmers own 206,900 acres of forest land; paper and chipboard companies, 131,300 acres; miscellaneous private corporations, 85,300 acres; and private individuals, 121,600 acres. About 1,500 acres is Indian land.

Aspen is the principal forest cover type. It covers about 42 percent of the forested acreage. Conifers cover

about 29 percent. About half are upland conifers, such as jack pine, red pine, white pine, balsam fir, and white spruce. The other half are lowland species, such as black spruce, northern white-cedar, and tamarack. Deciduous species cover about 27 percent. About 2 percent of the forest land is considered nonstocked. Itasca County is in the prime growth zone for aspen and has a significant potential for providing needed wood supplies (*6*).

Physiography, Relief, and Drainage

The physiography of Itasca County is related to the multiple forces at work during continental glaciation. The major landforms are the Aitkin, Agassiz, and Upham lacustrine plains; the Marcell moraine complex; the Nashwauk-Warba, Northome, and Sugar Hills moraines; the Blackduck and Swatara till plains; the Bemidji and Prairie River sand plains; and the Mesabi Range Formation. Bedrock-controlled topography is prominent on the Mesabi Range and in several isolated areas in the northeastern part of the county.

Elevation ranges from 1,230 feet above sea level where the Mississippi River leaves the county to 1,752 feet on the Sugar Hills moraine. Generally, it is less than 1,350 feet on the Aitkin and Upham lacustrine plains and 1,300 to 1,400 feet on the Agassiz lacustrine plain. On this lake plain, most of the slopes are gentle and local relief commonly is less than 10 feet. On the till plains and sand plains, slopes are nearly level to rolling and local relief commonly is 5 to 20 feet. Relief of 50 to 100 feet or more is fairly common on the moraines, on the Mesabi Range Formation, and near rock outcrops in several areas in the northeastern part of the county.

The headwaters of the Mississippi River drain about 52 percent of the county. The runoff flows southward. The Bigfork River drains about 35 percent of the county. Tributaries of the Littlefork River drain about 8 percent, and those of the Red Lake River drain about 2 percent. The Bigfork, Littlefork, and Red Lake Rivers ultimately drain into the Hudson Bay. Tributaries of the St. Louis River drain about 3 percent of the county. Numerous lakes and bogs also collect runoff. Several dams on the major lakes in the Mississippi River system help to control flooding (*7*).

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; 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 biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil 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-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 soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, 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. 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 interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to

meet local needs. Data were 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 farm records and from field or plot experiments on the same kinds of soil.

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 state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure 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.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. 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 soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns 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 (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

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

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit is a unique natural landscape. Typically, it consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in 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, Organic Soils in Upland Depressions

These soils formed dominantly in organic material of herbaceous and woody origin. They are very poorly drained. They are used dominantly as forest land.

1. Greenwood-Mooselake-Lupton

Nearly level, very poorly drained soils that formed in organic deposits; in upland bogs and depressions

This map unit is on lake plains, glacial moraines, and outwash plains. Local relief ranges from 2 to 5 feet. Slopes range from 0 to 2 percent.

This map unit makes up about 12 percent of the county. It is about 30 percent Greenwood soils, 20 percent Mooselake soils, 15 percent Lupton soils, and 35 percent minor soils, mainly other organic soils (fig. 1).

The Greenwood soils are extremely acid. They formed mainly in herbaceous material derived from reeds and sedges. Most of this material is moderately decomposed. Typically, the surface layer is light brownish gray peat about 15 inches thick. Below this to a depth of at least 51 inches is dark reddish brown and dark brown mucky peat.

The Mooselake soils are strongly acid to neutral. They formed mainly in woody material. Most of this material is moderately decomposed. Typically, the surface layer is pale brown mucky peat about 3 inches thick. The next layer is black mucky peat about 12 inches thick. Below this to a depth of at least 51 inches is dark reddish brown and black mucky peat that has woody fragments.

The Lupton soils are strongly acid to mildly alkaline. They formed mainly in woody material. Most of this material is well decomposed. Typically, the surface layer is pale brown peat about 2 inches thick. The next layer is black mucky peat about 6 inches thick. Below this to a depth of at least 51 inches is black peaty muck and muck.

Minor in this map unit are the organic Cathro, Dora, Loxley, and Rifle soils.

Most areas are forested. Black spruce and tamarack grow on the Greenwood soils. A wider range of species grows on the Mooselake and Lupton soils, including northern white-cedar, balsam fir, and lowland hardwoods, such as black ash and American elm. Harvesting and planting are limited by wetness and low soil strength. Tree growth and yields are low.

Many areas of this map unit are unsuitable for cultivated crops because the wetness is a severe limitation. A drainage system generally cannot be installed. A few areas are pastured and used for forage. This map unit is generally unsuitable for building site development and most sanitary facilities because of the wetness. Wild rice is grown in a few areas where rice paddies have been established.

Nearly Level to Very Steep, Loamy and Silty Soils on Uplands

These soils formed dominantly in loamy glacial till or in a silty and loamy mantle and in the underlying loamy glacial till. They are well drained or somewhat poorly drained. They are used dominantly as forest land.

2. Nashwauk-Keewatin

Nearly level to very steep, well drained and somewhat poorly drained, loamy and silty soils that formed in firm glacial till; on till plains and moraines

This map unit is on glacial moraines and till plains. Local relief ranges from 5 to 50 feet. Slopes range from 0 to 35 percent.

This map unit makes up about 15 percent of the county. It is about 55 percent Nashwauk soils, 15 percent Keewatin soils, and 30 percent minor soils (fig. 2).

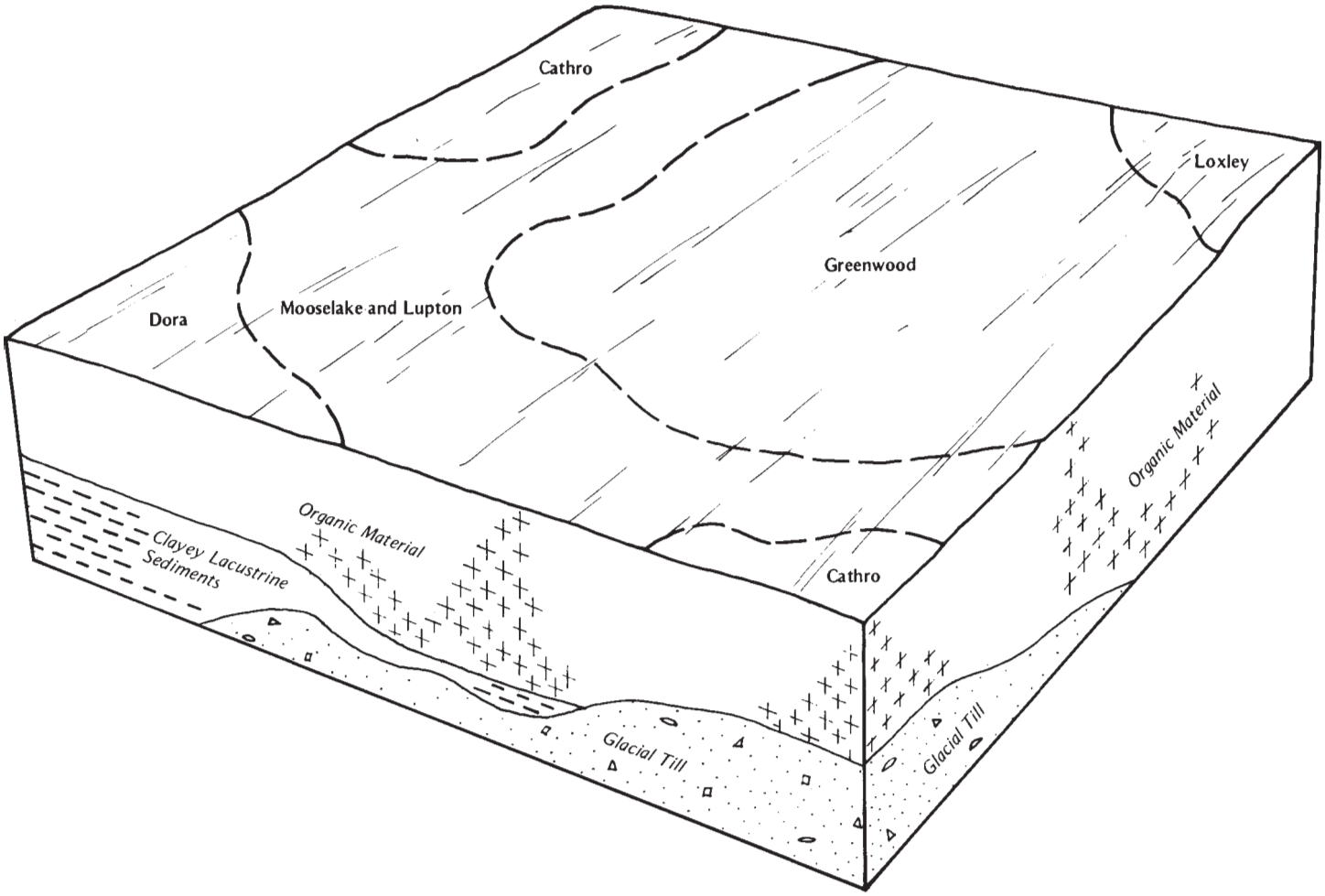


Figure 1.—Pattern of soils and parent material in the Greenwood-Mooselake-Lupton map unit.

The nearly level to very steep, well drained Nashwauk soils generally are on complex slopes. They typically have about 0.5 inch of organic forest litter at the surface. The surface layer is very dark gray fine sandy loam about 1 inch thick. The next layer is grayish brown fine sandy loam about 3 inches thick. The upper subsoil is yellowish brown fine sandy loam about 3 inches thick. The next layer is firm and brittle, brown, grayish brown, and light brownish gray loam about 9 inches thick. The lower subsoil to a depth of at least 60 inches is brown and light olive brown loam and silt loam.

The nearly level, somewhat poorly drained Keewatin soils are on plane and concave slopes. They typically have about 1 inch of organic forest litter at the surface. The surface layer is very dark gray and black silt loam about 1 inch thick. The subsurface layer is light brownish gray and grayish brown, mottled fine sandy loam about 15 inches thick. It is firm, dense, and brittle in the lower part. The next layer is about 10 inches of grayish brown, brown, and yellowish brown, mottled loam and light brownish gray fine sandy loam. This layer is firm, dense, and brittle. The subsoil is about 34 inches of brown and grayish brown, mottled, firm loam. The underlying material to a depth of at least 65 inches also is brown and grayish brown, mottled loam.

Minor in this map unit are the very poorly drained Blackhoof, Cathro, and Loxley soils in depressions, the well drained and moderately well drained Cutaway soils on convex slopes on sand-mantled till plains, and the somewhat poorly drained Sandwick soils in the less sloping areas on the sand-mantled till plains.

Most areas are forested. This map unit is well suited to the commonly grown deciduous species and most of the commonly grown conifers. The use of equipment is limited during wet periods. Operating the equipment is hazardous in the steeper areas of the Nashwauk soils.

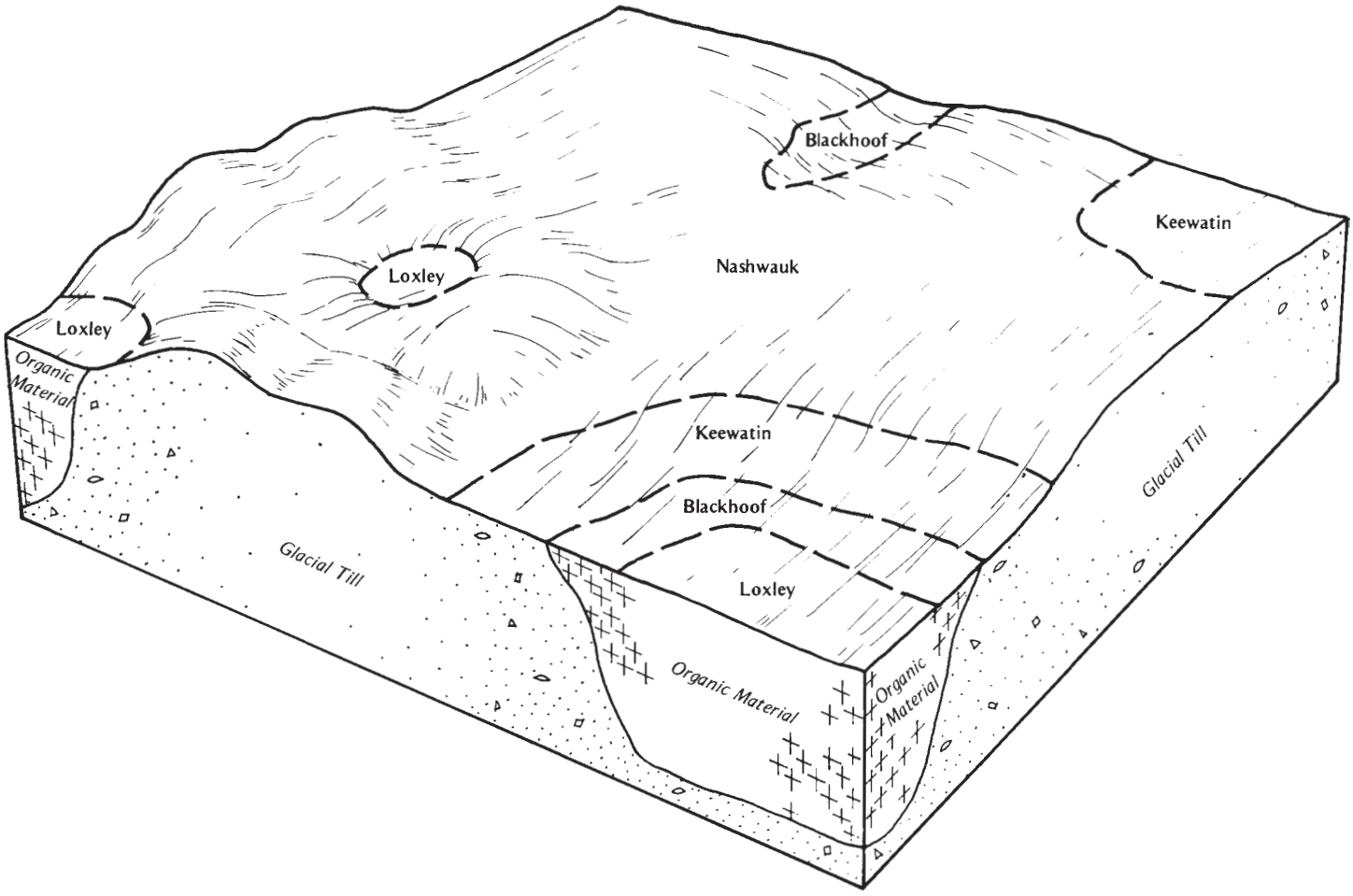


Figure 2.—Pattern of soils and parent material in the Nashwauk-Keewatin map unit.

These soils are wet for shorter periods than the Keewatin soils.

The major soils are fairly well suited or poorly suited to cultivated crops. Erosion is the main management concern. The dense subsurface layer and subsoil limit root penetration and the downward movement of air and water. Also, Keewatin soils are limited by wetness, which affects their use for a significant part of most years.

In most areas this map unit is fairly well suited or poorly suited to building site development and most sanitary facilities. The major management concerns are the wetness of the Keewatin soils and the slope of the steeper Nashwauk soils.

3. Warba-Nebish

Nearly level to steep, well drained, loamy soils that formed in glacial till; on till plains and moraines

This map unit is mostly on complex slopes on glacial moraines and till plains. Local relief ranges from 5 to 25 feet. Slopes range from 1 to 25 percent.

This map unit makes up about 16 percent of the county. It is about 40 percent Warba soils, 30 percent Nebish soils, and 30 percent minor soils.

The Warba soils typically have about 1 inch of organic forest litter at the surface. The surface layer is very dark gray fine sandy loam about 1 inch thick. The subsurface layer is grayish brown and light brownish gray fine sandy loam about 6 inches thick. The next 5 inches is a mixture of light brownish gray fine sandy loam and dark brown clay loam. The subsoil is light olive brown clay loam about 36 inches thick. The underlying material to a depth of at least 60 inches is light olive brown sandy clay loam.

The Nebish soils typically have a surface layer of very dark gray very fine sandy loam about 2 inches thick. The subsurface layer is grayish brown very fine sandy loam about 6 inches thick. The next 4 inches is dark yellowish brown clay loam and grayish brown very fine sandy

loam. The subsoil is about 27 inches thick. It is yellowish brown and brown, firm loam in the upper part and brown and light olive brown, friable loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown and light yellowish brown, calcareous loam.

Minor in this map unit are Stuntz, Shooker, and Talmoon soils. The somewhat poorly drained Stuntz soils are in nearly level areas and drainageways near the Warba soils. The poorly drained Shooker soils are in nearly level areas and drainageways near the Nebish soils. The very poorly drained Talmoon soils are in shallow depressions.

Most areas are forested. This map unit is well suited to a large number of deciduous species. Many coniferous species also grow well. Operating equipment is hazardous on the steep slopes.

This map unit is well suited to cultivated crops in all areas, except for those where slopes are so steep that erosion is a severe hazard. The steeper areas are fairly well suited to pasture.

The major soils that are nearly level to sloping generally are fairly well suited to building site development and sanitary facilities. In most areas a high shrink-swell potential, slow permeability, and frost action are limitations.

4. Itasca-Goodland

Nearly level to steep, well drained, silty soils that formed in silty and loamy material and in the underlying loamy glacial till or sandy deposits; on till plains and moraines

This map unit is mostly on complex slopes on silt-mantled glacial moraines and till plains. Local relief ranges from 5 to 75 feet. Slopes range from 1 to 25 percent.

This map unit makes up about 8 percent of the county. It is about 50 percent Itasca soils, 25 percent Goodland soils, and 25 percent minor soils (fig. 3).

The Itasca soils typically have about 1.5 inches of organic forest litter at the surface. The surface layer is grayish brown silt loam about 3 inches thick. The subsoil

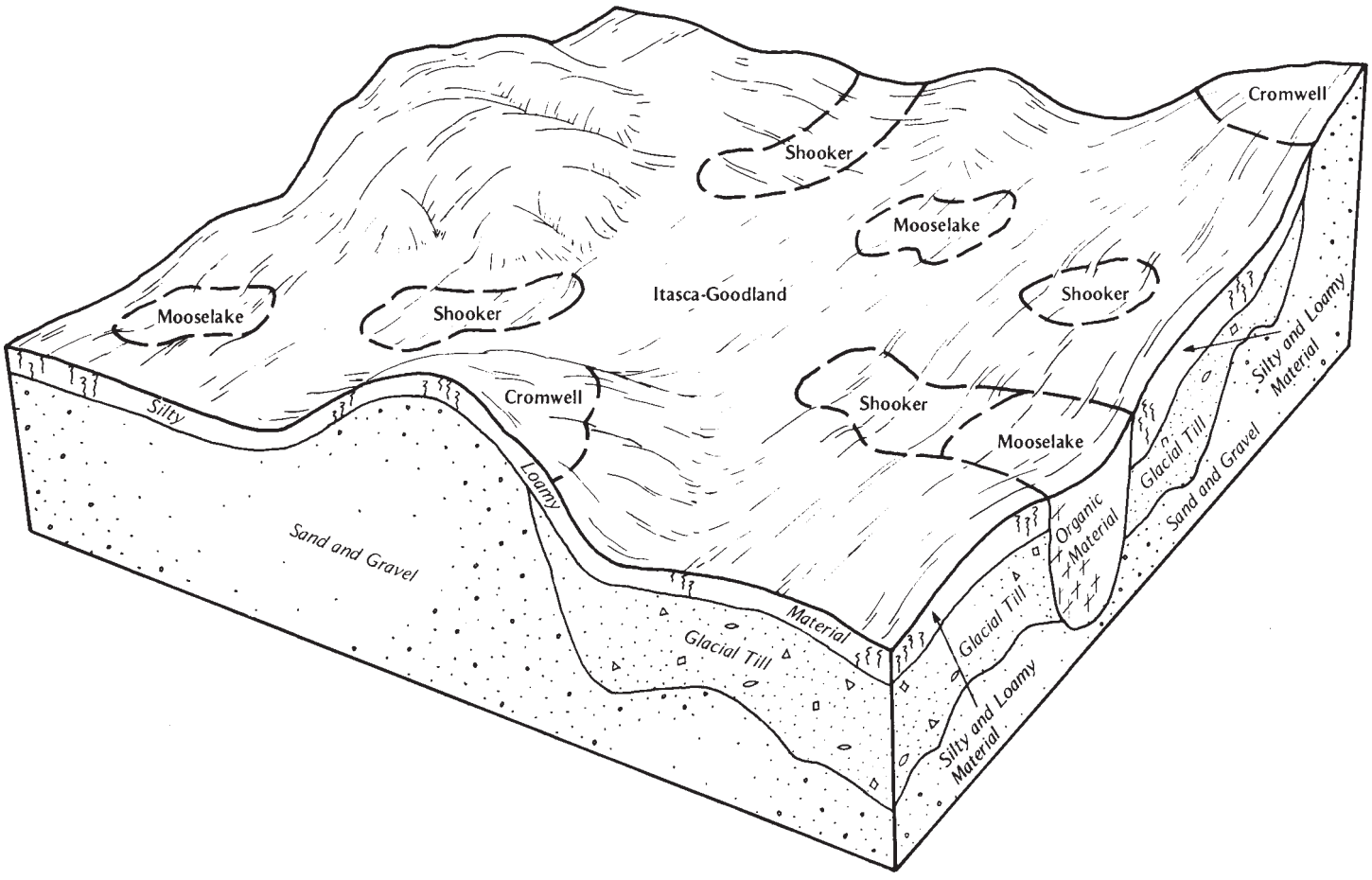


Figure 3.—Pattern of soils and parent material in the Itasca-Goodland map unit.

is about 52 inches thick. In sequence downward, it is yellowish brown silt loam; pale brown silt loam; mixed grayish brown, dark yellowish brown, and dark brown fine sandy loam; yellowish brown fine sandy loam; and brown, mottled fine sandy loam. The underlying material to a depth of at least 60 inches is light olive brown, mottled fine sandy loam.

The Goodland soils typically have about 2 inches of organic forest litter at the surface. The surface layer is grayish brown silt loam about 3 inches thick. The upper subsoil is yellowish brown silt loam about 5 inches thick. Below this is pale brown silt loam about 4 inches thick. The next 6 inches is mixed pale brown and light brownish gray loam and yellowish brown sandy loam. The lower subsoil is about 10 inches of yellowish brown fine sandy loam and 6 inches of brown gravelly loamy coarse sand. The underlying material to a depth of at least 60 inches is yellowish brown and brown gravelly sand.

Minor in this map unit are the excessively drained Cromwell soils on convex slopes, the poorly drained Shooker soils on concave slopes and on flats, the very poorly drained Talmoon soils in depressions, and Cathro, Greenwood, Lupton, and Mooselake soils, which formed in organic material in swamps and bogs.

Most areas are forested. The major soils are well suited to a wide range of native species. Aspen grows particularly well on the Itasca soils. These soils are soft in the spring and after rains. The main management concerns are the equipment limitation on the steeper slopes, especially during wet periods, and control of erosion.

The less sloping major soils are fairly well suited to small grain, hay and pasture, and corn used for silage. Control of erosion is the main management concern. The steeper slopes, which are more susceptible to erosion than the less sloping areas, can be used for hay and pasture. A continuous protective plant cover helps to control erosion on these slopes.

The less sloping major soils are well suited to building site development. Pollution is a hazard if sanitary facilities are installed in the Goodland soils. In many areas the slope is a limitation affecting building site development and sanitary facilities.

Nearly Level to Sloping, Sandy Soils on Uplands

These soils formed dominantly in sandy outwash or in sandy outwash and the underlying glacial till. They are excessively drained to somewhat poorly drained. They are used dominantly as forest land.

5. Menahga-Graycalm

Nearly level to sloping, excessively drained and somewhat excessively drained, sandy soils that formed in glacial outwash; on outwash plains and moraines

This map unit is in smooth areas on outwash plains and moraines. Local relief ranges from 5 to 40 feet. Slopes range from 0 to 10 percent.

This map unit makes up about 10 percent of the county. It is about 45 percent Menahga soils, 30 percent Graycalm soils, and 25 percent minor soils (fig. 4).

The excessively drained Menahga soils typically have a thin layer of organic forest litter at the surface. The surface layer is very dark gray and black loamy coarse sand about 1 inch thick. The subsurface layer is grayish brown loamy coarse sand about 2 inches thick. The subsoil is yellowish brown and brown sand about 35 inches thick. The underlying material to a depth of at least 60 inches is brown coarse sand.

The somewhat excessively drained Graycalm soils typically have a thin layer of organic forest litter at the surface. The surface layer is black loamy sand about 1 inch thick. The subsurface layer is light brownish gray loamy sand about 2 inches thick. The subsoil is about 14 inches of yellowish brown loamy sand and sand. The next 41 inches is light brownish gray and brown loamy sand and sand having thin, dark brown bands of very fine sandy loam and sandy loam. The underlying material to a depth of at least 60 inches is pale brown sand.

Minor in this map unit are the excessively drained, sandy and gravelly Mahtomedi soils on convex slopes, the somewhat poorly drained Meehan soils in nearly level areas, the very poorly drained Roscommon soils in depressions, and the very poorly drained Greenwood and Tawas soils, which formed in organic material in bogs and swamps.

Most areas are forested. This map unit is well suited to forestry uses. Native pine species grow well. Because of droughtiness, some seedling losses are likely.

These soils are poorly suited to cultivated crops because of a low available water capacity. Some areas are suited to pasture and hay.

The less sloping major soils are well suited to building site development. Because of the rapid permeability, pollution of ground water supplies is a hazard if sanitary facilities are installed in the major soils.

6. Cutaway-Sandwick

Nearly level to sloping, well drained and somewhat poorly drained, sandy soils that formed in sandy material and in the underlying loamy glacial till; on till plains and moraines

This map unit is on complex and plane slopes on sand-mantled glacial moraines and till plains. Local relief ranges from 2 to 20 feet. Slopes range from 0 to 8 percent.

This map unit makes up about 8 percent of the county. It is about 55 percent Cutaway soils, 20 percent Sandwick soils, and 25 percent minor soils.

The nearly level to sloping, well drained Cutaway soils typically have a surface layer of grayish brown loamy

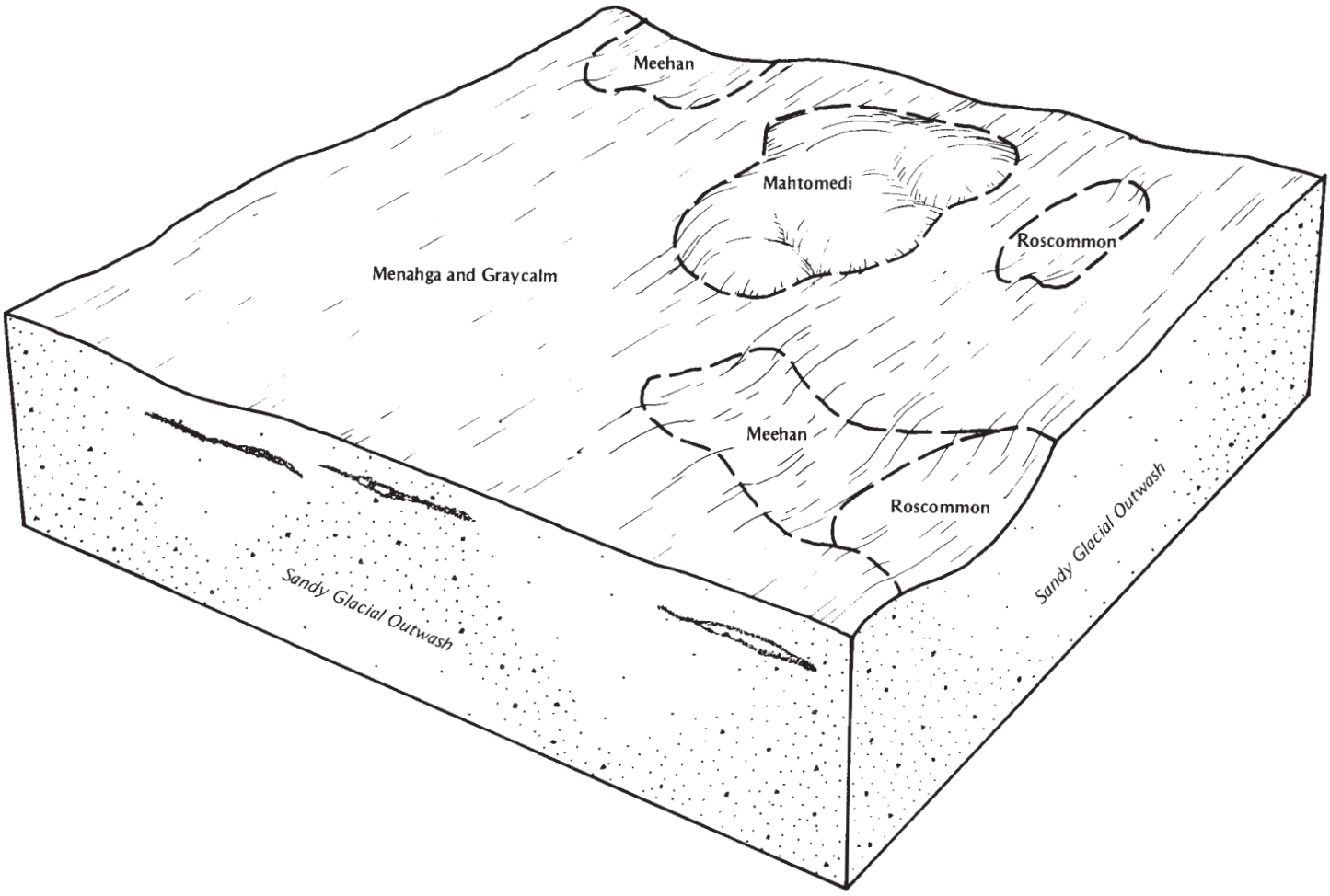


Figure 4.—Pattern of soils and parent material in the Menahga-Graycalm map unit.

sand about 4 inches thick. The upper subsoil is about 27 inches of dark brown loamy sand, yellowish brown sand, and brown and pale brown coarse sand. Below this is light brownish gray, firm loamy coarse sand about 4 inches thick. The next 4 inches is mixed brown clay loam and light brownish gray loamy sand. The lower subsoil is about 17 inches of light olive brown clay loam and loam. The underlying material to a depth of at least 60 inches is light olive brown loam.

The nearly level, somewhat poorly drained Sandwick soils typically have a surface layer of light brownish gray, mottled loamy fine sand about 4 inches thick. The upper subsoil is brown, mottled loamy fine sand about 6 inches thick. The next 18 inches is light brownish gray, mottled loamy fine sand and mixed light brownish gray and grayish brown, mottled loam. The lower subsoil is grayish brown, mottled loam about 10 inches thick. The underlying material to a depth of at least 60 inches also is grayish brown, mottled loam.

Minor in this map unit are the excessively drained Menahga and somewhat excessively drained Graycalm soils on the convex crests of slopes; the moderately well drained Thistledew soils on low, gentle slopes; the somewhat poorly drained Meehan soils in nearly level areas; the very poorly drained Roscommon soils in depressions and drainageways; and the very poorly drained Tawas, Mooselake, Lupton, and Loxley soils, which formed in organic material in swamps and bogs.

Most areas are forested. This map unit is well suited to many deciduous and coniferous species. The major limitations are the periodic wetness of the Sandwick soils and the seedling mortality caused by droughtiness in the Cutaway soils during some years.

The major soils are poorly suited to cultivated crops. The major management concerns are the wetness of the Sandwick soils and a low available water capacity in the sandy mantle of both the major soils.

This map unit is fairly well suited or poorly suited to building site development and most sanitary facilities. The wetness of the Sandwick soils is a limitation. Slow or moderately slow permeability in the subsoil and underlying material is a limitation in many areas.

Nearly Level to Sloping, Sandy, Loamy, and Silty Soils on Uplands

These soils formed dominantly in sandy outwash sediments, in stratified loamy and sandy lacustrine sediments, or in silty lacustrine sediments. The soils are excessively drained or are moderately well drained to poorly drained. They are used dominantly as forest land. Some areas are used for cultivated crops.

7. Zimmerman-Cowhorn

Nearly level to sloping, excessively drained and somewhat poorly drained, sandy soils that formed in outwash and lacustrine sediments; on outwash plains, lake plains, deltas, and terraces

This map unit is in smooth areas on glacial outwash plains and lake plains. Local relief ranges from 2 to 15 feet. Slopes range from 0 to 8 percent

This map unit makes up about 7 percent of the county. It is about 60 percent Zimmerman soils, 30 percent Cowhorn soils, and 10 percent minor soils.

The nearly level to sloping, excessively drained Zimmerman soils typically have a surface layer of dark grayish brown, grayish brown, and dark gray loamy fine sand about 3 inches thick. The subsoil is about 20 inches of dark yellowish brown loamy fine sand and yellowish brown fine sand. Below this to a depth of more than 60 inches is light gray and pale brown fine sand that has some thin bands of brown loamy fine sand.

The nearly level, somewhat poorly drained Cowhorn soils typically have a surface layer of grayish brown loamy very fine sand about 8 inches thick. The subsoil is about 43 inches thick. The upper part is light yellowish brown, yellowish brown, pale brown, brown, and light brownish gray, mottled loamy very fine sand. The lower part is light gray and light brownish gray, mottled loamy very fine sand. The underlying material to a depth of at least 60 inches is olive gray and light olive gray, mottled very fine sand.

Minor in this map unit are the well drained Wawina soils on convex slopes, the very poorly drained Sago soils in depressions, and the very poorly drained Mooselake, Lupton, and Greenwood soils, which formed in organic material in swamps and bogs.

Most areas are forested. The major soils are well suited to a wide range of species. They are especially well suited to the commonly grown upland conifers. Most upland deciduous species grow on the Cowhorn soils. Planting and harvesting are limited by the seasonal wetness of the Cowhorn soils.

The major soils are fairly well suited to small grain, forage crops for hay or pasture, and corn used for silage. The Zimmerman soils are well suited to potatoes, particularly if they are irrigated. Wetness and soil blowing are the main management concerns.

The Zimmerman soils are fairly well suited to building site development; however, the Cowhorn soils are poorly suited because of a seasonal high water table. The rapid permeability of the Zimmerman soils and the seasonal high water table in the Cowhorn soils are limitations on sites for most sanitary facilities.

8. Rosy-Spooner-Baudette

Nearly level and gently sloping, moderately well drained and poorly drained, loamy and silty soils that formed in lacustrine and outwash sediments; on lake plains and outwash plains

This map unit is in smooth areas on glacial lake and outwash plains. Local relief commonly ranges from 1 to 15 feet. Slopes range from 0 to 6 percent.

This map unit makes up about 4 percent of the county. It is about 30 percent Rosy soils, 25 percent Spooner soils, 25 percent Baudette soils, and 20 percent minor soils.

The nearly level and gently sloping, moderately well drained Rosy soils typically have about 2 inches of organic forest litter at the surface. The surface layer is dark gray and dark grayish brown very fine sandy loam about 2 inches thick. The subsurface layer is grayish brown and light brownish gray fine sandy loam about 7 inches thick. The subsoil is about 41 inches thick. The upper part is yellowish brown, mottled loam. The lower part is yellowish brown and brown, mottled sandy loam to silt loam. It is interlayered with grayish brown to pale brown loamy sand. The underlying material to a depth of more than 60 inches occurs as light olive brown, grayish brown, and light brownish gray, mottled strata that are similar in texture and arrangement to the strata in the lower part of the subsoil.

The nearly level, poorly drained Spooner soils typically have a thin layer of organic forest litter at the surface. The surface layer is very dark gray silt loam about 4 inches thick. The subsurface layer is light brownish gray, mottled silt loam about 5 inches thick. The subsoil is about 11 inches of grayish brown and dark grayish brown, mottled clay loam and loam. The underlying material to a depth of at least 60 inches is light brownish gray and light olive gray, mottled silt loam.

The nearly level and gently sloping, moderately well drained Baudette soils typically have a surface layer of dark gray silt loam about 7 inches thick. The subsurface layer is grayish brown silt loam about 2 inches thick. The subsoil is about 27 inches of brown, yellowish brown, light olive brown, and grayish brown silt loam and silty clay loam. It is mottled in the lower part. The underlying

material to a depth of at least 60 inches is grayish brown and light brownish gray silt loam.

Minor in this map unit are the poorly drained Morph soils in nearly level areas, the well drained Zimmerman soils on convex slopes, the very poorly drained Sago soils in depressions, and the very poorly drained Cathro, Lupton, Mooselake, and Seelyeville soils, which formed in organic material in swamps and bogs.

Many areas are cultivated. The map unit is well suited to small grain, hay and pasture, and corn used for silage. Wetness is the main limitation. Erosion is a hazard in some areas.

The major soils are well suited to deciduous trees, mainly aspen, and to spruce and fir. Periods of low soil strength limit the use of heavy equipment in the spring and after heavy rains.

The major soils are fairly well suited or poorly suited to building site development and most sanitary facilities. Wetness is the main limitation. Frost action and low strength are additional limitations.

Nearly Level to Steep, Clayey, Silty, and Loamy Soils on Uplands

These soils formed dominantly in clayey and silty lacustrine sediments and in clayey and loamy glacial till. The soils are moderately well drained or poorly drained. They are used dominantly as forest land.

9. Indus-Taylor

Nearly level and gently sloping, poorly drained and moderately well drained, clayey and silty soils that formed in lacustrine sediments; on lake plains

This map unit is in smooth areas on glacial lake plains. Local relief ranges from 1 to 15 feet. Slopes range from 0 to 6 percent.

This map unit makes up about 12 percent of the county. It is about 45 percent Indus soils, 20 percent Taylor soils, and 35 percent minor soils (fig. 5).

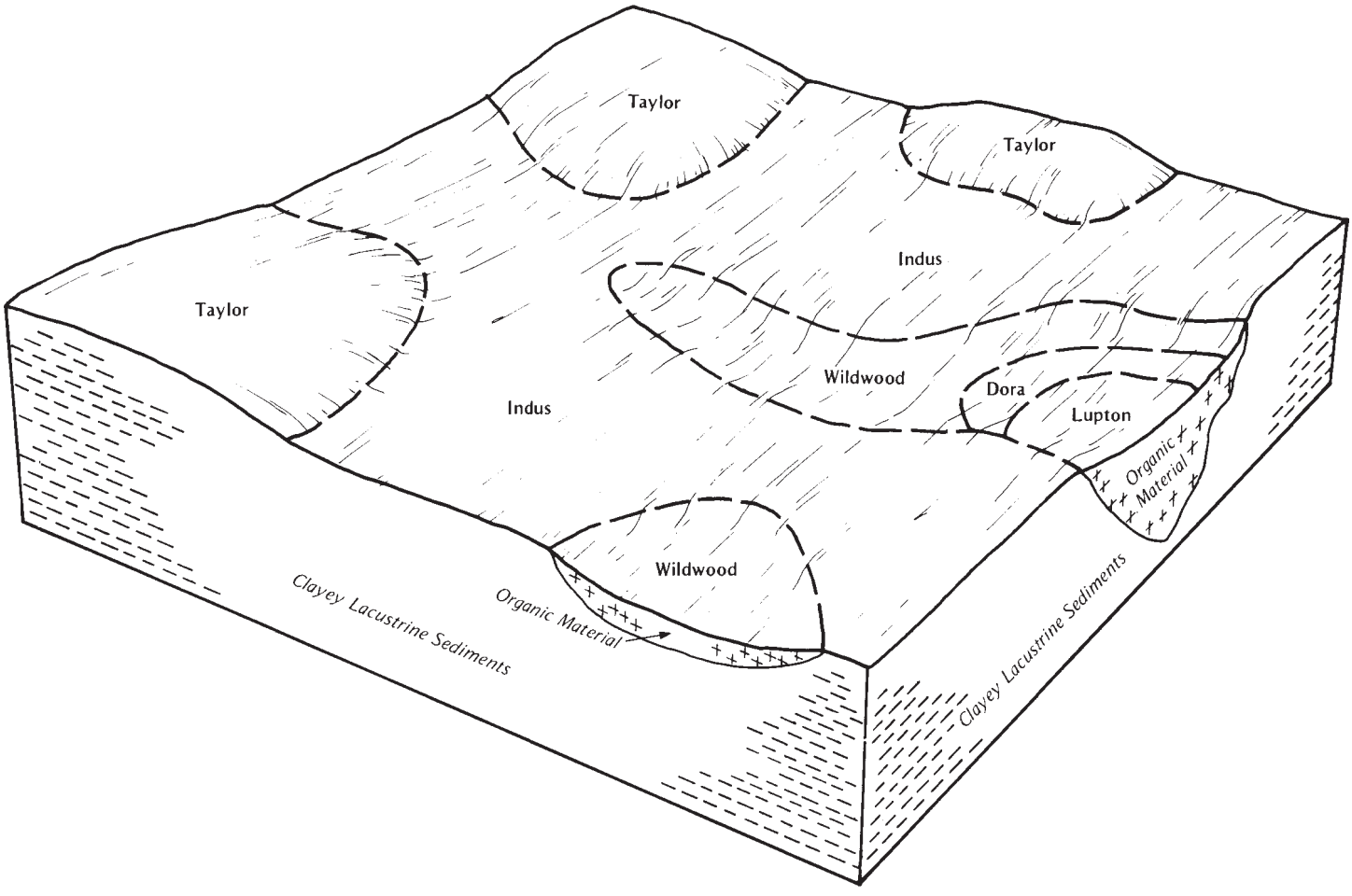


Figure 5.—Pattern of soils and parent material in the Indus-Taylor map unit.

The nearly level, poorly drained Indus soils typically have about 2 inches of forest litter at the surface. The surface layer is black clay about 3 inches thick. The subsurface layer is gray, mottled loam about 3 inches thick. The subsoil is dark gray and olive gray, mottled clay about 23 inches thick. The underlying material to a depth of at least 60 inches is olive gray and gray, mottled clay.

The nearly level and gently sloping, moderately well drained Taylor soils typically have a thin layer of organic litter at the surface. The surface layer is very dark gray silt loam about 2 inches thick. The subsurface layer is grayish brown silt loam about 4 inches thick. The subsoil is brown, dark yellowish brown, and dark grayish brown clay about 15 inches thick. The underlying material to a depth of at least 60 inches is dark grayish brown, grayish brown, and olive gray, mottled clay.

Minor in this map unit are the Brickton, Effie, Bearville, Dalbo, Thistledew, Dora, Mooselake, Lupton, Greenwood, and Wildwood soils. The poorly drained Brickton, Effie, and Bearville soils are in nearly level areas. The moderately well drained Dalbo and Thistledew soils are on convex slopes. The very poorly drained Dora, Mooselake, Lupton, Greenwood, and Wildwood soils formed in organic material in swamps and bogs.

Most areas are forested. The major soils are well suited to aspen, spruce, and fir species. The soft, boggy condition is a management concern when these soils are wet.

This map unit is fairly well suited to small grain and forage crops. Reducing the wetness and maintaining good tilth are the main management concerns. Erosion is a hazard in the more sloping areas.

This map unit is poorly suited to building site development and most sanitary facilities. Wetness, a high shrink-swell potential, frost action, low soil strength, and slow permeability are limitations affecting these uses.

10. Suomi-Effie

Nearly level to steep, moderately well drained and poorly drained, silty and loamy soils that formed in glacial till; on till plains and moraines

This map unit is mostly on complex slopes on glacial moraines and till plains. Local relief commonly ranges from 1 to 10 feet on the till plains and from 5 to 50 feet on the moraines. Slopes range from 0 to 25 percent.

This map unit makes up about 5 percent of the county. It is about 45 percent Suomi soils, 25 percent Effie soils, and 30 percent minor soils.

The nearly level to steep, moderately well drained Suomi soils typically have a thin layer of organic forest litter at the surface. The surface layer is black silt loam about 3 inches thick. The subsurface layer is dark gray silt loam about 6 inches thick. The next 3 inches is a mixture of grayish brown silt loam and dark brown clay. The subsoil is clay about 24 inches thick. The upper part is dark brown and dark yellowish brown and is mottled, and the lower part is dark grayish brown. The underlying material to a depth of at least 60 inches is grayish brown and dark grayish brown clay.

The nearly level, poorly drained Effie soils typically have about 2 inches of organic forest litter at the surface. The surface layer is light brownish gray and gray, mottled loam about 5 inches thick. The next 3 inches is grayish brown, mottled clay loam and light brownish gray and gray loam. The subsoil is grayish brown and dark grayish brown, mottled clay loam about 11 inches thick. The underlying material to a depth of at least 60 inches is light brownish gray and grayish brown, mottled silty clay loam and clay loam.

Minor in this map unit are the well drained and moderately well drained Warba soils on convex slopes, the poorly drained Indus soils on flats and concave slopes, the very poorly drained Wildwood soils in depressions, and the very poorly drained Cathro, Seelyeville, Mooselake, Lupton, and Bowstring soils, which formed in organic material in bogs and swamps.

Most areas are forested. This map unit is well suited to deciduous species, mainly aspen, and to conifers, such as spruce and fir. These soils are soft and boggy in the spring and after heavy rains. The use of heavy equipment is limited during these periods. Operating equipment is hazardous on the steeper slopes.

The major soils are fairly well suited to small grain and forage crops. Wetness and erosion are the main management concerns.

The major soils are poorly suited or fairly well suited to building site development and most sanitary facilities. The wetness of the Effie soils and the shrink-swell potential, restricted permeability, and potential for frost action in both of the major soils are the major limitations. Erosion is a hazard if the protective plant cover is removed from the steeper areas during construction.

Nearly Level and Undulating, Loamy and Sandy Soils on Flood Plains

These soils formed dominantly in loamy and sandy alluvial sediments. They are poorly drained and somewhat poorly drained. They are used dominantly as forest land.

11. Pengilly-Winterfield

Nearly level and undulating, poorly drained and somewhat poorly drained, loamy and sandy soils that formed in alluvium; on flood plains

This map unit is in smooth areas on flood plains. Local relief ranges from 1 to 10 feet. Slopes range from 0 to 4 percent.

This map unit makes up about 1 percent of the county. It is about 35 percent Pengilly soils, 25 percent Winterfield soils, and 40 percent minor soils.

The nearly level, poorly drained Pengilly soils are in low lying areas. Typically, they have a surface layer of very dark grayish brown, mottled loam about 4 inches thick. The underlying material to a depth of at least 60 inches is dark grayish brown, light brownish gray, dark gray, and dark brown, mottled, stratified silt loam, fine sandy loam, and loamy fine sand.

The nearly level and gently sloping, somewhat poorly drained Winterfield soils are on the slightly higher parts of the landscape. Typically, a layer of organic litter about 3 inches thick is at the surface. The surface layer is very dark brown loamy fine sand about 3 inches thick. The upper part of the underlying material is dark brown and dark grayish brown loamy fine sand. The next part is pale brown and brown, mottled fine sand. The lower part to a depth of at least 60 inches is pale brown, mottled sand.

Minor in this map unit are the excessively drained Zimmerman soils on convex slopes, the somewhat poorly drained Cowhorn soils on elevated flats, and the very poorly drained Bowstring, Cathro, and Sago soils in small depressions.

Most areas are forested. This map unit is fairly well suited to lowland hardwoods. The main management concerns are the equipment limitation during periods of flooding and low strength during wet periods, especially in areas of the Pengilly soils.

Because of the flooding, this map unit is generally unsuitable as cropland. It is suited to pasture for extensive periods in most years. It is generally unsuitable for building site development and sanitary facilities because of the flooding and the wetness.

Iron Mine Areas

These areas are dominated by features associated with iron mining activities, such as removing overburden, excavating iron ore, and processing taconite.

12. Slickens-Mine Pits-Mine Dumps

This map unit is on the Mesabi Iron Range. Local relief and slopes vary more in this unit than in the other units.

This map unit makes up about 2 percent of the county. It is about 40 percent Slickens, 20 percent mine dumps, 20 percent mine pits, and 20 percent minor soils and water areas. The minor soils are undisturbed areas of Nashwauk, Keewatin, and Warba soils.

Detailed Soil Map Units

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

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil 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 or of the underlying material, 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 or of the underlying material. They also can differ in slope, stoniness, wetness, 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, Suomi silt loam, 1 to 8 percent slopes, is a phase in the Suomi series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Warba-Menahga complex, 1 to 8 percent slopes, is an example.

A *soil association* is made up of two or more geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Seelyeville-Bowstring association is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Menahga and Graycalm soils, 0 to 8 percent slopes, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas.* Such areas generally have little or no soil material and support little or no vegetation. Dumps, mine, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

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.

Soil Descriptions

32B—Nebish very fine sandy loam, 2 to 6 percent slopes. This undulating, well drained soil is on convex slopes on glacial till plains and moraines. Individual areas are irregular in shape and range from about 15 to 600 acres in size.

Typically, the surface layer is very dark gray very fine sandy loam about 2 inches thick. The subsurface layer is grayish brown very fine sandy loam about 6 inches thick. The next 4 inches is dark yellowish brown clay loam and grayish brown very fine sandy loam. The subsoil is loam about 27 inches thick. The upper part is yellowish brown and brown and is firm, and the lower part is brown and light olive brown and is friable. The underlying material to a depth of about 64 inches is light olive brown and light yellowish brown, calcareous loam. In places the slope is

more than 6 percent or less than 2 percent. In some areas the subsoil has slightly more clay. In other areas the soil contains more silt and less sand. In a few places the underlying material is sandy. In a few areas the surface layer and subsurface layer are sandy.

Included with this soil in mapping are the poorly drained Shooker soils in small, nearly level or slightly concave areas and the very poorly drained Cathro and Talmoon soils in depressions. Also included are a few areas where tillage is impractical because of stoniness. Included soils make up 3 to 15 percent of the mapped areas.

Permeability is moderate in the Nebish soil, and available water capacity is moderate or high. Runoff is medium. The surface layer is slightly acid or neutral. The subsoil is slightly acid to moderately alkaline. The organic matter content is low to moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to many of the common upland tree species. Quaking aspen is predominant, but most stands also have some balsam fir, paper birch, and white spruce. A few stands are predominantly northern hardwoods. Natural regeneration of aspen typically is good. Losses of red pine seedlings commonly are severe in all areas, except for the crest of slopes. Careful planting of vigorous nursery stock reduces the seedling mortality rate. Adequate site preparation and control of competing vegetation help to achieve satisfactory survival and early growth rates of planted species. Deferment of harvesting or planting during periods when the soil is saturated in spring and after heavy rains helps to prevent excessive compaction and thus maintains the potential for seedling regeneration.

This soil is well suited to small grain, corn for silage, and forage crops. Erosion is a management concern. Seedbed preparation and planting are sometimes delayed by the wetness of the included soils in depressions. Draining the depressions increases the overall efficiency of cropping. Erosion can be controlled and good tilth maintained by effective crop residue management, periodically grown sod-forming crops, timely tillage, and contour farming. Erosion along waterways can be controlled by maintaining a permanent protective plant cover. Soil blowing in large open areas can be easily controlled by proper crop residue management, stripcropping, or windbreaks. In most areas stones hinder tillage. Removal of the stones reduces the risk of machinery damage.

The shrink-swell potential is a limitation if this soil is used as a site for dwellings without basements. Properly designing foundations and footings and backfilling around the foundations with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by frost action and by shrinking and swelling. Because of the restricted permeability, the soil cannot readily absorb the effluent in septic tank absorption fields. Installing a field that is larger than average helps to overcome this limitation.

The land capability classification is IIe, and the woodland ordination symbol is 7A.

32D—Nebish fine sandy loam, 10 to 25 percent slopes. This rolling to steep, well drained soil is on complex slopes on glacial moraines. Individual areas are irregularly shaped or elongated and range from 15 to about 300 acres in size.

Typically, about 2 inches of black organic forest litter is at the surface. The surface layer is dark grayish brown and grayish brown fine sandy loam about 3 inches thick. The subsurface layer is light brownish gray fine sandy loam about 6 inches thick. The next 6 inches is dark yellowish brown loam and light brownish gray and grayish brown fine sandy loam. The subsoil is sandy clay loam about 14 inches thick. The upper part is dark yellowish brown, and the lower part is light olive brown and dark yellowish brown. The underlying material to a depth of at least 60 inches is light olive brown, calcareous loam. In places the slope is less than 10 percent, and in a few areas it is more than 25 percent. In a few places the underlying material is sandy. In some areas the subsoil has slightly more clay. In other areas the surface layer and subsurface layer are sandy.

Included with this soil in mapping are areas of the very poorly drained Cathro and Talmoon soils in depressions less than 5 acres in size and small areas of the poorly drained Shooker soils in intermediate landscape positions. Also included are a few small areas where tillage is impractical because of stoniness. Included soils make up 2 to 10 percent of the mapped areas.

Permeability is moderate in the Nebish soil, and available water capacity is moderate or high. Surface runoff is rapid. The surface layer is slightly acid or neutral. The subsoil is slightly acid to mildly alkaline. The organic matter content is low to moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to most upland species of trees. Quaking aspen is predominant, but some stands are predominantly northern hardwoods. Most stands have some balsam fir, paper birch, and white spruce. Aspen generally grows rapidly. It regenerates rapidly following clearcutting. Regeneration of other species is less successful. Planting generally is needed to establish a satisfactory stand of conifers other than balsam fir. Balsam fir commonly regenerates as an understory species with aspen.

Adequate site preparation and control of competing vegetation help to achieve satisfactory survival and early growth rates of planted tree species. Most conifers can be successfully established, but seedling mortality of red pine typically is high in all areas, except for the crest of

slopes. Careful planting of vigorous nursery stock reduces the seedling mortality rate. Care is needed in operating machinery on this rolling to steep soil. Operating across the slope rather than up and down the hill when the trees are harvested or planted helps to control erosion. Deferment of harvesting or planting during periods when the soil is saturated in spring and after heavy rains helps to prevent excessive compaction and thus maintains the potential for seedling regeneration.

The less sloping areas that are farmed are used primarily for hay. This soil is poorly suited to cultivated crops because of the slope and the erosion hazard. Adapted forage crops grow well. Growing sod-forming crops helps to control erosion. Operating equipment is hazardous on slopes of more than 15 percent. Removal of stones reduces the risk of machinery damage. The wetness of the included Cathro and Talmoon soils interferes with the use of equipment and can delay planting and harvesting.

The slope is the main limitation if this soil is used as a site for dwellings. Extensive land shaping is generally needed. The buildings should be designed so that they conform to the natural slope of the land. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion. Land shaping and installing the distribution lines across the slope help to ensure that septic tank absorption fields function properly.

The land capability classification is IVe, and the woodland ordination symbol is 7R.

72—Shooker very fine sandy loam. This nearly level, poorly drained soil is on glacial till plains and moraines. Slopes are plane and smooth or are slightly concave. A few stones typically are on the surface and in the soil. Individual areas are irregularly shaped or elongated and range from 5 to about 200 acres in size.

Typically, the surface layer is very dark gray very fine sandy loam about 2 inches thick. The subsurface layer is light brownish gray, mottled very fine sandy loam about 7 inches thick. The subsoil is about 18 inches of grayish brown, mottled sandy clay loam and clay loam. The underlying material to a depth of about 60 inches is grayish brown, light grayish brown, and light olive gray, mottled loam and fine sandy loam. In a few places the subsoil and underlying material are silty clay loam or silt loam. In a few areas the surface layer and subsurface layer are sandy.

Included with this soil in mapping are small areas of the well drained Itasca and Nebish soils on convex slopes. Also included are the very poorly drained Cathro and Talmoon soils in small depressions. Included soils make up 3 to 15 percent of the mapped areas.

Permeability is moderate in the Shooker soil, and available water capacity is moderate or high. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet. The surface layer is medium acid to neutral. The subsoil is medium acid to mildly alkaline. The organic matter content is moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to trees. The common trees are quaking aspen, balsam fir, paper birch, American basswood, black ash, American elm, and white spruce. Quaking aspen is the most common species. It typically grows well. After clearcutting, aspen regeneration generally is vigorous. Balsam fir is a common understory species, especially with aspen. White spruce and black spruce are suitable conifers for planting.

Adequate site preparation and control of competing vegetation help to achieve satisfactory survival and early growth rates of planted tree species. Soft, boggy conditions during wet periods limit the use of wheeled harvesting or planting equipment. Operating such equipment when the soil is wet can result in excessive compaction and can reduce the potential for regeneration of the stands. Also, the equipment can become mired in the soil.

This soil is well suited to small grain if a tile drainage system is installed. Fall tillage normally allows the soil to warm up and dry out earlier in the spring and thus improves the timeliness of planting. If tilled when wet, the soil becomes cloddy. The cloddiness reduces the effective root zone and lowers yields. In most areas stones hinder tillage or other fieldwork, but they do not make tillage impractical. Removal of the stones reduces the risk of machinery damage. Effective crop residue management, stripcropping, and sod-forming crops help to maintain tilth and control soil blowing in large open areas.

Because of the wetness, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on well compacted, coarse textured base material helps to prevent frost damage.

The land capability classification is IIw, and the woodland ordination symbol is 6W.

147—Spooner silt loam. This nearly level, poorly drained soil is on glacial lake plains. Most slopes are plane, but some are very slightly concave or convex. Individual areas are elongated or irregularly shaped and range from about 5 to 150 acres in size.

Typically, about 1 inch of organic forest litter is at the surface. The surface layer is very dark gray silt loam about 4 inches thick. The subsurface layer is light brownish gray, mottled silt loam about 5 inches thick. The subsoil is about 11 inches of grayish brown, mottled clay loam and loam. The underlying material to a depth of about 60 inches is light brownish gray and light olive gray, mottled silt loam. In some places the subsoil has

slightly more clay. In other places the subsoil and underlying material have thin strata of sandy material.

Included with this soil in mapping are small areas of the moderately well drained Baudette soils on convex slopes. Also included are some areas of the very poorly drained Cathro soils in small depressions. Included soils make up 1 to 10 percent of the mapped areas.

Permeability is moderate in the Spooner soil, and available water capacity is high. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet. The surface layer is medium acid to neutral. The subsoil is medium acid to mildly alkaline. The organic matter content is moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to trees. The common species are quaking aspen, paper birch, balsam fir, black ash, and American elm. Quaking aspen grows well. Aspen regeneration is rapid following clearcutting. Balsam fir is fairly common as an understory species with aspen. Planting is needed if white spruce, a desirable species, is to be grown extensively. Control or removal of competing vegetation improves the survival and growth rates of conifers. Soft, boggy conditions during the spring and after heavy rains limit the use of equipment. Wheeled equipment, especially heavy equipment, should be used only during the drier periods or when the soil is frozen.

If drained, this soil is well suited to small grain, corn for silage, and forage crops. If tilled when wet, it becomes cloddy. The cloddiness reduces the effective root zone and lowers yields. Effective crop residue management, stripcropping, and sod-forming crops help to maintain good tilth and control soil blowing in large open areas.

Because of the wetness, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on well compacted, coarse textured base material helps to prevent frost damage.

The land capability classification is IIw, and the woodland ordination symbol is 7W.

158B—Zimmerman loamy fine sand, 1 to 8 percent slopes. This nearly level to sloping, excessively drained soil is on glacial lake plains and outwash plains. Slopes are plane or slightly convex. Individual areas are irregular in shape and range from about 15 to 250 acres in size.

Typically, about 1 inch of organic forest litter is at the surface. The surface layer is dark grayish brown, grayish brown, and dark gray loamy fine sand about 3 inches thick. The subsoil is about 20 inches of dark yellowish brown loamy fine sand and yellowish brown fine sand. The next 40 inches is light gray and pale brown fine sand that has thin bands of brown loamy fine sand. The underlying material to a depth of at least 75 inches is pale brown fine sand. In places the soil has no brown bands in the subsoil. In a few places the underlying material has loamy layers. In some areas the soil has sandy layers of predominantly coarse sand. In a few areas it has more very fine sand and less fine sand. In places it is well drained.

Included with this soil in mapping are small areas of the somewhat poorly drained Cowhorn soils in shallow depressions and drainageways and areas of the very poorly drained Sago soils in the deeper depressions. Included soils make up 1 to 10 percent of the mapped areas.

Permeability is rapid in the Zimmerman soil, and available water capacity is low. Surface runoff is slow. The soil is strongly acid or medium acid throughout. The organic matter content and natural fertility are low.

Most areas are forested. This soil is well suited to conifers, mainly pines. Eastern white pine, red pine, jack pine, aspen, white spruce, balsam fir, and northern hardwoods are the common trees. Adequate site preparation and control of competing vegetation help to achieve satisfactory survival and early growth rates of planted species. Erosion losses are generally slight in the nearly level areas. If the protective plant cover is disturbed, however, the more sloping areas are easily eroded during heavy rains.

This soil is moderately suited to the cultivated crops commonly grown in the county. The low natural fertility is a limitation. Also, droughtiness is a limitation in most years. Applications of fertilizer are needed. Deep-rooted crops are less affected by drought than shallow-rooted ones. The soil is suitable for irrigation. Water erosion can be controlled and good tilth maintained by effective crop residue management, periodically grown sod-forming crops, contour farming, and timely tillage. A permanent protective plant cover helps to control erosion in waterways. Soil blowing can be controlled by effective crop residue management, stripcropping, and windbreaks.

This soil is suitable as a site for dwellings and local roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IIIs, and the woodland ordination symbol is 8S.

167B—Baudette silt loam, 0 to 5 percent slopes. This nearly level and gently sloping, moderately well drained soil is on glacial lake plains. Slopes are slightly convex or plane. Individual areas are irregularly shaped or elongated and range from about 15 to 100 acres in size.

Typically, the surface layer is dark gray silt loam about 7 inches thick. The subsurface layer is grayish brown silt loam about 2 inches thick. The subsoil is about 27 inches thick. The upper part is brown, yellowish brown, and grayish brown, mottled silt loam and silty clay loam,

and the lower part is multicolored, mottled silt loam. The underlying material to a depth of at least 60 inches is grayish brown and light brownish gray, mottled silt loam. In uncultivated areas the surface layer is black or very dark gray silt loam. In some places the subsoil contains slightly more clay, and in other places it is stratified, loamy and sandy material. In some areas the soil is slightly more sloping and is well drained.

Included with this soil in mapping are small areas of the nearly level, poorly drained Spooner soils. These soils make up less than 10 percent of the mapped areas.

Permeability is moderate in the Baudette soil, and available water capacity is high. Surface runoff is slow or medium. The seasonal high water table is at a depth of 3 to 6 feet. The surface layer is medium acid to neutral. The subsoil is medium acid to mildly alkaline. The organic matter content is moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to many upland species of trees. Quaking aspen is the most common species. Natural regeneration of aspen typically is good. Other common trees are paper birch, balsam fir, black ash, and American elm. A few white spruce generally are mixed with aspen in the stands. If conifers are planted, few seedling losses occur, but red pine losses typically are severe. Adequate site preparation and control of competing vegetation help to achieve satisfactory survival and early growth rates of planted species. In the spring and after heavy rains, the soil is soft and boggy and cannot support harvesting and planting machinery. Deferment of equipment use during wet periods or use of better suited machinery helps to prevent excessive compaction and increases the seedling survival rate.

Some areas are used as cropland. This soil is well suited to small grain, corn for silage, and forage crops. Erosion is a hazard in the more sloping areas. It can be controlled by contour farming, effective crop residue management, and periodically grown sod-forming crops. Erosion along waterways can be controlled by maintaining a permanent protective plant cover. Timely tillage and crop residue management help to maintain tilth. In large open areas soil blowing is a hazard. It can be controlled by effective crop residue management, stripcropping, or windbreaks.

If dwellings are constructed on this soil, the lower floor should be built above the seasonal high water table. Tile drains around foundations help to remove excess subsurface water. Proper landscaping can divert surface water away from the buildings. Constructing local roads on well compacted, coarse textured base material helps to prevent frost damage. The soil is poorly suited to septic tank absorption fields because of the seasonal high water table. This limitation is less severe near the crest of slopes than in the more sloping areas. It can be overcome by mounding with suitable material.

The land capability classification is IIe, and the woodland ordination symbol is 7A.

202—Meehan loamy sand. This nearly level, somewhat poorly drained soil is on outwash plains and glacial lake plains. Slopes are plane and smooth or are slightly convex or concave. Individual areas are irregular in shape and range from about 5 to 240 acres in size.

Typically, organic litter about 2 inches thick is at the surface. The surface layer is black loamy sand about 1 inch thick. The subsurface layer is light brownish gray loamy sand about 4 inches thick. The subsoil is about 30 inches thick. It is dark yellowish brown and brown, mottled loamy sand in the upper part and dark brown, mottled sand in the lower part. The underlying material to a depth of about 60 inches is light brownish gray, mottled coarse sand. In places the soil has thin bands of loamy material in the subsoil and underlying material. In a few places the surface layer is loamy fine sand, sandy loam, or fine sandy loam. In some areas the soil is poorly drained.

Included with this soil in mapping are areas of the excessively drained Menahga and somewhat excessively drained Graycalm soils on gentle slopes or slight rises. Also included are small areas of the very poorly drained Roscommon and Tawas soils in depressions. Included soils make up about 2 to 10 percent of the mapped areas.

Permeability is rapid in the Meehan soil, and available water capacity is low. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet. The soil is strongly acid to neutral throughout. The organic matter content and natural fertility are low.

Most areas are forested. This soil is well suited to trees tolerant of periodic wetness. Deciduous trees are the most common species, but some stands are dominated by coniferous species. Regeneration of aspen following clearcutting is usually satisfactory. Suitable conifers can be established without extensive site preparation or control of competing vegetation. Seedling mortality sometimes occurs because of wetness. The mortality rate can be reduced by planting water-tolerant species.

This soil is poorly suited to small grain and to corn for silage. If drained, it is fairly well suited to forage crops. The wetness is the main management concern.

This soil is poorly suited to dwellings because of the wetness. The buildings should be constructed without basements. Proper landscaping can divert surface water away from the buildings. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by wetness and frost action. The soil is poorly suited to septic tank absorption fields because it has a seasonal high water table and because it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground

water supplies. In some areas a mound type of absorption field is suitable.

The land capability classification is IVw, and the woodland ordination symbol is 6W.

240B—Warba fine sandy loam, 1 to 8 percent slopes. This nearly level to rolling, well drained soil is on complex slopes on glacial moraines and till plains. A few stones typically are on the surface and in the soil. Slopes are mostly convex. Individual areas are irregular in shape and range from about 15 to 1,000 acres in size.

Typically, 1 inch of organic forest litter is at the surface. The surface layer is very dark gray fine sandy loam about 1 inch thick. The subsurface layer is grayish brown and light brownish gray fine sandy loam about 6 inches thick. The next 5 inches is light brownish gray fine sandy loam and dark brown clay loam. The subsoil is light olive brown clay loam about 36 inches thick. The underlying material to a depth of at least 60 inches is light olive brown sandy clay loam. In a few places the surface layer is sandy loam. In some areas the subsoil has slightly more clay. In other areas the soil is moderately well drained.

Included with this soil in mapping are small areas of Cutaway soils. These soils have 20 to 40 inches of sandy material over a loamy subsoil. Also included are small areas of the somewhat poorly drained Stuntz and very poorly drained Cathro and Talmoon soils, mainly in depressions. Included soils make up 2 to 15 percent of the mapped areas.

Permeability is moderately slow in the Warba soil, and available water capacity is high. Surface runoff is medium. The surface layer is strongly acid to slightly acid. The subsoil is strongly acid to neutral. The organic matter content is low to moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to many of the common upland species of trees. Deciduous trees, mainly quaking aspen, are the most common species. Northern hardwoods are dominant in some stands. Most stands include some conifers, mainly balsam fir and, to a lesser extent, white spruce, eastern white pine, and red pine. Natural regeneration of aspen typically is good after logging. Seedling losses generally are small, but red pine losses are severe in all areas, except for the crest of slopes. Adequate site preparation and control of competing vegetation help to achieve satisfactory survival and early growth rates of planted species. Deferment of harvesting or planting during wet periods helps to prevent excessive compaction and thus maintains the potential for seedling regeneration.

This soil is well suited to small grain, corn for silage, and forage crops. Erosion is a management concern. It can be controlled by effective crop residue management, contour farming, and periodically grown sod-forming crops. Erosion along waterways can be controlled by maintaining a permanent plant cover. Sod-forming crops, effective crop residue management, and timely tillage help to maintain tilth. Soil blowing is a hazard in large open areas. It can be controlled by proper crop residue management, stripcropping, or windbreaks. Fieldwork is sometimes delayed by the wetness of the included soils in depressions. Draining the depressions improves the efficiency of cropping. The surface stones hinder tillage, but they do not make tillage impractical. Removal of the stones reduces the risk of machinery damage.

If dwellings are constructed on this soil, the shrink-swell potential is a limitation. Properly designing foundations and footings and backfilling around the foundations with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Proper landscaping can divert surface water away from the buildings. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength. Because of the restricted permeability, the soil cannot readily absorb the effluent in septic tank absorption fields. Installing a field that is larger than average helps to overcome this limitation.

The land capability classification is IIe, and the woodland ordination symbol is 7A.

240D—Warba fine sandy loam, 10 to 25 percent slopes. This rolling to steep, well drained soil is on complex slopes on glacial moraines. A few stones typically are on the surface and in the soil. Individual areas are irregularly shaped or elongated and range from about 15 to 500 acres in size.

Typically, about 2 inches of organic forest litter is at the surface. The surface layer is black fine sandy loam about 2 inches thick. The subsurface layer is light brownish gray fine sandy loam about 6 inches thick. The next 6 inches is dark brown and brown loam and grayish brown fine sandy loam. The subsoil is dark brown clay loam about 28 inches thick. The underlying material to a depth of at least 60 inches is grayish brown and light olive brown loam. In some areas the slope is less than 10 percent, and in a few areas it is more than 25 percent. In a few places the underlying material is sandy. In some small areas the subsoil has slightly more clay. In other small areas the surface layer and subsurface layer are sandy.

Included with this soil in mapping are small areas of the well drained Cutaway soils. These soils have 20 to 40 inches of sandy material over a loamy subsoil. They are in landscape positions similar to those of the Warba soil. Also included are areas of the very poorly drained Cathro and Talmoon soils in small depressions and very small areas of the somewhat poorly drained Stuntz soils on the less sloping parts of the landscape. Included soils make up 1 to 10 percent of the mapped areas.

Permeability is moderately slow in the Warba soil, and available water capacity is high. Surface runoff is rapid. The surface layer is strongly acid to slightly acid. The

subsoil is strongly acid to neutral. The organic matter content is low to moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to most of the common upland species of trees. Quaking aspen typically is dominant, but some stands have mainly northern hardwoods. Most stands have some conifers, mainly balsam fir, white spruce, eastern white pine, and red pine. Aspen typically grows rapidly. Regeneration of aspen following clearcutting is rapid.

Planting generally is needed to establish a satisfactory stand of conifers other than balsam fir. The commonly planted conifers other than red pine can become established and grow well if competing vegetation is controlled or removed. Seedling mortality of red pine is severe in all areas, except for the crest of slopes. Careful planting of vigorous nursery stock reduces the seedling mortality rate. Operating equipment across the slope rather than up and down the hill when the trees are harvested or planted helps to control erosion. Operating equipment is hazardous in areas where the slope is more than 15 percent.

Areas that are farmed are used primarily for hay or pasture. This soil is generally unsuited to cultivated crops because of a severe erosion hazard. Suitable forage crops grow well. Sod-forming crops are effective in controlling erosion. Operating equipment is hazardous in areas where the slope is more than 15 percent. Removal of stones reduces the risk of equipment damage. The wetness of the included Cathro and Talmoon soils restricts fieldwork.

Because of the slope, this soil is generally unsuitable as a site for dwellings, sanitary facilities, and local roads. Soils that are better suited to these uses are generally nearby. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion. Constructing the roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength and frost action.

The land capability classification is VIe, and the woodland ordination symbol is 7R.

243—Stuntz very fine sandy loam. This nearly level, somewhat poorly drained soil is on plane and slightly concave slopes on till plains and moraines. A few stones typically are on the surface and in the soil. Individual areas are irregularly shaped or elongated and range from about 5 to 500 acres in size.

Typically, about 1.5 inches of organic forest litter is at the surface. The surface layer is very dark gray very fine sandy loam about 1 inch thick. The subsurface layer is light gray and light brownish gray, mottled very fine sandy loam about 12 inches thick. The next 10 inches is olive brown, mottled clay loam and light brownish gray and pale brown, mottled very fine sandy loam. The subsoil is light olive brown and olive brown, mottled clay loam about 20 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled clay loam. In places layers of silt loam or silty clay loam are in the subsoil and underlying material. In a few areas the soil is poorly drained. In a few places the surface layer is sandy.

Included with this soil in mapping are small areas of the well drained Warba soils on convex slopes. Also included are some areas of the very poorly drained Cathro and Talmoon soils in small depressions. Included soils make up 5 to 10 percent of the mapped areas.

Permeability is moderately slow in the Stuntz soil, and available water capacity is high. Surface runoff is slow. The seasonal high water table is at a depth of 1.5 to 3.0 feet. The surface layer is very strongly acid to slightly acid. The subsoil is strongly acid to mildly alkaline. The organic matter content is moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to trees. The common trees are quaking aspen, paper birch, balsam fir, American basswood, American elm, sugar maple, and white spruce. Quaking aspen is predominant. It normally grows well and regenerates rapidly after clearcutting. It also competes vigorously when conversion to other species is attempted. White spruce and balsam fir are suitable conifers for planting.

Adequate site preparation and control or removal of competing vegetation are necessary before satisfactory establishment and early growth of conifers can be achieved. Soft, boggy conditions limit the use of heavy wheeled equipment during the spring and after heavy rains. Operating such equipment when the soil is wet can result in excessive compaction and can reduce the potential for regeneration of the stands. Also, the equipment can become mired in the soil.

If drained, this soil is well suited to small grain and forage crops. The wetness is the main management concern. The soil dries out earlier in the spring if it is tilled in the fall. It becomes cloddy if tilled when wet. The cloddiness generally reduces the effective root zone and lowers yields. Most areas have some stones, but the amount is not enough to make tillage impractical. Effective crop residue management, stripcropping, and periodically grown sod-forming crops help to maintain good tilth and control soil blowing in large open areas.

If dwellings are constructed on this soil, the lower floor or basement level should be built above the seasonal high water table. Proper landscaping can divert surface water away from the buildings. Properly designing foundations and footings and backfilling around the foundations with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength and frost action.

The soil is poorly suited to septic tank absorption fields because of the seasonal high water table and the restricted permeability. These limitations can be overcome by mounding with suitable material.

The land capability classification is IIw, and the woodland ordination symbol is 6A.

268B—Cromwell fine sandy loam, 1 to 10 percent slopes. This nearly level to sloping, excessively drained soil is on outwash plains. Slopes are convex or plane. Individual areas are irregular in shape and range from about 15 to 300 acres in size.

Typically, 1 inch of organic forest litter is at the surface. The surface layer is very dark gray fine sandy loam about 3 inches thick. The subsurface layer is gray and grayish brown fine sandy loam about 2 inches thick. The subsoil is about 33 inches thick. It is yellowish brown and brown. The upper part is sandy loam and loamy sand, and the lower part is coarse sand. The underlying material to a depth of at least 60 inches is brown and yellowish brown coarse sand. In places the loamy material is more than 20 or less than 10 inches thick. In a few small areas, the soil is sandy throughout or the underlying material is loamy.

Included with this soil in mapping are small areas of poorly drained, nearly level or slightly depressional, sandy soils. Also included are some areas of the very poorly drained Cathro, Sago, and Tawas soils in small depressions. Included soils make up 3 to 10 percent of the mapped areas.

Permeability is moderate in the upper part of the Cromwell soil and rapid in the lower part. Available water capacity is low. Surface runoff is slow or medium. The loamy layers in the surface soil and subsoil are very strongly acid to medium acid. The sandy layers in the subsoil and underlying material are strongly acid to slightly acid. The organic matter content and natural fertility are low.

Most areas are forested. This soil is well suited to a wide range of the common upland tree species. Most areas have mixed stands of northern hardwoods, conifers, and aspen. Red oak, paper birch, and American basswood are common hardwoods. Balsam fir, red pine, and eastern white pine are common conifers. Balsam fir commonly regenerates naturally as an understory species. Planting is needed if an adequate number of other conifers is to be established in the stand.

Adequate site preparation and control of competing vegetation help to achieve satisfactory survival and early growth rates of planted tree species. Regeneration of aspen following clearcutting typically results in an adequate population of young trees. The main root zone of trees is the mantle of loamy material 10 to 20 inches thick. Because of this shallow root zone, windthrow is fairly common, particularly in mature, low-population stands. Clearcutting rather than selective cutting reduces the windthrow hazard and improves regeneration. The use of equipment is seldom limited, except for a short period in early spring when the loamy material is saturated. The hazard of erosion is slight, but operating equipment up and down the hill, particularly in drainageways, should be avoided.

This soil is poorly suited to small grain and to corn for silage. It is fairly well suited to forage crops. Erosion is the main management concern. Effective crop residue management, stripcropping, and sod-forming crops help to maintain good tilth, control soil blowing in large open areas, and control water erosion in sloping areas. Contour farming also helps to control erosion. A permanent protective plant cover is needed in waterways. Some areas have small stones, but the amount is not enough to make tillage impractical. Because the soil is free of excess moisture and warms up early in the spring, crops can be planted early in the year. The growth of late-season crops, however, commonly is restricted by an inadequate moisture supply.

This soil is suitable as a site for dwellings and local roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IVe, and the woodland ordination symbol is 7S.

268D—Cromwell fine sandy loam, 10 to 25 percent slopes. This rolling to steep, excessively drained soil is on side slopes bordering depressions and drainageways on outwash plains. Most slopes are complex. Individual areas are irregularly shaped or elongated and range from about 15 to 200 acres in size.

Typically, the surface layer is very dark gray fine sandy loam about 3 inches thick. The subsurface layer is gray and grayish brown fine sandy loam about 2 inches thick. The subsoil is 29 inches thick. The upper part is yellowish brown and brown sandy loam, and the lower part is yellowish brown gravelly loamy sand and gravelly coarse sand. The underlying material to a depth of at least 60 inches is brown coarse sand. In some areas the upper loamy material is less than 10 or more than 20 inches thick. In a few areas the soil is sandy throughout. In places the underlying material is gravelly coarse sand or very gravelly coarse sand. In some small areas the slope is more than 25 percent, and in some areas it is less than 10 percent.

Included with this soil in mapping are small areas of the very poorly drained Cathro, Loxley, and Tawas soils in depressions. These soils make up 2 to 10 percent of the mapped areas.

Permeability is moderate in the upper part of the Cromwell soil and rapid in the lower part. Available water capacity is low. Surface runoff is medium. The loamy layers in the surface soil and subsoil are very strongly acid to medium acid. The sandy layers in the subsoil and

underlying material are strongly acid to slightly acid. The organic matter content and natural fertility are low.

Most areas are forested. This soil is well suited to a wide range of the common upland tree species. Most areas have mixed stands of northern hardwoods, conifers, and aspen. Red oak, paper birch, and American basswood are common hardwoods. Balsam fir, red pine, and eastern white pine are common conifers. Regeneration of aspen following clearcutting typically results in an adequate population of young trees.

Adequate site preparation and control of competing vegetation help to achieve satisfactory survival and early growth rates of planted tree species. Because of droughtiness, some seedling losses are probable on south- and west-facing slopes, particularly on the slope crests. Careful planting of vigorous nursery stock reduces the seedling mortality rate. The main root zone of trees is the mantle of loamy material 10 to 20 inches thick. Because of this shallow root zone, windthrow is fairly common, particularly in mature, low-population stands. Clearcutting rather than selective cutting reduces the windthrow hazard and improves regeneration. Proper harvesting and planting methods can prevent downhill channeling of water, which accelerates erosion.

This soil is moderately suited to forage crops for hay or pasture. It is generally unsuitable for cultivated crops because of the slope and the hazard of erosion. Pastures should be renovated with as little soil disturbance as possible. Farming across the slope rather than up and down the hill helps to control erosion. Care is needed in operating machinery because of the slope. The wetness of the included soils in depressions hinders fieldwork.

Because of the slope, this soil is generally unsuitable as a site for dwellings, sanitary facilities, and local roads. Soils that are better suited to these uses are generally nearby. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion.

The land capability classification is VIe, and the woodland ordination symbol is 7R.

458E—Menahga loamy sand, 10 to 30 percent slopes. This rolling to very steep, excessively drained soil is on complex slopes on outwash plains. Individual areas are irregular in shape and range from about 15 to 300 acres in size.

Typically, about 1 inch of organic forest litter is at the surface. The surface layer is very dark gray loamy sand about 1 inch thick. The subsurface layer is grayish brown and dark grayish brown loamy sand about 2 inches thick. The subsoil is about 41 inches thick. The upper part is yellowish brown and brown loamy sand, and the lower part is brown and pale brown sand. The underlying material to a depth of at least 60 inches is brown and pale brown sand. In places the soil is sand or coarse sand throughout. In some small areas the subsoil has thin layers of dark brown material that contains slightly more clay. In a few areas the surface soil is sandy loam or coarse sandy loam as much as 12 inches thick. In places the soil has a few stones and boulders.

Included with this soil in mapping are small areas of Meehan and Roscommon soils. The somewhat poorly drained, sandy Meehan soils are in shallow depressions and nearly level areas. The poorly drained and very poorly drained Roscommon soils are in the deeper depressions and drainageways. Included soils make up 1 to 5 percent of the mapped areas.

Permeability is rapid in the Menahga soil, and available water capacity is low. Surface runoff is medium or slow. The surface layer is very strongly acid to medium acid. The subsoil and underlying material are strongly acid to slightly acid. The organic matter content and natural fertility are low.

Most areas are forested. This soil is well suited to pine species. The most common trees are red pine and jack pine. Aspen, balsam fir, and some northern hardwoods are mixed with the pines or are in small stands. Adequate site preparation is needed to ensure good seedling establishment. Plant competition generally is not vigorous, but control measures are needed to promote early growth of conifers. Caution is needed in operating harvesting and planting equipment on the steep and very steep slopes. Erosion on logging roads and skid trails is a management concern. It can be controlled by building the roads and trails on the contour.

Because of the slope and a severe hazard of erosion, this soil is unsuitable for cultivated crops and is poorly suited to pasture. Forage yields are low in pastured areas. Restricted grazing, which helps to maintain the plant cover, reduces the susceptibility to erosion. Open areas are subject to soil blowing. The rolling to very steep slopes limit the use of machinery.

Because of the slope, this soil is generally unsuitable as a site for dwellings, sanitary facilities, and local roads. Soils that are better suited to these uses are generally nearby. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion.

The land capability classification is VIIe, and the woodland ordination symbol is 7R.

533—Loxley peat. This nearly level, very poorly drained, organic soil is in bogs on glacial moraines and till plains. Ponding is common in the spring and after periods of heavy rainfall. Individual areas are irregularly shaped or round and range from about 20 to 400 acres in size.

Typically, the surface layer is brown sphagnum peat about 8 inches thick. The next layer is very dark grayish brown mucky peat about 4 inches thick. Below this to a depth of about 65 inches is dark brown and very dark

brown muck that has a layer of mucky peat between depths of 16 and 18 inches. In a few places mucky peat is dominant throughout the soil. In a few areas mineral soil is within a depth of 51 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Keewatin and Sandwick soils and the well drained and moderately well drained Nashwauk soils. These soils are around the edges of the bogs or on small knolls within the bogs. They make up 1 to 5 percent of the mapped areas.

Permeability is moderately slow to moderately rapid in the Loxley soil, and available water capacity is very high. Surface runoff and internal drainage are very slow. The seasonal high water table is 1 foot above the surface to 1 foot below. The soil is extremely acid throughout. Natural fertility is low. Soil strength is very low.

Most areas are forested. This soil is poorly suited to most tree species. Black spruce and tamarack are the principal trees. The growth rate is slow, but it can be improved by lowering the water table. The methods and timing of harvesting and planting are severely limited by wetness. Harvesting is limited to periods when the ground is frozen. Live sphagnum surface soil provides a satisfactory seedbed for black spruce, but regeneration in areas lacking sphagnum is better after the vegetation is burned. Early seedling growth can be improved by control or removal of competing vegetation. Clearcutting rather than selective cutting improves regeneration and reduces the severe windthrow hazard.

Because of the extreme wetness and the low fertility, this soil is generally unsuitable for cultivated crops. It is well suited to the development of wetland wildlife habitat. Open areas of water can be developed by excavations, but machine access is a problem because of low strength.

Because of the ponding, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and frost action. Because of low strength, road settlement is a continuing problem unless the organic material is removed.

The land capability classification is VIw, and the woodland ordination symbol is 3W.

541—Rifle mucky peat. This nearly level, very poorly drained, organic soil is in bogs on glacial lake plains, outwash plains, and moraines. Ponding is common in the spring and after heavy rains. Individual areas are irregular in shape and range from about 20 to 800 acres in size.

Typically, the surface layer is black mucky peat about 4 inches thick. Below this to a depth of at least 60 inches is dark reddish brown and dark brown mucky peat. In some areas the surface layer is muck. In other areas mineral soil is within a depth of 51 inches. In places the soil is extremely acid.

Included with this soil in mapping are small areas of the somewhat poorly drained Cowhorn and poorly drained Indus soils on nearly level and gently sloping uplands. Also included are the moderately well drained Taylor and well drained Wawina soils in convex areas on uplands. Included soils make up 2 to 10 percent of the mapped areas.

Permeability is moderate or moderately rapid in the Rifle soil, and available water capacity is very high. Surface runoff is very slow or ponded. The seasonal high water table is 1 foot above the surface to 1 foot below. The soil is strongly acid to neutral throughout. Natural fertility is low. Soil strength is very low.

Most areas are forested. This soil is fairly well suited to lowland trees. Black spruce, tamarack, balsam fir, white cedar, and black ash are the common trees. The growth rate is slow, but it can be improved by lowering the water table. The methods and timing of harvesting and planting are limited by wetness. Harvesting is limited to periods when the ground is frozen. Black spruce is the principal species for which efforts are made to encourage regeneration. Following clearcutting, site preparation for seeding black spruce commonly includes burning the remaining vegetation, except where the surface soil is live sphagnum. Control or removal of competing vegetation typically increases seedling survival and early growth rates. Clearcutting rather than selective cutting reduces the severe windthrow hazard.

Because of the extreme wetness and the low fertility, this soil is generally unsuitable for cultivation. It is suited to the development of wetland wildlife habitat. Open areas of water can be developed by excavations, but machine access is a problem because of low strength.

Because of the ponding, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and frost action. Because of low strength, road settlement is a continuing problem unless the organic material is removed.

The land capability classification is VIw, and the woodland ordination symbol is 4W.

544—Cathro muck. This nearly level, very poorly drained, organic soil is in drainageways, in small depressions, and at the outer margins of large bogs on lake plains and glacial moraines. It typically is ponded in the spring and after heavy rains. Individual areas are irregular in shape and range from about 20 to 250 acres in size.

Typically, the surface layer is black muck about 5 inches thick. The next layer is very dark brown mucky peat about 9 inches thick. Below this is black muck

about 25 inches thick. The underlying material to a depth of at least 60 inches is dark gray loam. In places the surface layer is mucky peat. In some areas the soil has thick layers of mucky peat. In other areas the organic material is less than 16 or more than 50 inches thick.

Included with this soil in mapping are small areas of the somewhat poorly drained Keewatin and Stuntz and poorly drained Morph, Shooker, and Spooner soils on the slightly higher parts of the landscape. These soils make up 2 to 10 percent of the mapped areas.

Permeability is moderate or moderately rapid in the organic part of the Cathro soil and moderate or moderately slow in the loamy part. Available water capacity is very high. Surface runoff is ponded or very slow. The seasonal high water table is 1 foot above the surface to 1 foot below. The organic material is medium acid to mildly alkaline. The loamy material is slightly acid to moderately alkaline. The organic matter content is very high, and natural fertility is low. Soil strength is very low.

Most areas are forested. This soil is poorly suited to most tree species. The common trees are black ash, northern white-cedar, balsam fir, tamarack, and black spruce. Growth rates typically are slow, but they can be improved by removal of excess water. The methods and timing of tree harvesting and planting are limited by wetness. Harvesting is limited to periods when the ground is frozen. Black spruce is the principal species for which efforts are made to encourage regeneration. Following clearcutting, site preparation for seeding black spruce commonly includes burning the remaining vegetation, except where the surface soil is live sphagnum. Plant competition typically is vigorous. Measures that control the competing vegetation increase the seedling survival and the early growth rates. Clearcutting rather than selective cutting reduces the windthrow hazard.

This soil is generally unsuitable for cultivated crops, pasture, and hay because of the extreme wetness and the low fertility. Wetland wildlife habitat can be easily developed or enhanced.

Because of the ponding, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and frost action. Because of low strength, road settlement is a continuing problem unless the organic material is removed.

The land capability classification is VIw, and the woodland ordination symbol is 3W.

549—Greenwood peat. This nearly level, very poorly drained, organic soil is in bogs on glacial moraines. It typically is ponded in the spring and after heavy rains. Individual areas are irregularly shaped or circular and range from about 20 to 2,500 acres in size.

Typically, the surface layer is light brownish gray sphagnum peat about 15 inches thick. Below this to a depth of at least 60 inches is dark reddish brown and dark brown mucky peat. In a few places sphagnum peat or herbaceous muck is the dominant organic material. In some areas mineral soil is within a depth of 51 inches. In a few places the soil is strongly acid.

Included with this soil in mapping are small areas of the somewhat poorly drained Cowhorn and poorly drained Indus and Brickton soils on the slightly higher parts of the landscape. These soils make up 1 to 5 percent of the mapped areas.

Permeability is moderately rapid in the Greenwood soil, and available water capacity is very high. Surface runoff is very slow or ponded. The seasonal high water table is 1 foot above the surface to 1 foot below. The soil is extremely acid throughout. Natural fertility and soil strength are very low.

Most areas are forested. This soil is poorly suited to most tree species. Black spruce and tamarack are the most common trees (fig. 6). The growth rate is slow, but it can be improved by removal of excess water. The methods and timing of tree harvesting and planting are limited by wetness. Harvesting is limited to periods when the ground is frozen. A live sphagnum surface layer is an acceptable seedbed for black spruce. If seed sources for both species are available, regeneration of tamarack is more successful than regeneration of black spruce after an area is burned. Early growth rates can be improved by control of competing vegetation. Clearcutting rather than selective cutting reduces the severe windthrow hazard.

Because of the extreme wetness, the very low fertility, and the extreme acidity, this soil is unsuited to cultivated crops. It is suited to wetland wildlife habitat. Open water areas can be developed by excavations, but equipment access is a problem because of low strength.

Because of the ponding; this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and frost action. Because of low strength, road settlement is a continuing problem unless the organic material is removed.

The land capability classification is VIIw, and the woodland ordination symbol is 3W.

550—Dora mucky peat. This very poorly drained, nearly level soil is in small bogs and at the edges of large bogs on glacial lake plains and moraines. It is ponded in spring and after heavy rains. Individual areas are irregular in shape and range from about 15 to 180 acres in size.

Figure 6.—Black spruce and tamarack on Greenwood peat.

Typically, the surface soil is black mucky peat about 12 inches thick. The next layer is black muck about 20 inches thick. Below this is black mucky silty clay loam about 4 inches thick. The underlying material to a depth of at least 60 inches is gray and olive gray, mottled silty clay loam and silty clay. In some areas the organic material is more than 51 or less than 16 inches thick.

Included with this soil in mapping are small areas of the poorly drained, clayey Indus and Brickton soils. These soils make up 1 to 5 percent of the mapped areas.

Permeability is moderate or moderately rapid in the organic part of the Dora soil and very slow in the clayey material. Available water capacity is very high. Surface runoff is very slow or ponded. The seasonal high water table is 2 feet above the surface to 1 foot below. Reaction is medium acid to neutral in the organic layers. The organic matter content is very high, and natural fertility is low. Soil strength is very low.

Most areas are forested. This soil is fairly well suited to lowland trees. Black spruce, black ash, and northern white-cedar are the dominant species. The growth rates of all trees can be increased somewhat by lowering the water table. Clearcutting of black spruce rather than selective cutting enhances regeneration and reduces the windthrow hazard. The methods and timing of tree harvesting and planting are severely limited by wetness. Harvesting is limited to periods when the ground is frozen. Live sphagnum surface soil is a satisfactory seedbed for black spruce. In areas that have no live sphagnum, regeneration is better after the slash and vegetation are burned. Early growth rates can be improved by control or removal of competing vegetation.

Because of the extreme wetness and the low fertility, this soil is generally unsuitable for cultivated crops. It is suited to the development of wetland wildlife habitat. Open water areas can be developed by excavations, but machine access is a problem because of low strength. In places blasting can establish open water areas.

Because of the ponding, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and frost action. Because of low strength, road settlement is a continuing problem unless the organic material is removed.

The land capability classification is VIw, and the woodland ordination symbol is 4W.

614—Blackhoof muck. This nearly level, very poorly drained soil is on concave and plane slopes on till plains and glacial moraines. It is ponded in spring and after

heavy rains. A few stones typically are in the soil. Individual areas are elongated or irregularly shaped and range from 5 to about 80 acres in size.

Typically, the surface layer is black muck about 8 inches thick. The subsurface layer is black loam about 3 inches thick. The subsoil is dark gray, dark grayish brown, gray, and olive gray, mottled loam about 33 inches thick. The underlying material to a depth of at least 60 inches is grayish brown, mottled loam. In some places it is fine sandy loam. In other places a sandy layer as much as 20 inches thick is directly below the organic material. In some areas the surface layer is thinner or thicker.

Included with this soil in mapping are small areas of the somewhat poorly drained Keewatin and Sandwick soils on the slightly higher parts of the landscape. These soils make up less than 15 percent of the mapped areas.

Permeability is very slow or slow in the Blackhoof soil, and available water capacity is high or very high. Surface runoff is very slow or ponded. The seasonal high water table is 2 feet above the surface to 1 foot below. Reaction ranges from strongly acid in the upper part of the soil to mildly alkaline in the lower part. The organic matter content is high, and natural fertility is medium.

Most areas are undrained and support native reeds, sedges, grasses, willows, alder, and dogwood. Some areas support black ash and tamarack. This soil is poorly suited to most tree species. Adequate site preparation and control of competing vegetation improve seedling establishment. The use of heavy equipment is severely limited by wetness. Harvesting is limited to periods when the ground is frozen. Clearcutting rather than selective cutting reduces the severe windthrow hazard.

Because of the extreme wetness, this soil is generally unsuitable for cultivated crops, forage crops, and small grain. It is well suited to the development of wetland wildlife habitat.

Because of the ponding, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and frost action.

The land capability classification is IVw, and the woodland ordination symbol is 3W.

615—Cowhorn loamy very fine sand. This nearly level, somewhat poorly drained soil is on glacial lake plains, deltas, and river terraces (fig. 7). Slopes are plane and smooth or are slightly convex or concave. Individual areas are irregularly shaped or elongated and range from about 15 to 350 acres in size.

Typically, the surface layer is grayish brown loamy very fine sand about 8 inches thick. The subsoil is mottled loamy very fine sand about 43 inches thick. The upper part is light yellowish brown, yellowish brown, brown, pale brown, and light brownish gray, and the lower part is light olive gray, light gray, and light brownish gray. The underlying material to a depth of at least 60 inches is olive gray and light olive gray, mottled very fine sand. In places lenses of sand, coarse sand, or gravelly sand are in the underlying material.

Included with this soil in mapping are small areas of the well drained Wawina and excessively drained Zimmerman soils on convex slopes. Also included are some small areas of the very poorly drained Sago soils in depressions. Included soils make up 3 to 10 percent of the mapped areas.

Permeability is moderately rapid in the Cowhorn soil, and available water capacity is high. Surface runoff is slow. The seasonal high water table is at a depth of 1.5 to 3.0 feet. The surface layer and subsoil are strongly acid to slightly acid. The organic matter content and natural fertility are low.

This soil is well suited to trees. Quaking aspen is the most abundant species. Balsam fir, white spruce, paper birch, red pine, jack pine, and northern hardwoods also are common. If an area is to be converted to conifers, white spruce and white pine are the best suited species. Adequate site preparation and control of competing vegetation help to establish planted seedlings. Deferment of harvesting or planting during wet periods helps to prevent excessive soil damage and maintains the potential for seedling regeneration.

Most areas are farmed. If drained, this soil is well suited to many of the crops commonly grown in the county. Forage grasses, legumes, and small grain are the principal crops. The wetness is the main management concern. A drainage system that includes tile drains is needed. Applications of fertilizer also are needed. Proper crop residue management and sod-forming crops help to control soil blowing. Sod-forming grasses are helpful in controlling erosion along ditches and outlets.

If dwellings are constructed on this soil, the lower floor or basement level should be constructed above the seasonal high water table. Proper landscaping can divert surface water away from the buildings. Constructing local roads on well compacted, coarse textured base material helps to prevent frost damage. The soil is poorly suited to septic tank absorption fields because of the seasonal high water table. This limitation can be overcome by mounding with suitable material.

The land capability classification is IIw, and the woodland ordination symbol is 6A.

616—Effie loam. This nearly level, poorly drained soil is on glacial till plains and moraines. A few stones typically are on the surface and in the soil. Slopes are plane. Individual areas are irregular in shape and range from about 15 to 500 acres in size.

Typically, a black mat of forest litter about 2 inches thick is at the surface. The surface layer is light brownish

Figure 7.—An area of Cowhorn loamy very fine sand. A feedlot pollution control system is in the foreground.

gray and gray, mottled loam about 5 inches thick. The next 3 inches is grayish brown, mottled clay loam and light brownish gray and gray loam. The subsoil is grayish brown and dark grayish brown, mottled clay loam about 11 inches thick. The upper part of the underlying material is light brownish gray and grayish brown, mottled silty clay loam. The lower part to a depth of at least 60 inches is light brownish gray, mottled clay loam. In places the subsoil contains less clay and more sand.

Included with this soil in mapping are small areas of the moderately well drained Suomi soils on convex slopes and the very poorly drained Dora and Wildwood soils in small depressions. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is slow in the Effie soil, and available water capacity is high. Surface runoff is slow or very slow. The seasonal high water table is at a depth of 1.0 to 2.5 feet. The surface soil is medium acid to neutral. The subsoil is medium acid to mildly alkaline. The organic matter content is moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to quaking aspen. Quaking aspen is the dominant species. Balsam fir and paper birch are fairly common. White spruce, eastern white pine, and black ash are in some stands. Regeneration and growth of aspen following clearcutting are quite rapid. Little site preparation is needed for this species. Planting is needed if a satisfactory stand of white spruce is to be established. Adequate site preparation and control of competing vegetation help to achieve satisfactory survival and early growth rates of planted conifers. The use of equipment is limited by wetness during the spring and after heavy rains. The use of heavy equipment during these periods can result in excessive compaction and can reduce the potential for tree regeneration. Clearcutting rather than selective cutting reduces the severe windthrow hazard and improves aspen regeneration.

If drained, this soil is well suited to many of the crops commonly grown in the county. Areas that are farmed are used primarily for hay and pasture, but small grain can also be grown. The wetness is the main management concern. A drainage system is necessary. Fall tillage permits earlier seedbed preparation in spring and helps to maintain good tilth. Tilling when the soil is wet can result in the formation of hard clods. The risk of soil blowing can be reduced by proper crop residue management and by sod-forming crops. Removal of stones reduces the risk of machinery damage.

Because of the wetness, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength and frost action.

The land capability classification is IIw, and the woodland ordination symbol is 7W.

617B—Goodland silt loam, 1 to 10 percent slopes. This nearly level to rolling, well drained soil is on convex to concave slopes on glacial moraines and till plains. A few stones typically are on the surface and in the soil. Individual areas are irregular in shape and range from about 15 to 400 acres in size.

Typically, about 2 inches of organic forest litter is at the surface. The surface layer is grayish brown silt loam about 3 inches thick. The upper subsoil is yellowish brown silt loam about 5 inches thick. The next layer is pale brown silt loam about 4 inches thick. Below this is about 4 inches of pale brown and light brownish gray loam and yellowish brown sandy loam. The lower subsoil is about 16 inches thick. It is yellowish brown fine sandy loam in the upper part and brown gravelly loamy coarse sand in the lower part. The underlying material to a depth of at least 60 inches is yellowish brown and brown gravelly sand. In some places the loamy mantle is thinner. In other places the underlying material is sandy loam. In a few areas the soil has a higher content of coarse fragments.

Included with this soil in mapping are small areas of the excessively drained Cromwell, Graycalm, and Menahga soils on the upper slopes. Also included are areas of very poorly drained, organic soils in small, closed depressions. Included soils make up 2 to 10 percent of the mapped areas.

Permeability is moderate in the upper part of the Goodland soil and rapid in the underlying material. Available water capacity is moderate. Surface runoff is medium or rapid. The surface layer and subsoil are strongly acid to slightly acid. The organic matter content is moderate, and natural fertility is low.

Most areas are forested. This soil is well suited to northern hardwoods and conifers. Aspen, northern hardwoods, balsam fir, red pine, and white spruce are the most common species. Planting is necessary if a high population of conifers is to be established. If the site is adequately prepared and competing vegetation is controlled, seedling mortality is usually slight. Operating equipment across the slope helps to prevent the formation of small gullies.

This soil is moderately suited to cultivated crops and well suited to forage crops. Measures that correct the acidity of the soil and applications of fertilizer are necessary. Erosion is a hazard in the more sloping areas. It can be controlled by sod-forming forage crops and effective crop residue management. Many areas have surface stones, but the amount is not enough to make tillage impractical. Removal of the stones reduces the risk of machinery damage.

This soil is suitable for building site development. Constructing local roads on well compacted, coarse textured base material helps to prevent frost damage. The soil readily absorbs but does not adequately filter effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IIIe, and the woodland ordination symbol is 6A.

618B—Itasca silt loam, 1 to 10 percent slopes. This nearly level to rolling, well drained soil is on plane and complex slopes on glacial till plains and moraines. A few stones typically are on the surface and in the soil.

Individual areas are irregular in shape and range from about 15 to 600 acres in size.

Typically about 1.5 inches of organic forest litter is at the surface. The surface layer is grayish brown silt loam about 3 inches thick. The upper subsoil is yellowish brown silt loam about 6 inches thick. Below this is pale brown silt loam about 10 inches thick. The next 16 inches is grayish brown, dark yellowish brown, and dark brown fine sandy loam. The lower subsoil is fine sandy loam about 20 inches thick. It is yellowish brown in the upper part and brown in the lower part. The underlying material to a depth of at least 60 inches is light olive brown fine sandy loam. In some places the subsoil has slightly more clay. In other places the lower part of the underlying material is sandy. In some areas a thin layer of sandy material is between the silty surface soil and the lower subsoil of fine sandy loam.

Included with this soil in mapping are small areas of Cathro, Shooker, and Talmoon soils. The very poorly drained Cathro and Talmoon soils are in depressions less than 5 acres in size. The poorly drained Shooker soils are in nearly level areas. Included soils make up 2 to 10 percent of the mapped areas.

Permeability is moderate in the Itasca soil, and available water capacity is high. Surface runoff is medium. The surface layer is strongly acid to slightly acid, and the subsoil is medium acid to neutral. The organic matter content is moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to many upland tree species. Existing stands are mainly aspen or northern hardwoods. Most have some balsam fir and, in places, a few naturally regenerated eastern white pine, white spruce, or red pine. Regeneration of aspen following clearcutting is rapid and commonly requires a minimum of site preparation (fig. 8). Conifers normally can be established if the site is adequately prepared, if competing vegetation is removed or controlled, and if suitable species are selected for planting. Red pine grows well in existing stands, but attempts to establish this species by planting have had limited success. Operating equipment during wet periods compacts the soil and reduces the potential for reestablishing trees.

This soil is moderately suited to small grain and to corn for silage. It is well suited to forage crops. Erosion is the main management concern. Effective crop residue management, sod-forming crops, timely tillage, and contour farming help to control erosion and maintain good tilth. Soil blowing in large open areas can be controlled by effective crop residue management, stripcropping, and windbreaks. In most areas a few stones hinder tillage, but the amount is not enough to make tillage impractical. Removal of the stones reduces the risk of machinery damage. The wetness of the included soils in small depressions can delay fieldwork and limit the use of machinery. Draining the depressions improves the overall efficiency of cropping.

This soil is suitable for building site development. Constructing local roads on well compacted, coarse textured base material helps to prevent frost damage. Because of the restricted permeability, the soil cannot readily absorb the effluent in septic tank absorption fields. Installing a field that is larger than average helps to overcome this limitation.

The land capability classification is IIIe, and the woodland ordination symbol is 8A.

619—Keewatin silt loam. This nearly level, somewhat poorly drained soil is on plane and slightly concave slopes on glacial moraines and till plains. A few stones typically are on the surface and in the soil. Individual areas are irregular in shape and range from about 5 to 350 acres in size.

Typically, about 1 inch of organic forest litter is at the surface. The surface layer is very dark gray and black silt loam about 1 inch thick. The subsurface layer is about 15 inches of light brownish gray and grayish brown, mottled fine sandy loam and sandy loam. It is firm, dense, and brittle in the lower part. The next layer is about 10 inches of grayish brown, brown, and yellowish brown, mottled loam and light brownish gray sandy loam. This layer is firm, dense, and brittle. The subsoil is brown and grayish brown, mottled loam about 34 inches thick. The underlying material to a depth of at least 65 inches also is brown and grayish brown, mottled loam. In places the surface layer and subsurface layer contain more sand. In some small areas the soil is poorly drained. In a few places the subsoil has a slightly higher content of clay.

Included with this soil in mapping are small areas of the well drained Nashwauk and Cutaway soils on convex slopes. Also included are small areas of the very poorly drained Blackhoof and Cathro soils in depressions. Included soils make up about 2 to 10 percent of the mapped areas.

Permeability is slow in the Keewatin soil, and available water capacity is low or moderate. Surface runoff is slow. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet. The surface layer is strongly acid to slightly acid. The subsoil is medium acid to neutral. The organic matter content is moderate to low, and natural fertility is low.

Most areas are forested. This soil is well suited to quaking aspen and balsam fir. It is suited to all of the common upland conifers, except for red pine. The common trees are quaking aspen, balsam fir, and black ash. Aspen typically regenerates well following clearcutting. Seedling survival and early growth rates of planted conifers can be improved by removal or control of competing vegetation. Deferment of harvesting or planting during periods when the soil is saturated in spring and after heavy rains helps to prevent excessive

Figure 8.—Aspen regeneration on Itasca silt loam, 1 to 10 percent slopes.

compaction and thus maintains the potential for seedling regeneration. Clearcutting rather than selective cutting reduces the severe windthrow hazard and improves aspen regeneration.

This soil is moderately suited to cultivated crops, forage crops, and small grain. The wetness is the main management concern. A drainage system is needed. The excessive acidity and the low fertility can be overcome by applications of lime and fertilizer. The low available water capacity restricts productivity even in areas where the other limitations are overcome. Crops that can utilize spring rainfall and mature early typically are better suited than those dependent on rainfall late in summer. Removal of stones reduces the risk of damage to machinery.

This soil is poorly suited to dwellings because of the wetness. The buildings should be constructed without basements. Proper landscaping can divert surface water away from the buildings. Tile drains around foundations help to remove excess subsurface water. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by wetness and frost action. The soil is poorly suited to septic tank absorption fields because of the seasonal high water table and the

restricted permeability. These limitations can be overcome by mounding with suitable material.

The land capability classification is IIIw, and the woodland ordination symbol is 6W.

620B—Cutaway loamy sand, 0 to 8 percent slopes. This nearly level to rolling, well drained soil is on plane and complex slopes on glacial moraines. A few stones typically are on the surface and in the soil. Individual areas are irregular in shape and range from about 10 to 250 acres in size.

Typically, the surface layer is grayish brown loamy sand about 4 inches thick. The upper subsoil is about 27 inches of dark brown loamy sand, yellowish brown sand, and pale brown coarse sand. The next layer is light brownish gray loamy coarse sand about 4 inches thick. Below this is about 4 inches of brown clay loam mixed with light brownish gray loamy sand. The lower subsoil is about 17 inches of light olive brown clay loam and loam. The underlying material to a depth of at least 60 inches is light olive brown loam. In places the sandy material is more than 40 or less than 20 inches thick. In some areas the soil is moderately well drained.

Included with this soil in mapping are areas of the somewhat poorly drained Sandwick soils on slightly concave slopes and in drainageways. Also included are small areas of Nashwauk, Nebish, and Warba soils. These soils do not have a sandy mantle. They are in landscape positions similar to those of the Cutaway soil. Included soils make up 2 to 15 percent of the mapped areas.

Permeability is rapid in the upper part of the Cutaway soil and moderately slow or slow in the underlying material. Available water capacity is moderate. Surface runoff is slow. The surface layer is strongly acid or medium acid. The subsoil is strongly acid to slightly acid. The content of organic matter and natural fertility are low.

Most areas are forested. This soil is well suited to many upland tree species. Quaking aspen is dominant. Northern hardwoods, red pine, jack pine, balsam fir, and white spruce also are common. Natural regeneration and growth of aspen following clearcutting are rapid. Planting generally is needed if an adequate stand of conifers is to be established. Adequate site preparation and control of competing vegetation help to establish planted seedlings. A moderate seedling mortality rate can be expected in some years because of the droughtiness of the sandy mantle. Careful planting of vigorous nursery stock reduces the seedling mortality rate.

This soil is moderately suited to cultivated crops and small grain. It is well suited to forage crops. The main management concerns are erosion, droughtiness, and the low fertility. Applications of fertilizer and an adequate moisture supply are necessary. Erosion can be controlled by farming on the contour and by applying tillage methods that leave large amounts of crop residue on the surface. Removal of stones reduces the risk of damage to machinery.

This soil is suitable as a site for dwellings and local roads. It is generally unsuitable as a site for septic tank absorption fields. Soils that are better suited to this use are generally nearby.

The land capability classification is IIIe, and the woodland ordination symbol is 6S.

621—Morph very fine sandy loam. This nearly level, poorly drained soil is on plane and slightly concave slopes on glacial lake plains and outwash plains. Individual areas are irregular in shape and range from about 15 to 250 acres in size.

Typically, the surface layer is very dark gray very fine sandy loam about 4 inches thick. The subsurface layer is grayish brown, mottled very fine sandy loam about 9 inches thick. The next 10 inches is grayish brown, mottled fine sandy loam and light brownish gray loamy fine sand. The subsoil is about 17 inches thick. The upper part is grayish brown, mottled fine sandy loam, and the lower part is olive gray, mottled loam and grayish brown, mottled sandy loam. The underlying material to a depth of at least 60 inches is grayish brown and light brownish gray, mottled very fine sandy loam, loamy fine sand, and silt loam. In some places the soil has fewer sandy layers and has more silt and clay in the upper 40 inches. In other places the sandy layers are dominant.

Included with this soil in mapping are areas of the moderately well drained Rosy soils on the higher parts of the landscape and small areas of poorly drained soils that are sandy throughout. Also included are the very poorly drained, stratified, sandy and loamy Sago soils in small depressions. Included soils make up 3 to 15 percent of the mapped areas.

Permeability is moderate in the Morph soil, and available water capacity is moderate or high. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet. The surface soil is strongly acid to slightly acid. The subsoil is slightly acid to moderately alkaline. The organic matter content is moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to quaking aspen and balsam fir. Quaking aspen, balsam fir, paper birch, and black ash are the common trees. Quaking aspen grows well and regenerates rapidly following clearcutting. White spruce and balsam fir are suitable species for planting if conversion to conifers is desired. Adequate site preparation and control of competing vegetation increase the seedling survival and early growth rates. Boggy conditions during wet periods limit the use of wheeled harvesting or planting equipment. If used during wet periods, this equipment can become mired in the soil. Also, compaction can occur, and the potential for regeneration of the stands is reduced. Harvesting is limited to dry periods in the

summer or to periods when the ground is frozen. Clearcutting rather than selective cutting reduces the severe windthrow hazard.

If drained, this soil is moderately suited to cultivated crops and small grain. It is well suited to forage crops. A drainage system and applications of fertilizer are necessary. Soil blowing is a hazard in large open areas, but it can be controlled by crop residue management, stripcropping, and periodically grown sod-forming crops. Erosion along waterways can be controlled by maintaining a permanent protective plant cover.

Because of the wetness, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on well compacted, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by frost action.

The land capability classification is IIIw, and the woodland ordination symbol is 7W.

622B—Nashwauk fine sandy loam, 1 to 10 percent slopes. This nearly level to rolling, well drained soil is on convex slopes on glacial moraines. A few stones and boulders typically are on the surface and in the soil. Individual areas are irregular in shape and range from about 15 to 1,200 acres in size.

Typically, about 0.5 inch of organic forest litter is at the surface. The surface layer is very dark gray fine sandy loam about 1 inch thick. The subsurface layer is grayish brown fine sandy loam about 3 inches thick. The upper subsoil is yellowish brown fine sandy loam about 3 inches thick. The next 9 inches is massive, brittle, brown loam mixed with light brownish gray loam. The lower subsoil to a depth of at least 60 inches is brown and light olive brown loam and silt loam. In some places the soil has small amounts of grayish brown material in the subsoil. In other places layers in the subsoil and underlying material have a higher content of clay. In the central part of the county, the soil contains more sand and less silt and clay. It is redder in some small areas along the St. Louis County line, south of the Iron Range. In some areas the soil is moderately well drained.

Included with this soil in mapping are small areas of the nearly level, somewhat poorly drained Keewatin soils and small areas of the very poorly drained Blackhoof and Cathro soils in depressions. Also included are small areas of Cutaway soils in landscape positions similar to those of the Nashwauk soil. These soils are sandy in the upper part and loamy in the lower part. Included soils make up 3 to 15 percent of the mapped areas.

Permeability is slow in the Nashwauk soil, and available water capacity is low or moderate. Surface runoff is medium. The surface layer is very strongly acid to slightly acid. The subsoil is strongly acid to neutral. The organic matter content and natural fertility are low.

Most areas are forested. This soil is well suited to most tree species. The common species are quaking aspen, paper birch, American basswood, red oak, balsam fir, and white spruce. Aspen is the most common species. Balsam fir and, to a lesser extent, white spruce commonly regenerate as understory species. Adequate stands of white spruce do not regenerate naturally. Most upland conifers, except for red pine, are suitable for planting. Seedling survival and early growth rates can be increased by control or removal of competing vegetation. If heavy wheeled equipment is used when the soil is wet, normally in the spring and after heavy rains, excessive compaction can reduce the potential for seedling regeneration. Clearcutting rather than selective cutting reduces the severe windthrow hazard.

This soil is moderately suited to forage and small grain crops. Erosion is the main management concern. It can be controlled by crop residue management, timely tillage, stripcropping, and periodically grown sod-forming crops. The excessive acidity and low fertility can be overcome by applications of lime and fertilizer. The low available water capacity restricts productivity. Crops that can utilize spring rainfall and mature early typically are better suited than those dependent on rainfall late in summer. Removal of stones and boulders reduces the risk of damage to machinery.

Dwellings constructed in the more sloping areas of this soil should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. Building local roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion. Providing well compacted, coarse textured base material helps to prevent frost damage. Because of the restricted permeability, the soil cannot readily absorb the effluent in septic tank absorption fields. Installing a field that is larger than average helps to overcome this limitation.

The land capability classification is IIIe, and the woodland ordination symbol is 6D.

622E—Nashwauk fine sandy loam, 12 to 35 percent slopes. This hilly to very steep, well drained soil is on complex slopes on glacial moraines and along drainageways on till plains. A few stones and boulders typically are on the surface and in the soil. Individual areas are irregularly shaped or elongated and range from about 15 to 300 acres in size.

Typically, the surface layer is very dark gray fine sandy loam about 3 inches thick. The subsurface layer is grayish brown and very dark gray fine sandy loam about 1 inch thick. The upper subsoil is yellowish brown fine sandy loam about 8 inches thick. The next layer is yellowish brown and light brownish gray, firm, brittle sandy clay loam about 4 inches thick. The lower subsoil is about 42 inches of yellowish brown clay loam and brown sandy clay loam. The underlying material to a depth of at least 60 inches is brown and pale brown fine

sandy loam. In places the subsoil and underlying material have more clay. In some areas in the central part of the county, they have more sand and less silt and clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Keewatin and very poorly drained Blackhoof and Cathro soils in depressions. Also included are small areas of Cutaway soils on the less sloping parts of the landscape. These soils are sandy in the upper part and loamy in the lower part. Included soils make up 1 to 10 percent of the mapped areas.

Permeability is slow in the Nashwauk soil, and available water capacity is low or moderate. Surface runoff is medium or rapid. The surface layer is very strongly acid to slightly acid. The subsoil is strongly acid to neutral. The organic matter content and natural fertility are low.

Most areas are forested. This soil is well suited to most of the common tree species. The most common species are quaking aspen, paper birch, American basswood, red oak, balsam fir, and white spruce. Regeneration of aspen following clearcutting is rapid. Balsam fir commonly regenerates as an understory species. Planting generally is needed if a satisfactory stand of other conifers is to be established. Most upland conifers grow at acceptable rates.

Seedling losses of red pine commonly are significantly greater than those of other species. Seedling survival and early growth rates can be increased by control or removal of competing vegetation. Erosion on logging roads and skid trails is a major management concern. It can be controlled by building the roads and skid trails on the contour. The use of equipment is limited by the slope. Operating heavy wheeled equipment during wet periods early in spring and after periods of heavy rain can result in excessive compaction. Clearcutting rather than selective cutting reduces the windthrow hazard and improves aspen regeneration.

Because of the slope and the hazard of erosion, this soil is unsuited to cultivated crops. The less sloping areas are poorly suited to forage crops. The very steep areas can be used only for grazing. The excessive acidity and low fertility can be overcome by applications of lime and fertilizer. The low available water capacity restricts productivity. Removal of stones and boulders reduces the risk of damage to machinery.

Because of the slope, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. The slope also is the main limitation on sites for local roads. Extensive cutting and filling are generally needed. Building the roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion.

The land capability classification is VIIe, and the woodland ordination symbol is 6R.

624B—Rosy very fine sandy loam, 0 to 6 percent slopes. This nearly level and undulating, moderately well drained soil is on smooth, plane, or convex slopes on glacial lake plains and outwash plains. Individual areas are irregular in shape and range from about 15 to 450 acres in size.

Typically, about 2 inches of organic forest litter is at the surface. The surface layer is dark gray and dark grayish brown very fine sandy loam about 2 inches thick. The subsurface layer is grayish brown and light brownish gray fine sandy loam about 7 inches thick. The next 3 inches is yellowish brown and brown loam mixed with grayish brown and light brownish gray very fine sandy loam. The subsoil is about 38 inches thick. The upper part is yellowish brown loam, and the lower part is stratified yellowish brown and brown, mottled sandy loam, fine sandy loam, loam, and silt loam and grayish brown, light brownish gray, and pale brown loamy sand. The underlying material to a depth of at least 60 inches is light brownish gray, light olive brown, and grayish brown, mottled, stratified loamy fine sand, sandy loam, loamy very fine sand, and silt loam. In some places the soil has fewer sandy layers. In other places it contains more sand in the loamy layers. In a few areas it is more sloping and better drained.

Included with this soil in mapping are small areas of Morph, Sago, and Zimmerman soils. The poorly drained Morph soils are in shallow depressions and on low lying flats. The excessively drained Zimmerman soils are in landscape positions similar to those of the Rosy soil. They are sandy throughout. The very poorly drained Sago soils are in depressions. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Rosy soil, and available water capacity is moderate or high. Surface runoff is slow or medium. The seasonal high water table is at a depth of 3 to 5 feet. The surface soil and subsoil are strongly acid to neutral. The content of organic matter is moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to the common upland tree species. Quaking aspen, paper birch, balsam fir, and northern hardwoods are the most common trees. Natural regeneration of aspen following clearcutting is rapid. White spruce is suitable for planting if conversion to conifers is desired. Control or removal of competing vegetation increases seedling survival and early growth rates. The use of heavy wheeled equipment during wet periods can result in excessive compaction, which reduces the potential for regeneration.

This soil is well suited to small grain, corn for silage, and forage crops. Erosion is a management concern. Soil blowing is a hazard in open areas, but it can be controlled by effective crop residue management, stripcropping, and periodically grown sod-forming crops. Erosion along waterways can be controlled by maintaining a permanent protective plant cover. Timely fieldwork at the proper moisture content and tillage

methods that leave large amounts of crop residue on the surface help to maintain good tilth.

If dwellings are constructed on this soil, the lower floor should be built above the seasonal high water table. Tile drains around foundations help to remove excess surface water. Proper landscaping can divert surface water away from the buildings. Constructing local roads on well compacted, coarse textured base material helps to prevent frost damage. The soil is poorly suited to septic tank absorption fields because of the seasonal high water table. This limitation can be overcome by mounding with suitable material.

The land capability classification is IIe, and the woodland ordination symbol is 7A.

625—Sandwick loamy fine sand. This nearly level, somewhat poorly drained soil is on glacial moraines and till plains. Slopes are smooth and plane or are slightly concave or convex. A few stones and boulders typically are on the surface and in the soil. Individual areas are irregular in shape and range from about 5 to 400 acres in size.

Typically, the surface layer is light brownish gray, mottled loamy fine sand about 4 inches thick. The upper subsoil is light brownish gray and brown, mottled loamy fine sand about 18 inches thick. The next 6 inches is light brownish gray and grayish brown, mottled loam about 6 inches thick. The lower subsoil is grayish brown, mottled loam about 10 inches thick. The underlying material to a depth of at least 60 inches is grayish brown, mottled loam. In some places the subsoil and underlying material contain more clay. In other places the sandy mantle is less than 20 or more than 40 inches thick. In some areas a thin layer of gravel and stones is directly above the loamy material.

Included with this soil in mapping are small areas of the well drained Cutaway, Nashwauk, and Warba soils. Also included are some small areas of very poorly drained, organic soils in depressions. Included soils make up 2 to 15 percent of the mapped areas.

Permeability is rapid in the upper part of the Sandwick soil and moderately slow in the lower part. Available water capacity is moderate or high. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 2 feet. The surface layer is strongly acid to slightly acid. The subsoil is strongly acid to neutral. The organic matter content and natural fertility are low.

Most areas are forested. This soil is well suited to quaking aspen and balsam fir. Quaking aspen is the dominant species. Balsam fir, paper birch, and black ash also are common. Natural regeneration of aspen following clearcutting is rapid. Planting is needed if a high population of conifers is to be established. White spruce, balsam fir, and eastern white pine are suitable for planting. Adequate site preparation and control of competing vegetation increase the seedling survival and early growth rates. The use of heavy wheeled equipment during wet periods, normally in spring and after heavy rains, can result in excessive compaction, which reduces the potential for regeneration.

This soil is moderately suited to cultivated crops. If a drainage system is installed, forage crops and small grain can be grown. Measures that reduce acidity and applications of fertilizer are necessary. Removal of stones reduces the risk of damage to machinery.

Because of the wetness, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength.

The land capability classification is IIIw, and the woodland ordination symbol is 7W.

626B—Suomi silt loam, 1 to 8 percent slopes. This nearly level to rolling, moderately well drained soil is on complex and smooth slopes on glacial moraines and till plains. A few stones typically are on the surface and in the soil. Individual areas are irregular in shape and range from about 15 to 280 acres in size.

Typically, about a 0.5 inch of organic litter is at the surface. The surface layer is black silt loam about 3 inches thick. The subsurface layer is dark gray silt loam about 6 inches thick. The next 3 inches is grayish brown silt loam mixed with dark brown clay. The subsoil is clay about 24 inches thick. The upper part is dark brown and dark yellowish brown and is mottled, and the lower part is dark grayish brown. The underlying material to a depth of at least 60 inches is grayish brown and dark grayish brown clay. In some areas the soil is well drained. In a few places it contains less clay.

Included with this soil in mapping are small areas of the poorly drained Brickton, Effie, and Indus soils on flats and in shallow depressions. These soils make up 2 to 10 percent of the mapped areas.

Permeability is slow in the Suomi soil, and available water capacity is moderate or high. Surface runoff is medium or rapid. The surface layer and subsoil are strongly acid to neutral. The content of organic matter is moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to many upland tree species. Quaking aspen is dominant and in mature stands is normally of high quality. Paper birch, American basswood, sugar maple, red oak, balsam fir, eastern white pine, and white spruce are other common species. Regeneration and growth of aspen following clearcutting are rapid and require a minimum of site preparation. Adequate site preparation and control of competing vegetation are needed if a stand of conifers is to be established. Deferment of heavy equipment use during wet periods helps to prevent compaction and maintains the potential for seedling regeneration.

Areas that are farmed are used primarily for hay and pasture. This soil is well suited to cultivated crops and forage crops. Erosion is a management concern. It can

be controlled by effective crop residue management and by sod-forming crops. Because of the clayey texture close to the surface, careful management is necessary to maintain good tilth. Plowing too deeply or when the soil is wet can result in the formation of hard clods. Fall tillage permits earlier preparation of a seedbed in the spring. Removal of stones reduces the risk of damage to machinery.

If dwellings are constructed on this soil, the shrink-swell potential is a limitation. Properly designing foundations and footings and backfilling around the foundations with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Proper landscaping can divert surface water away from the buildings. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength. Because of the restricted permeability, the soil cannot readily absorb the effluent in septic tank absorption fields. Installing a field that is larger than average helps to overcome this limitation.

The land capability classification is IIe, and the woodland ordination symbol is 7A.

626D—Suomi loam, 10 to 25 percent slopes. This rolling to steep, moderately well drained soil is on complex slopes on glacial moraines. A few stones typically are on the surface and in the soil. Individual areas are irregular in shape and range from about 15 to 175 acres in size.

Typically, the surface layer is very dark brown loam about 3 inches thick. The subsurface layer is grayish brown loam about 3 inches thick. The subsoil is about 27 inches thick. It is dark brown, mottled clay and brown, mottled clay loam. The upper part of the underlying material is grayish brown and light brownish gray, mottled silty clay loam. The lower part to a depth of at least 60 inches is grayish brown and light brownish gray loam. In places the subsoil contains less clay. In small areas on the crest of slopes, the soil is well drained.

Included with this soil in mapping are small areas of the poorly drained Brickton, Effie, and Indus soils. These soils are on flats and in shallow depressions. Also included are small areas of organic soils in deep depressions. Included soils make up 2 to 10 percent of the mapped areas.

Permeability is slow in the Suomi soil, and available water capacity is moderate or high. Surface runoff is rapid. The surface layer and subsoil are strongly acid to neutral. The content of organic matter is moderate, and natural fertility is medium.

Most areas are forested. This soil is well suited to aspen, northern hardwoods, and some conifers. Quaking aspen is dominant and in mature stands is normally of high quality. Balsam fir, white spruce, paper birch, and some eastern white pine also are common. Regeneration of aspen following clearcutting is rapid. Adequate site preparation and control of competing vegetation are needed if a stand of conifers is to be established.

The use of logging equipment is limited by the slope. Operating the equipment on the contour helps to control erosion. If the equipment is operated up and down the slope, channels that concentrate runoff and accelerate erosion can form. Building logging roads and skid trails on the contour reduces the susceptibility to erosion. Deferment of equipment use during wet periods helps to prevent compaction and maintains the potential for seedling regeneration.

The soil is generally unsuited to cultivated crops because of the slope and a severe hazard of erosion. Forage crops for hay and pasture can be grown in the less sloping areas. A cover of these crops reduces the risk of erosion. Removal of stones reduces the risk of damage to machinery.

Because of the slope, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. The soil is generally unsuitable as a site for local roads because of the slope and low strength. Extensive cutting and filling are generally needed. Providing well compacted, coarse textured base material helps to prevent the damage caused by low strength. Building the roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion.

The land capability classification is VIe, and the woodland ordination symbol is 7R.

627—Tawas muck. This very poorly drained, nearly level, organic soil is in bogs on outwash plains and glacial lake plains. It generally is at the outer margin of large bogs. It commonly is ponded in the spring. Individual areas are irregular in shape and range from about 15 to 300 acres in size.

Typically, the surface layer is black muck about 13 inches thick. The next layer is dark reddish brown muck about 18 inches thick. The underlying material to a depth of at least 60 inches is olive gray, mottled loamy sand and light olive gray, mottled coarse sand. In places the muck is less than 16 inches thick, and in a few areas it is more than 51 inches thick. In a few places the soil is mucky peat that contains mainly woody fibers.

Included with this soil in mapping are small areas of the excessively drained Menahga and Zimmerman soils on convex slopes. Also included are areas of the somewhat poorly drained Cowhorn and Meehan soils on nearly level slopes. Included soils make up 1 to 10 percent of the mapped areas.

Permeability is moderately slow to moderately rapid in the organic part of the Tawas soil and moderately rapid in the sandy underlying material. Available water capacity is high. Surface runoff is ponded. The seasonal high water table is 1 foot above the surface to 1 foot below. The organic material is very strongly acid to slightly acid.

The organic matter content is very high, and natural fertility is low.

Most areas are forested. This soil is fairly well suited to lowland conifers and hardwoods. Northern white-cedar, tamarack, black ash, black spruce, and balsam fir are the most common trees. Growth rates are slow, but they can be improved by a drainage system. The methods and timing of tree harvesting and planting are severely limited by wetness. Harvesting is limited to periods when the ground is frozen. Clearcutting rather than selective cutting improves regeneration and reduces the windthrow hazard, particularly if black spruce is grown.

This soil is generally unsuitable for cultivated crops and pasture because of the extreme wetness. Drainage is not feasible in most areas. Many areas are subject to frost late in spring and early in fall. Shallow excavations generally provide enough water for the growth of the aquatic vegetation suitable for wetland wildlife habitat. The extreme wetness and low strength, however, limit the access of excavating equipment. In places blasting is an acceptable method of providing open water areas.

Because of the ponding, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and frost action. Because of low strength, road settlement is a continuing problem unless the organic material is removed.

The land capability classification is VIw, and the woodland ordination symbol is 4W.

628—Talmoon silt loam. This nearly level, very poorly drained soil is on concave slopes on glacial till plains. It is subject to ponding. A few stones typically are on the surface and in the soil. Individual areas are irregularly shaped or elongated and range from about 5 to 120 acres in size.

Typically, the surface layer is very dark gray silt loam about 6 inches thick. The subsurface layer is about 10 inches thick. The upper part is gray and dark gray, mottled silt loam, and the lower part is grayish brown and light brownish gray, mottled very fine sandy loam. The subsoil is about 26 inches of olive gray, mottled sandy clay loam and loam. The underlying material to a depth of at least 60 inches is light olive gray and olive gray, mottled loam. In places the surface layer is muck as much as 15 inches thick. In a few places thin layers of sandy material are directly below the muck. In some areas the subsoil has less clay.

Included with this soil in mapping are small areas of Cathro, Shooker, and Stuntz soils. Cathro soils have more than 16 inches of organic material. They are nearer to the center of depressions than the Talmoon soil. The poorly drained Shooker and somewhat poorly drained Stuntz soils are on the slightly higher parts of the landscape. Included soils make up 2 to 15 percent of the mapped areas.

Permeability is moderately slow in the Talmoon soil, and available water capacity is high. Surface runoff is very slow or ponded. The seasonal high water table is 1.0 foot above the surface to 1.5 feet below. The surface layer is strongly acid to neutral. The subsoil is medium acid to neutral. The organic matter content is moderate, and natural fertility is medium.

Most areas support stands of black ash and American elm. Some support brush, reeds, and sedges. This soil is poorly suited to most trees. Growth rates can be improved somewhat by a drainage system. Black spruce is suitable for planting if conversion to conifers is desired. Control of competing vegetation increases the seedling survival and early growth rates. Because of the excessive wetness, most species are shallow rooted. Mature trees are highly susceptible to windthrow. Clearcutting rather than selective cutting reduces the windthrow hazard and improves regeneration. The wetness limits the use of heavy equipment most of the year. The equipment can be used only when the ground is adequately frozen.

If well managed, this soil is moderately suited to most farm crops. An adequate drainage system and applications of fertilizer are necessary. The wetness is the main limitation. The soil is subject to frost late in spring and early in fall. Removal of stones reduces the risk of damage to machinery.

Because of the ponding, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw, and the woodland ordination symbol is 3W.

629B—Wawina loamy very fine sand, 0 to 10 percent slopes. This nearly level to sloping, well drained soil is on smooth, convex, or plane slopes on glacial lake plains, deltas, and river terraces. Individual areas are irregular in shape and range from about 15 to 180 acres in size.

Typically, about 1 inch of organic forest litter is at the surface. The surface layer is dark gray loamy very fine sand about 2 inches thick. The subsurface layer is dark grayish brown loamy very fine sand about 1 inch thick. The subsoil is yellowish brown, dark yellowish brown, and pale brown very fine sand about 28 inches thick. The underlying material to a depth of at least 60 inches is light olive brown very fine sand. In places the subsoil and underlying material have thin layers of brown loamy very fine sand or very fine sandy loam. These layers total less than 6 inches thick. In some areas the content

of fine sand is slightly more than that of very fine sand. In other areas the soil is moderately well drained.

Included with this soil in mapping are small areas of the somewhat poorly drained Cowhorn soils in slight depressions and the very poorly drained Sago soils in the deeper depressions. Included soils make up 2 to 10 percent of the mapped areas.

Permeability is moderately rapid in the Wawina soil, and available water capacity is moderate. Surface runoff is medium. The soil is strongly acid to slightly acid throughout. The organic matter content and natural fertility are low.

Most areas are forested. This soil is well suited to most upland tree species. Aspen, paper birch, and balsam fir are dominant, but red pine and white spruce also are common. Aspen and conifers grow well. If the site is adequately prepared and competing vegetation is controlled, seedling mortality normally is not a significant problem. The slope limits the use of equipment. Operating the equipment on the contour helps to control erosion. Deferment of equipment use during wet periods helps to prevent compaction and maintains the potential for seedling regeneration.

This soil is moderately suited to the farm crops commonly grown in the county. Forage crops and small grain can be grown. Erosion is the principal hazard. Also, soil blowing is a hazard in open areas. Effective crop residue management and contour farming help to prevent excessive soil loss. Applications of lime and fertilizer are needed. Irrigation can improve productivity.

This soil is suitable for building site development and septic tank absorption fields. Constructing local roads on well compacted, coarse textured base material helps to prevent frost damage.

The land capability classification is IIIe, and the woodland ordination symbol is 6S.

630—Wildwood muck. This nearly level, very poorly drained soil is in depressions, on flats, and in drainageways on glacial lake plains. It is ponded in the spring and after heavy rains. Individual areas are irregular in shape and range from about 5 to 150 acres in size.

Typically, the surface layer is dark reddish brown and black muck about 12 inches thick. The subsurface layer is black silty clay about 5 inches thick. The subsoil is dark gray and very dark gray clay about 7 inches thick. The underlying material to a depth of at least 60 inches is gray, mottled clay. In places the organic material is more than 16 inches thick. In a few areas the soil has a very thin organic surface layer or no organic surface layer. In a few places the subsoil and underlying material have less clay and more silt.

Included with this soil in mapping are small areas of the poorly drained Brickton, Effie, and Indus soils on the slightly higher parts of the landscape. These soils make up 3 to 15 percent of the mapped areas.

Permeability is slow in the Wildwood soil, and available water capacity is high. Surface runoff is very slow or ponded. The seasonal high water table is 1 foot above the surface to 1 foot below. The surface layer is medium acid or slightly acid. The subsoil is medium acid to neutral. The content of organic matter is high, and natural fertility is medium.

Most areas are forested. Lowland hardwoods, balsam fir, northern white-cedar, and black spruce are dominant. This soil is poorly suited to most tree species. Growth rates can be increased by a drainage system. The methods and timing of tree harvesting and planting are limited by prolonged wetness. Harvesting is limited to periods when the ground is frozen. Control of competing vegetation is needed until the seedlings are well established. Clearcutting rather than selective cutting reduces the windthrow hazard and improves regeneration and early growth. The extreme wetness results in a high rate of seedling mortality. Careful planting of vigorous nursery stock reduces the seedling mortality rate.

Unless drained, this soil is generally unsuited to the crops commonly grown in the county. If a drainage system is installed and nutrient deficiencies are corrected by applications of fertilizer, the soil is well suited to selected forage crops. Most areas are subject to frost late in spring and early in fall. The soil is well suited to the development of wetland wildlife habitat. Open areas of water can be developed by excavations.

Because of the ponding, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and low strength.

The land capability classification is Vw, and the woodland ordination symbol is 3W.

655—Bearville loamy sand. This nearly level, poorly drained soil is at the edges of glacial lake plains and on deltas on the lake plains. Individual areas are irregular in shape and range from about 20 to 300 acres in size.

Typically, the surface layer is very dark gray loamy sand about 2 inches thick. The subsurface layer is about 14 inches of grayish brown and light brownish gray, mottled loamy sand and sand. The subsoil is about 19 inches thick. It is grayish brown and mottled. The upper part is sandy clay loam, and the lower part is clay. The underlying material to a depth of about 60 inches is grayish brown and light brownish gray, mottled clay. In some places the sandy mantle is less than 10 or more than 20 inches thick. In other places the subsoil does not have a loamy layer.

Included with this soil in mapping are small areas of Brickton, Indus, and Thistledew soils. The poorly drained, clayey Indus and Brickton soils are in landscape

positions similar to those of the Bearville soil. They do not have a sandy mantle. The moderately well drained Thistledew soils are on convex slopes. Included soils make up 3 to 15 percent of the mapped areas.

Permeability is rapid in the sandy mantle of the Bearville soil, moderately slow in the loamy material, and slow in the clayey underlying material. Available water capacity is moderate. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet. The surface layer is strongly acid to slightly acid. The subsoil is medium acid to neutral. The organic matter content and natural fertility are low.

Most areas are forested. This soil is well suited to selected trees. Quaking aspen is the dominant species. It grows well and regenerates rapidly following clearcutting. Balsam fir, white spruce, and black ash are in many stands. Planting is necessary if a high population of conifers is desired. White spruce and eastern white pine are suitable for planting. Control of competing vegetation increases the seedling survival and early growth rates. Trees on this soil are shallow rooted and are subject to windthrow during storms. Clearcutting rather than selective cutting improves regeneration and reduces the windthrow hazard. The soil is wet and is soft and boggy in the spring and after heavy rains. Deferring the use of heavy wheeled equipment during these periods helps to prevent excessive compaction, which can inhibit regeneration.

This soil is moderately suited to cultivated crops. If a drainage system is installed, small grain and forage crops can be grown. Applications of lime and fertilizer are needed.

Because of the wetness, this soil is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by frost action and low strength.

The land capability classification is IIIw, and the woodland ordination symbol is 7W.

656B—Thistledew loamy fine sand, 0 to 6 percent slopes. This nearly level and gently sloping, moderately well drained soil is on convex slopes at the edges of glacial lake plains and on deltas on the lake plains. Individual areas are irregular in shape and range from about 20 to 300 acres in size.

Typically, about 1 inch of organic forest litter is at the surface. The surface layer is gray loamy fine sand about 2 inches thick. The upper subsoil is about 14 inches of yellowish brown and brown fine sandy loam and loamy fine sand. The next layer is light brownish gray fine sand about 7 inches thick. The lower subsoil is about 23 inches of brown and dark yellowish brown, mottled sandy clay loam and dark grayish brown, mottled clay. The underlying material to a depth of at least 60 inches is grayish brown, mottled clay. In places the sandy mantle is less than 14 or more than 36 inches thick.

Included with this soil in mapping are small areas of the poorly drained Bearville and Indus soils in depressions. These soils make up 2 to 10 percent of the mapped areas.

Permeability is rapid in the sandy mantle of the Thistledew soil, moderately slow in the loamy material, and slow in the clayey underlying material. Available water capacity is moderate. Surface runoff is slow. The seasonal high water table is at a depth of 3 to 4 feet. The organic matter content and natural fertility are low. The surface layer and subsoil are strongly acid to neutral.

Most areas are forested. This soil is well suited to many of the common upland tree species. Quaking aspen is the dominant species. Jack pine, red pine, paper birch, balsam fir, and white spruce are in most stands. Regeneration of aspen following clearcutting is fairly rapid. If competing vegetation is controlled, the soil is well suited to conifers. Because of the clayey underlying material, the seedling mortality rate is high. It can be reduced by careful planting of vigorous nursery stock. Trees on this soil are shallow rooted and are subject to windthrow during storms. Clearcutting rather than selective cutting reduces the windthrow hazard and improves regeneration.

This soil is moderately suited to cultivated crops. The growth of forage crops and small grain is hindered by a droughty root zone and the low fertility. Effective crop residue management helps to control erosion and conserves moisture. Farming on the contour also helps to control erosion.

If dwellings are constructed on this soil, the lower floor or basement level should be constructed above the seasonal high water table. Tile drains around foundations help to remove excess subsurface water. Proper landscaping can divert surface water away from the buildings. The soil is suitable as a site for local roads. It is poorly suited to septic tank absorption fields because the upper part does not adequately filter the effluent and the lower part does not readily absorb the effluent. The seasonal high water table also is a limitation. The poor filtering capacity can result in the pollution of ground water supplies. The absorption field functions better if the site is mounded with suitable material.

The land capability classification is IIIs, and the woodland ordination symbol is 6S.

797—Mooselake and Lupton mucky peats. These very poorly drained, nearly level, organic soils are in bogs on lake plains, outwash plains, and glacial moraines. In some large bogs they are only in peripheral areas. Water normally ponds on these soils in the spring. Individual areas are irregularly shaped or elongated and range from about 20 to 600 acres in size. Some are

nearly all Mooselake soil, and others are nearly all Lupton soil.

The Mooselake soil typically has a surface layer of pale brown mucky peat about 3 inches thick. The next layer is black mucky peat about 12 inches thick. Below this to a depth of at least 60 inches is dark reddish brown mucky peat that contains woody fragments.

The Lupton soil typically has a surface layer of pale brown mucky peat about 2 inches thick. The next layer is black mucky peat about 6 inches thick. Below this to a depth of at least 60 inches is black muck. In some places the organic material is predominantly herbaceous rather than woody. In other places mineral soil material is within a depth of 51 inches.

Included with these soils in mapping are small areas of poorly drained to well drained, mineral soils on concave uplands. These included soils make up 1 to 5 percent of the mapped areas.

Permeability is moderate to rapid in the Mooselake soil and moderately slow to moderately rapid in the Lupton soil. Available water capacity is very high in both soils. Surface runoff is very slow or ponded. The seasonal high water table is 1 foot above the surface to 1 foot below. Reaction is strongly acid to neutral throughout the profile. The organic matter content is very high, and natural fertility is low. Soil strength is very low.

Most areas are forested. These soils are poorly suited to most lowland trees. The forest cover consists of northern white-cedar, black ash, black spruce, tamarack, balsam fir, and paper birch. Growth rates are slow or moderately slow, but they can be improved by a drainage system. The methods and timing of tree harvesting and planting are limited by wetness. Harvesting is limited to periods when the ground is frozen. A live sphagnum surface soil is an adequate seedbed for black spruce. Regeneration of black spruce in areas that have no live sphagnum is better after the vegetation is burned. Careful planting of vigorous nursery stock reduces the seedling mortality rate. Plant competition is severe. It should be controlled until the seedlings are well established. Clearcutting rather than selective cutting improves regeneration and reduces the windthrow hazard.

These soils are generally unsuitable as cropland because of the extreme wetness. Most areas are subject to frost late in spring and early in fall. Shallow excavations generally provide enough water for the growth of the aquatic vegetation suitable for wetland wildlife habitat. Low strength, however, limits the access of excavating equipment.

Because of the ponding, these soils are generally unsuitable as sites for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and frost action. Because of low strength, road settlement is a continuing problem unless the organic material is removed.

The land capability classification is VIw, and the woodland ordination symbol is 3W.

798—Sago and Roscommon soils. These nearly level, very poorly drained and poorly drained soils are on plane to concave slopes in depressions and on low lying flats on glacial lake plains, outwash plains, and terraces. The soils are subject to ponding. Individual areas are irregularly shaped or elongated and range from about 5 to 120 acres in size. Some are predominantly Sago soil, and others are predominantly Roscommon soil.

Typically, Sago soil has a surface layer of black and very dark brown muck about 13 inches thick. The next layer is black and very dark gray silt loam about 2 inches thick. The subsoil is about 26 inches thick. The upper part is olive gray, mottled loamy very fine sand, and the lower part is gray, mottled very fine sandy loam. The underlying material to a depth of at least 60 inches is gray, mottled, stratified very fine sand, loamy very fine sand, very fine sandy loam, and silt loam. In places the organic material is more than 15 inches thick. In a few areas the underlying material is loamy glacial till.

Typically, Roscommon soil has a surface layer of black mucky loamy sand about 6 inches thick. The underlying material to a depth of at least 60 inches is olive gray, light olive gray, and light gray, stratified loamy sand, loamy coarse sand, and sand. In places it has thin layers of loamy material. In a few areas the soil has thin layers of gravelly coarse sand. In a few places the underlying material is loamy below a depth of 40 inches. In some areas the surface layer is muck.

Included with these soils in mapping are small areas of the somewhat poorly drained Cowhorn and Meehan soils on the slightly higher parts of the landscape. Also included are a few small areas of the excessively drained Menahga and Zimmerman soils on convex slopes. Included soils make up 2 to 10 percent of the mapped areas.

Permeability is moderate in the Sago soil and rapid in the Roscommon soil. Available water capacity is high in the Sago soil and low in the Roscommon soil. Surface runoff is very slow or ponded on both soils. The seasonal high water table is 1 foot above the surface to 1 foot below. The surface layer is very strongly acid to slightly acid. The content of organic matter is very high in the Sago soil and moderate in the Roscommon soil. Natural fertility is low in both soils.

Most areas support brush or reeds and sedges. These soils are fairly well suited to lowland trees. Black spruce, tamarack, northern white-cedar, and black ash are the most common species. Black spruce is a suitable commercial species. Clearcutting rather than selective cutting reduces the windthrow hazard. Adequate site preparation, control of competing vegetation, and measures that lower the water table reduce the seedling

mortality rate. The use of heavy equipment is limited by wetness. The equipment should be used only when the ground is frozen.

Unless drained, these soils are poorly suited to farm crops. Small grain and forage are the most commonly grown crops. A drainage system and applications of fertilizer are necessary.

Because of the ponding, these soils are generally unsuitable as sites for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and frost action.

The land capability classification is IVw, and the woodland ordination symbol is 4W.

799—Seelyeville-Bowstring association. These very poorly drained, nearly level, organic soils are in bogs and swamps dissected by streams. They are flooded in the spring and after heavy rains. The Bowstring soil is mainly adjacent to streams. Individual areas are elongated or irregularly shaped and range from about 15 to 200 acres in size. The pattern and relative proportion of the two soils are somewhat similar from area to area.

Typically, Seelyeville soil has a surface layer of very dark brown muck about 28 inches thick. The next layer is dark brown mucky peat about 9 inches thick. Below this to a depth of at least 60 inches is very dark brown muck.

Typically, Bowstring soil has a surface layer of dark reddish brown muck about 11 inches thick. Below this to a depth of at least 60 inches is very dark grayish brown and dark reddish brown muck interbedded with gray mucky sand. In some areas the organic material is predominantly woody fiber. In a few areas a layer of mineral soil material 12 or more inches thick is within a depth of 51 inches.

Included with these soils in mapping are small areas of the poorly drained Pengilly soils and the somewhat poorly drained, sandy Winterfield soils. These included soils are on the slightly higher parts of the landscape. They make up 1 to 10 percent of the mapped areas.

Permeability is moderate or moderately slow in the Seelyeville soil and moderately rapid to moderately slow in the Bowstring soil. Available water capacity is very high in both soils. Surface runoff is very slow or ponded. The seasonal high water table is 2 feet above to 2 feet below the surface of the Seelyeville soil and is within a depth of 2 feet in the Bowstring soil. Reaction is medium acid to moderately alkaline throughout the profile. The organic matter content is very high, and natural fertility is low. Soil strength is very low.

Most areas support native grasses and sedges. The Seelyeville soil is poorly suited to most tree species. The most common species are black ash, northern white-cedar, black spruce, and tamarack. Tree harvesting and planting are limited by the extreme wetness. Harvesting is limited to periods when the ground is frozen. Because of the ponding and the seasonal wetness, the seedling mortality rate is high. It can be reduced by careful planting of vigorous nursery stock. Clearcutting rather than selective cutting reduces the windthrow hazard.

These soils are generally unsuited to cultivated crops because of the extreme wetness. Typically, they are subject to frost late in spring and early in fall. Some areas are suited to the construction of dikes used in wild rice farming. Shallow excavations generally provide enough water for the growth of the aquatic vegetation suitable for wetland wildlife habitat. The wetness and low strength, however, limit the access of excavating equipment.

Because of the flooding and the ponding, these soils are generally unsuitable as sites for dwellings and sanitary facilities. Soils that are better suited for these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding, ponding, and frost action. Because of low strength, road settlement is a continuing problem unless the organic material is removed.

The land capability classification is VIw. The woodland ordination symbol assigned to the Seelyeville soil is 4W.

801B—Taylor and Dalbo silt loams, 0 to 6 percent slopes. These nearly level and gently sloping, moderately well drained soils are on smooth, convex, and plane slopes on glacial lake plains. Individual areas are irregular in shape and range from about 15 to 700 acres in size. The Taylor soil is dominant in most areas, but the Dalbo soil is dominant in some areas.

Typically, Taylor soil has about 1 inch of organic forest litter at the surface. The surface layer is very dark gray silt loam about 2 inches thick. The subsurface layer is grayish brown silt loam about 4 inches thick. The subsoil is brown, dark yellowish brown, and dark grayish brown clay about 15 inches thick. The underlying material to a depth of at least 60 inches is dark grayish brown, grayish brown, and olive gray, mottled clay.

Typically, Dalbo soil has about 1 inch of organic forest litter at the surface. The surface layer is very dark gray silt loam about 1 inch thick. The subsurface layer is gray and light brownish gray silt loam about 5 inches thick. The next 3 inches is mixed dark brown silty clay loam and grayish brown silt loam. The subsoil is about 26 inches of dark yellowish brown, dark brown, and brown clay and silty clay. The underlying material to a depth of at least 60 inches is light olive brown, mottled silty clay loam. In some places the subsoil has slightly more sand and gravel. In other places it has less clay and more silt.

Included with these soils in mapping are small areas of the poorly drained, clayey Brickton and Indus soils on the slightly lower parts of the landscape. Also included are the very poorly drained, clayey Wildwood soils in

shallow depressions and drainageways. Included soils make up 2 to 15 percent of the mapped areas.

Permeability is very slow in the Taylor soil and moderately slow or slow in the Dalbo soil. Available water capacity is moderate in the Taylor soil and high in the Dalbo soil. Surface runoff is medium or rapid on the Taylor soil and slow or medium on the Dalbo soil. The seasonal high water table is at a depth of 3.0 to 6.0 feet in both soils. The organic matter content is moderate, and natural fertility is medium.

Most areas are forested. These soils are well suited to many upland tree species. Most stands are dominated by quaking aspen, but balsam fir, white spruce, paper birch, and eastern white pine are fairly common. Regeneration of aspen following clearcutting is rapid. If conifers are to be established, adequate site preparation and control of competing vegetation are necessary. During spring runoff and after heavy rains, the soils are soft and boggy. Deferring the use of heavy wheeled equipment during these periods helps to prevent excessive compaction, which reduces the potential for seedling regeneration.

These soils are well suited to cultivated crops, forage crops, and small grain (fig. 9). Erosion is a management concern. Timely fieldwork at the proper moisture content and tillage methods that leave large amounts of crop residue on the surface help to control erosion and maintain good tilth. Fall tillage usually allows for earlier planting in the spring.

If dwellings are constructed on these soils, the lower floor or basement level should be built above the seasonal high water table. Tile drains around foundations help to remove excess subsurface water. Proper landscaping can divert surface water away from the buildings. Properly designing foundations and footings and backfilling around the foundations with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by frost action, low strength, and shrinking and swelling.

These soils are poorly suited to septic tank absorption fields because of the seasonal high water table and the restricted permeability. These limitations can be overcome by mounding with suitable material.

The land capability classification is IIe. The woodland ordination symbol assigned to the Taylor soil is 6A, and that assigned to the Dalbo soil is 7A.

803B—Warba-Menahga complex, 1 to 8 percent slopes. These nearly level to rolling soils are on glacial moraines. Generally, the well drained Warba soil is on the middle or lower parts of the slopes. It typically has a few stones on and below the surface. The excessively

Figure 9.—Corn grown for silage on Taylor and Dalbo silt loams, 0 to 6 percent slopes.

drained Menahga soil is mainly on the convex parts of slopes. Slopes are concave and convex. Individual areas are irregular in shape and range from about 20 to 600 acres in size. They are about 55 percent Warba soil and 35 percent Menahga soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping is not practical.

Typically, Warba soil has about 1 inch of organic forest litter at the surface. The surface layer is very dark gray fine sandy loam about 1 inch thick. The subsurface layer is grayish brown and light brownish gray fine sandy loam about 6 inches thick. The next 5 inches is light brownish gray fine sandy loam mixed with dark brown clay loam. The subsoil is light olive brown clay loam about 36 inches thick. The underlying material to a depth of at least 60 inches is light olive brown sandy clay loam. In some places the subsoil and underlying material contain more sand. In other places the underlying material is closer to the surface and has more carbonates.

Typically, Menahga soil has about 1 inch of organic litter at the surface. The surface layer is very dark gray and black loamy coarse sand about 1 inch thick. The subsurface layer is grayish brown loamy coarse sand about 2 inches thick. The subsoil is yellowish brown and brown sand about 35 inches thick. The underlying material to a depth of at least 60 inches is brown coarse sand. In some areas the soil contains more gravel. In other areas the subsoil has thin bands of dark brown, loamy material. In places the underlying material is loamy.

Included with these soils in mapping are small areas of Sandwick, Stuntz, and Talmoon soils. The somewhat poorly drained Sandwick and Stuntz soils are on plane or concave slopes. The very poorly drained, loamy Talmoon soils are in depressions. Included soils make up 2 to 15 percent of the mapped areas.

Permeability is moderately slow in the Warba soil and rapid in the Menahga soil. Available water capacity is high in the Warba soil and low in the Menahga soil. Surface runoff is medium on the Warba soil and slow on the Menahga soil. The Warba soil is strongly acid to slightly acid in the surface layer and strongly acid to neutral in the subsoil. The Menahga soil is very strongly acid to medium acid in the surface layer and very strongly acid in the subsoil. The organic matter content is moderate in the Warba soil and low in the Menahga soil. Natural fertility is medium in the Warba soil and low in the Menahga soil.

Most areas are forested. These soils are well suited to many of the common upland tree species. Quaking aspen is the dominant species on the Warba soil, and aspen, birch, jack pine, and red pine are common on the Menahga soil. Balsam fir is fairly common on both soils. Aspen grows best on the Warba soil. Red pine and jack pine grow well on both soils. Following clearcutting, aspen regenerates and grows well, especially on the Warba soil.

Seedling mortality generally is slight on the Warba soil, but mortality of red pine is severe unless the seedlings are planted on the crest of slopes. Because of droughtiness, the seedling mortality rate is high on the sandy Menahga soil. It can be reduced by careful planting of vigorous nursery stock. Adequate site preparation and control of competing vegetation increase seedling survival and early growth rates. Deferring the use of heavy equipment when the Warba soil is wet helps to prevent excessive compaction and thus maintains the potential for regeneration.

These soils are moderately suited to cultivated crops and small grain. They are well suited to forage crops. The Warba soil normally is more productive than the Menahga soil. Water erosion and soil blowing are hazards. They can be controlled by effective crop residue management, stripcropping, windbreaks, and sod-forming crops. Erosion along waterways can be controlled by maintaining a permanent plant cover.

If buildings are constructed on these soils, the shrink-swell potential of the Warba soil is a limitation. Properly designing foundations and footings and backfilling around the foundations with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by the low strength of the Warba soil. The Menahga soil is well suited to dwellings and local roads.

These soils are poorly suited to septic tank absorption fields. The Menahga soil does not adequately filter the effluent, and the Warba soil does not readily absorb the effluent. The poor filtering capacity of the Menahga soil can result in the pollution of ground water. If septic tank systems are installed in these soils, onsite investigation is needed to determine the soil type and the measures that can overcome the limitations.

The land capability classification is IIIe. The woodland ordination symbol assigned to the Warba soil is 7A, and that assigned to the Menahga soil is 7S.

803D—Warba-Menahga complex, 10 to 25 percent slopes. These rolling to steep soils are on glacial moraines. The Warba soil is well drained. It typically has a few stones on and below the surface. The Menahga soil is excessively drained. Individual areas are irregular in shape and range from about 15 to 350 acres in size. They are about 50 percent Warba soil and 40 percent Menahga soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping is not practical.

Typically, the Warba soil has about 1 inch of organic forest litter at the surface. The surface layer is very dark gray fine sandy loam about 1 inch thick. The subsurface layer is grayish brown and light brownish gray fine sandy loam about 6 inches thick. The next 5 inches is light brownish gray fine sandy loam mixed with dark brown

clay loam. The subsoil is light olive brown clay loam about 36 inches thick. The underlying material to a depth of at least 60 inches is light olive brown sandy clay loam. In places the subsoil and underlying material are fine sandy loam. In some areas the underlying material is sand. In other areas it is closer to the surface.

Typically, the Menahga soil has about 1 inch of organic litter at the surface. The surface layer is very dark gray and black loamy coarse sand about 1 inch thick. The subsurface layer is grayish brown loamy coarse sand about 2 inches thick. The subsoil is yellowish brown and brown sand about 35 inches thick. The underlying material to a depth of at least 60 inches is brown coarse sand. In some places the surface soil and subsoil have a higher content of coarse fragments. In other places thin bands of brown, loamy material are in the subsoil. In some areas the underlying material is loamy. In a few areas the surface layer is thin and loamy.

Included with these soils in mapping are small areas of the somewhat poorly drained, loamy Stuntz soils on nearly level slopes. Also included are the very poorly drained Talmoon and Cathro soils in small depressions. Included soils make up about 10 percent of the mapped areas.

Permeability is moderately slow in the Warba soil and rapid in the Menahga soil. Available water capacity is high in the Warba soil and low in the Menahga soil. Surface runoff is medium on the Warba soil and slow on the Menahga soil. The Warba soil is strongly acid to slightly acid in the surface layer and strongly acid to neutral in the subsoil. The Menahga soil is very strongly acid to medium acid in the surface layer and very strongly acid to slightly acid in the subsoil. The organic matter content is moderate in the Warba soil and low in the Menahga soil. Natural fertility is medium in the Warba soil and low in the Menahga soil.

Most areas are forested. These soils are well suited to most of the common tree species. Quaking aspen is the dominant species on the Warba soil. Aspen and birch mixed with conifers, mainly jack pine and red pine, are common on the Menahga soil. Balsam fir and, to a lesser extent, white spruce grow on both soils. Stands of northern hardwoods also are common. Aspen grows best on the Warba soil. Jack pine and red pine grow well on both soils. Following clearcutting, aspen regenerates and grows well, especially on the Warba soil.

The seedling mortality rate of red pine is severe on the Warba soil unless the seedlings are planted on the crest of slopes. Adequate site preparation and control of competing vegetation increase the seedling survival and early growth rates. The slope limits the use of equipment. Deferring the use of heavy equipment when the Warba soil is wet helps to prevent excessive compaction and erosion. Building logging roads and skid trails on the contour helps to control erosion.

These soils are generally unsuitable for cultivated crops because of a severe hazard of erosion. Operating farm machinery is hazardous because of the slope. Maintaining a permanent plant cover helps to control erosion.

Because of the slope, these soils are generally unsuitable as sites for dwellings, sanitary facilities, and local roads. Soils that are better suited to these uses are generally nearby.

The land capability classification is VIIe, and the woodland ordination symbol is 7R.

844F—Mahtomedi and Emmert soils, 12 to 50 percent slopes. These hilly to very steep, excessively drained soils are on glacial moraines and outwash plains. Slopes are smooth, concave, or convex. They are 25 to 250 feet long. Individual areas are elongated and range from 5 to about 130 acres in size. The Mahtomedi soil is dominant in some areas, and the Emmert soil is dominant in other areas.

Typically, the Mahtomedi soil has about 1 inch of organic forest litter at the surface. The surface layer is black loamy sand about 3 inches thick. The subsoil is about 30 inches thick. It is dark yellowish brown loamy coarse sand and gravelly loamy coarse sand in the upper part and brown gravelly coarse sand in the lower part. The underlying material to a depth of at least 60 inches is brown and yellowish brown gravelly coarse sand. In places the subsoil has thin layers of loamy material.

Typically, the Emmert soil has about 1 inch of organic forest litter at the surface. The surface layer is very dark brown gravelly loamy coarse sand about 1 inch thick. The subsurface layer is grayish brown gravelly loamy coarse sand about 2 inches thick. The subsoil is about 14 inches of dark yellowish brown gravelly loamy coarse sand and yellowish brown very gravelly coarse sand. The underlying material to a depth of at least 60 inches is brown very gravelly coarse sand. In a few areas the soil contains less gravel. In some small areas the surface layer is stony or bouldery.

Included with these soils in mapping are small areas of soils that have loamy or clayey material as much as 24 inches thick in the upper part and soils that are loamy throughout. These included soils are in landscape positions similar to those of the Mahtomedi and Emmert soils. Also included are the somewhat poorly drained Meehan soils, the poorly drained and very poorly drained Roscommon soils, and very poorly drained, organic soils in small depressions. Included soils make up 2 to 15 percent of the mapped areas.

Permeability is rapid in the Mahtomedi soil and very rapid in the Emmert soil. Available water capacity is very low or low in both soils. Surface runoff is medium. The surface soil and subsoil are strongly acid to slightly acid. The organic matter content and natural fertility are low.

Most areas are forested. These soils are well suited to red pine, jack pine, and eastern white pine. They are better suited to conifers than to other species. Red pine

and jack pine are the most common species. Droughtiness and low fertility are limitations affecting planted seedlings. The seedling mortality rate can be reduced by selection of good planting stock; by early planting, which allows the seedlings to take advantage of spring moisture; and by good planting methods, which ensure that root systems are firmly in contact with moist soil. The slope is the major factor limiting equipment use. Building logging roads and skid trails on the contour and disturbing the surface as little as possible help to control erosion. Chemical control of competing vegetation may be necessary.

These soils are generally unsuitable for cultivated crops because of a severe hazard of erosion, the extreme droughtiness, the slope, and the low fertility.

Because of the slope, these soils are generally unsuitable as sites for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion.

The land capability classification is VIIe, and the woodland ordination symbol is 6R.

866B—Menahga-Itasca complex, 1 to 10 percent slopes. These nearly level to rolling soils are on concave and convex glacial moraines. The Menahga soil is excessively drained. The Itasca soil is well drained. It typically has a few stones on and below the surface. Individual areas are irregular in shape and range from about 50 to 700 acres in size. They are about 55 percent Menahga soil and 35 percent Itasca soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping is not practical.

Typically, the Menahga soil has a thin layer of organic litter at the surface. The surface layer is very dark gray and black loamy coarse sand about 1 inch thick. The subsurface layer is grayish brown loamy coarse sand about 2 inches thick. The subsoil is about 35 inches thick. It is dark brown loamy sand in the upper part and dark yellowish brown and yellowish brown coarse sand in the lower part. The underlying material to a depth of at least 60 inches is light yellowish brown coarse sand. In some places the subsoil has thin layers of dark brown material that contains slightly more clay. In other places the content of coarse fragments is higher. In a few areas the underlying material is loamy.

Typically, the Itasca soil has a surface layer of grayish brown silt loam about 3 inches thick. The upper subsoil is yellowish brown silt loam about 6 inches thick. The next layer is pale brown silt loam about 10 inches thick. Below this is about 16 inches of grayish brown fine sandy loam mixed with dark brown fine sandy loam. The lower subsoil is about 20 inches of yellowish brown and brown fine sandy loam. The underlying material to a depth of at least 60 inches is light olive brown, mottled fine sandy loam. In some places the subsoil has more clay. In other places the underlying material is sandy. In a few areas a thin layer of sandy material is between the silty mantle and the lower subsoil.

Included with these soils in mapping are small areas of the somewhat poorly drained Meehan and Sandwick soils on flats and small areas of the very poorly drained Cathro, Roscommon, and Talmoon soils in depressions. Included soils make up 1 to 10 percent of the mapped areas.

Permeability is rapid in the Menahga soil and moderate in the Itasca soil. Available water capacity is low in the Menahga soil and high in the Itasca soil. Surface runoff is slow on the Menahga soil and medium on the Itasca soil. The Menahga soil is very strongly acid to medium acid in the surface layer and very strongly acid to slightly acid in the subsoil. The Itasca soil is strongly acid to slightly acid in the surface layer and medium acid to neutral in the subsoil. The organic matter content is low in the Menahga soil and moderate in the Itasca soil. Natural fertility is low in the Menahga soil and medium in the Itasca soil.

Most areas are forested. These soils are well suited to trees. Red pine and jack pine are common on the Menahga soil, and aspen is predominant on the Itasca soil. Balsam fir and, to a lesser extent, white spruce grow on both soils. Stands of northern hardwoods also are common. Red pine and jack pine grow equally well on both soils, but aspen grows best on the Itasca soil. Following clearcutting, aspen regenerates well, especially on the Itasca soil.

The seedling mortality rate on the Itasca soil generally is slight, but the mortality rate of red pine commonly is moderate or severe, except on the crest of slopes. Because of droughtiness, the seedling mortality rate is high on the Menahga soil. It can be reduced by careful planting of vigorous nursery stock. Adequate site preparation and control of competing vegetation increase the seedling survival and early growth rates. The use of heavy equipment is limited early in spring and after periods of heavy rains because the Itasca soil is soft when it is wet. Operating this equipment during wet periods causes excessive compaction in the upper part of the root zone and can reduce the potential for regeneration.

These soils are poorly suited to cultivated crops. They are well suited to forage crops. Erosion is the main management concern. Effective crop residue management, stripcropping, and periodically grown sod-forming crops help to control erosion in large open areas. Applications of fertilizer are needed. Carefully managing grazing in sandy areas helps to prevent damage to pasture plants.

These soils are suitable for building site development. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by frost action in the Itasca soil. The soils are

poorly suited to septic tank absorption fields. The Menahga soil does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies. The Itasca soil does not readily absorb the effluent. If septic tank systems are installed in these soils, onsite investigation is needed to determine the soil type and the measures that can overcome the limitations.

The land capability classification is IVe. The woodland ordination symbol assigned to the Menahga soil is 7S, and that assigned to the Itasca soil is 8A.

866E—Menahga-Itasca complex, 10 to 25 percent slopes. These rolling to steep soils are on concave and convex slopes on glacial moraines. The Menahga soil is excessively drained. The Itasca soil is well drained. It typically has a few stones on and below the surface. Individual areas are irregular in shape and range from about 30 to 500 acres in size. They generally are about 60 percent Menahga soil and 30 percent Itasca soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping is not practical.

Typically, the Menahga soil has a thin layer of organic litter at the surface. The surface layer is grayish brown loamy sand about 2 inches thick. The subsoil is about 31 inches of dark brown loamy sand and dark brown and dark yellowish brown sand. The underlying material to a depth of at least 60 inches is light yellowish brown and pale brown sand. In some areas the subsoil has thin layers of dark brown material that contains slightly more clay. In other areas the content of coarse fragments is higher. In places the underlying material is loamy within a depth of 60 inches. In a few areas the surface layer is thin and loamy.

Typically, the Itasca soil has a surface layer of grayish brown silt loam about 3 inches thick. The upper subsoil is yellowish brown silt loam about 6 inches thick. The next layer is pale brown silt loam about 10 inches thick. Below this is about 16 inches of grayish brown fine sandy loam mixed with dark brown fine sandy loam. The lower subsoil is about 20 inches of yellowish brown and brown fine sandy loam. The underlying material to a depth of at least 60 inches is light olive brown sandy loam. In some places the subsoil has more clay. In other places the underlying material is sandy. In a few areas a thin layer of sandy material is between the silty mantle and the lower subsoil.

Included with these soils in mapping are small areas of the somewhat poorly drained Meehan soils on flats and in drainageways and small areas of the very poorly drained Cathro, Roscommon, and Talmoon soils in depressions. Included soils make up 3 to 10 percent of the mapped areas.

Permeability is rapid in the Menahga soil and moderate in the Itasca soil. Available water capacity is low in the Menahga soil and high in the Itasca soil. Surface runoff is medium on the Menahga soil and rapid on the Itasca soil. The Menahga soil is very strongly acid to medium acid in the surface layer and very strongly acid to slightly acid in the subsoil. The Itasca soil is strongly acid to slightly acid in the surface layer and medium acid to neutral in the subsoil. The content of organic matter is low in the Menahga soil and moderate in the Itasca soil. Natural fertility is low in the Menahga soil and medium in the Itasca soil.

Most areas are forested. These soils are well suited to most upland tree species. Red pine and jack pine are the dominant species on the Menahga soil, and aspen is dominant on the Itasca soil. Balsam fir and, to a lesser extent, white spruce also are common. Red pine and jack pine grow equally well on both soils, but aspen grows best on the Itasca soil. Following clearcutting, aspen regenerates well, especially on the Itasca soil.

The seedling mortality rate for red pine commonly is moderate or severe on the Itasca soil. It can be reduced by planting near the crest of slopes. Adequate site preparation and control of competing vegetation increase seedling survival and early growth rates. The slope is the major factor limiting the use of equipment. Operating the equipment on the contour as much as possible helps to control erosion. Operating heavy wheeled equipment when the Itasca soil is wet can cause severe compaction.

Because of the slope and a severe hazard of erosion, these soils are unsuitable for cultivated crops. They are poorly suited to pasture. Forage production is good on the Itasca soil, but it is low on the Menahga soil because of droughtiness.

Because of the slope, these soils are generally unsuitable as sites for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion.

The land capability classification is VIIe. The woodland ordination symbol assigned to the Menahga soil is 7R, and that assigned to the Itasca soil is 8R.

867B—Menahga and Graycalm soils, 0 to 8 percent slopes. These nearly level to rolling soils are on plane and convex slopes on outwash plains. The Menahga soil is excessively drained, and the Graycalm soil is somewhat excessively drained. Individual areas are irregular in shape and range from about 15 to 450 acres in size. The Menahga soil is dominant in most areas, but a few areas are nearly all Graycalm soil.

Typically, the Menahga soil has a thin layer of organic litter at the surface. The surface layer is very dark gray and black loamy coarse sand about 1 inch thick. The subsurface layer is grayish brown loamy coarse sand about 2 inches thick. The subsoil is yellowish brown and brown sand about 35 inches thick. The underlying

material to a depth of at least 60 inches is brown coarse sand.

Typically, the Graycalm soil has about 2 inches of organic forest litter at the surface. The surface layer is black loamy sand about 1 inch thick. The subsurface layer is light brownish gray loamy sand about 2 inches thick. The subsoil is about 14 inches of yellowish brown loamy sand and sand. The next layer is light brownish gray loamy sand about 16 inches thick. Below this is about 25 inches of brown and light brownish gray sand that has thin bands of multicolored very fine sandy loam and sandy loam. The underlying material to a depth of at least 60 inches is pale brown sand. In some areas the soil is underlain by loamy material. In other areas the content of coarse fragments is higher. In places the surface layer is sandy loam or fine sandy loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Meehan soils on flats and in slight depressions. Also included are small areas of the very poorly drained Roscommon and Tawas soils in deep depressions. Included soils make up about 1 to 5 percent of the mapped areas.

Permeability is rapid in the Menahga and Graycalm soils, and available water capacity is low. Surface runoff is slow on the Menahga soil and slow or very slow on the Graycalm soil. The Menahga soil is very strongly acid to medium acid in the surface soil and very strongly acid to slightly acid in the subsoil. The Graycalm soil is very strongly acid to slightly acid in the surface soil and subsoil. The organic matter content and natural fertility are low in both soils.

Most areas are forested. These soils are well suited to pine, mainly red pine and jack pine (fig. 10). Red pine, jack pine, and quaking aspen are the dominant species. Balsam fir and white spruce are in most stands. Although plant competition is not severe, adequate site preparation and control of competing vegetation are needed to increase the seedling survival and early growth rates.

Because of the low fertility and droughtiness, these soils are poorly suited to cultivated crops and small grain. They are well suited to forage crops. Early maturing crops can best utilize spring and early summer moisture. Some areas can be used for pasture, but careful management is needed to prevent overgrazing. The rapid permeability and low available water capacity limit the suitability of the soils for irrigation. Soil blowing is a hazard in exposed areas. It can be controlled by effective crop residue management, stripcropping, sod-forming crops, and windbreaks.

These soils are suitable as sites for dwellings and local roads. They readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IVs, and the woodland ordination symbol is 7S.

868B—Mahtomedi and Graycalm soils, 1 to 10 percent slopes. These nearly level to rolling soils are on outwash plains. The Mahtomedi soil is excessively drained, and the Graycalm soil is somewhat excessively drained. Slopes are smooth, concave, or convex. Individual areas are circular or irregularly shaped and range from about 20 to 150 acres in size. The Mahtomedi soil is dominant in most areas, but the Graycalm soil is dominant in some areas.

Typically, the Mahtomedi soil has about 1 inch of organic forest litter at the surface. The surface layer is dark grayish brown loamy coarse sand about 4 inches thick. The subsoil is about 30 inches thick. The upper part is dark yellowish brown loamy coarse sand, and the lower part is dark yellowish brown gravelly loamy sand and brown gravelly coarse sand. The underlying material to a depth of at least 60 inches is brown and yellowish brown gravelly coarse sand. In some areas the content of coarse fragments is lower. In other areas the surface layer and subsoil have thin layers of sandy loam.

Typically, the Graycalm soil has about 2 inches of organic forest litter at the surface. The surface layer is black loamy sand about 1 inch thick. The subsurface layer is grayish brown and dark grayish brown loamy sand about 2 inches thick. The subsoil is yellowish brown and brown loamy sand about 14 inches thick. The next layer is light brownish gray loamy sand about 16 inches thick. The next 25 inches is brown and light brownish gray sand that has thin bands of multicolored very fine sandy loam and sandy loam. The underlying material to a depth of at least 60 inches is light brownish gray sand. In some areas the soil is underlain by loamy material within a depth of 60 inches. In other areas the bands below the subsoil total more than 6 inches in thickness.

Included with these soils in mapping are areas of the somewhat poorly drained Meehan soils in shallow depressions and drainageways. Also included are a few small areas of the very poorly drained Roscommon and Tawas soils in the deeper depressions. Included soils make up about 1 to 5 percent of the mapped areas.

Permeability is rapid in the Mahtomedi and Graycalm soils. Available water capacity is low in the Graycalm soil and low or very low in the Mahtomedi soil. Surface runoff is slow on the Mahtomedi soil and slow or very slow on the Graycalm soil. The Mahtomedi soil is strongly acid to slightly acid in the surface and subsoil. The Graycalm soil is very strongly acid to slightly acid in the surface soil and subsoil. The organic matter content and natural fertility are low in both soils.

Most areas are forested. These soils are well suited to most upland tree species. They are best suited to conifers. Red pine and jack pine are the dominant species. Aspen, paper birch, balsam fir, white spruce, and eastern white pine also grow on these soils. Because of droughtiness, the seedling mortality rate is high. It can be reduced by careful planting of vigorous

Figure 10.—A stand of jack pine on Menahga and Graycalm soils, 0 to 8 percent slopes.

nursery stock. If the site is adequately prepared, plant competition is not a serious problem. In some areas, however, competition from naturally regenerating aspen limits the growth of planted conifers.

Because of the low or very low available water capacity, these soils are poorly suited to cultivated crops and small grain. They are well suited to hay and pasture. Early maturing crops can best utilize early spring moisture.

These soils are suitable as sites for dwellings and local roads. They readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IVs. The woodland ordination symbol assigned to the Mahtomedi soil is 6S, and that assigned to the Graycalm soil is 7S.

869—Lobo and Waskish peats. These very poorly drained, nearly level soils are on the higher, slightly convex parts of large bogs. They generally are wet throughout the year. Individual areas are circular or elongated and range from about 80 to 600 acres in size. Most areas are nearly all Lobo soil. Some are Lobo and Waskish soils. Commonly, a large area of Lobo soil surrounds a lesser area of Waskish soil.

Typically, the Lobo soil has a surface layer of dark brown sphagnum peat about 6 inches thick. The next layer is dark brown sphagnum peat about 38 inches thick. Below this to a depth of at least 63 inches is dark brown and dark reddish brown, herbaceous mucky peat. In places the sphagnum peat is less than 35 inches thick.

Typically, the Waskish soil has a surface layer of light yellowish brown sphagnum peat about 7 inches thick. The next layer is dark brown and brown sphagnum peat about 19 inches thick. The next 6 inches is dark brown mucky peat. Below this to a depth of at least 63 inches is reddish brown sphagnum peat.

Permeability is rapid in the upper part of the Lobo soil and moderate or moderately rapid in the lower part. It is rapid in the Waskish soil. Available water capacity is very high in both soils. Surface runoff is very slow. The seasonal high water table is within a depth of 2 feet. Reaction is extremely acid throughout both soils. The organic matter content is very high, and natural fertility is very low.

Most areas are forested. These soils are poorly suited to trees. Black spruce, the dominant species, grows very slowly. Lowering the water table can increase the growth rate, but large increases should not be expected. The methods and timing of tree harvesting and planting are limited by prolonged wetness. Harvesting is limited to periods when the ground is frozen. Live sphagnum moss is a suitable seedbed for black spruce. Clearcutting rather than selective cutting improves stand regeneration and reduces the windthrow hazard.

Because of the wetness, these soils are unsuitable as cropland. In areas where it is thick enough, the sphagnum peat can be harvested commercially. The soils are limited as sites for the development of wetland wildlife habitat. Areas of open water can be developed by excavations. Because of low strength, however, accessing these soils with excavating equipment is very difficult. The peat typically is too thick for blasting to be effective.

Because of the wetness, these soils are generally unsuitable as sites for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by wetness and frost action. Because of low strength, road settlement is a continuing problem unless the organic material is removed.

The land capability classification is VIIw, and the woodland ordination symbol is 3W.

870C—Itasca-Goodland silt loams, 2 to 12 percent slopes. These undulating to rolling, well drained soils are on concave and convex slopes on glacial moraines. A few stones typically are on and below the surface. Individual areas are irregular in shape and range from about 15 to 500 acres in size. They are about 55 percent Itasca soil and 30 percent Goodland soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping is not practical.

Typically, the Itasca soil has about 1.5 inches of organic litter at the surface. The surface layer is grayish brown silt loam about 3 inches thick. The upper subsoil is yellowish brown silt loam about 6 inches thick. The next layer is pale brown silt loam about 10 inches thick. Below this is grayish brown and dark brown fine sandy loam about 16 inches thick. The lower subsoil is about 20 inches of yellowish brown and brown fine sandy loam. The underlying material to a depth of at least 60 inches is light olive brown, mottled fine sandy loam. In places the silty mantle is thicker. In a few areas the subsoil has more clay. In some areas a thin layer of sandy material is between the silty mantle and the lower subsoil.

Typically, the Goodland soil has about 2 inches of organic material at the surface. The surface layer is grayish brown silt loam about 3 inches thick. The upper subsoil is yellowish brown silt loam about 5 inches thick. The next layer is pale brown silt loam about 4 inches thick. Below this is about 6 inches of pale brown and light brownish gray loam mixed with yellowish brown sandy loam. The lower subsoil is about 16 inches of yellowish brown fine sandy loam and brown gravelly loamy coarse sand. The underlying material to a depth of at least 60 inches is yellowish brown and brown gravelly sand. In places it has thin layers of sandy loam. In a few areas the content of coarse fragments is higher. In a few places the soil is shallow to sand and gravel.

Included with these soils in mapping are small areas of the poorly drained, loamy Shooker soils on nearly level slopes, the very poorly drained, loamy Talmoon soils in slight depressions and drainageways, and the very poorly drained Cathro soils in the deeper depressions. Also included are a few areas of well drained soils that are sandy throughout. Included soils make up about 3 to 15 percent of the mapped areas.

Permeability is moderate in the Itasca soil. It is moderate in the upper part of the Goodland soil and rapid in the lower part. Available water capacity is high in the Itasca soil and moderate or high in the Goodland soil. Surface runoff is medium on both soils. Both are strongly acid to slightly acid in the surface layer and subsoil. The content of organic matter is moderate, and natural fertility is medium.

Most areas are forested. These soils are well suited to most upland tree species. Existing stands are mainly aspen or northern hardwoods. Most have some balsam fir and white spruce and a few red pines and white pines. Regeneration of aspen following clearcutting is rapid. If conversion to conifers is desired, white spruce and white pine are more easily established than red pine. Adequate site preparation and control of competing vegetation increase the seedling survival and early growth rates. Wetness early in spring and after heavy rains can temporarily limit the use of heavy equipment. Limited use of this equipment during wet periods reduces the risk of erosion and helps to maintain a good potential for regeneration.

These soils are moderately suited to cultivated crops and small grain. They are well suited to forage crops. Water erosion and soil blowing are the main management concerns. They can be controlled by effective crop residue management, stripcropping, contour farming, windbreaks, and sod-forming crops. Draining isolated wet spots improves the overall efficiency of cropping. Removal of stones reduces the risk of damage to machinery.

Dwellings constructed on these soils should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. Constructing local roads on well compacted, coarse textured base material helps to prevent frost damage.

These soils are poorly suited to septic tank absorption fields. The Goodland soil does not adequately filter the effluent, and the Itasca soil does not readily absorb the effluent. The poor filtering capacity of the Goodland soil can result in the pollution of ground water. If septic tank systems are installed in these soils, onsite investigation is needed to determine the soil type and the measures that can overcome the limitations. The distribution lines should be installed across the slope.

The land capability classification is IIIe. The woodland ordination symbol assigned to the Itasca soil is 8A, and that assigned to the Goodland soil is 6A.

870E—Itasca-Goodland silt loams, 12 to 25 percent slopes. These hilly to steep, well drained soils are on concave and convex slopes on glacial moraines. A few stones typically are on and below the surface. Individual areas are irregular in shape and range from about 15 to 350 acres in size. They are about 50 percent Itasca soil and 40 percent Goodland soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping is not practical.

Typically, the Itasca soil has about 1.5 inches of organic litter at the surface. The surface layer is grayish brown silt loam about 3 inches thick. The upper subsoil is yellowish brown silt loam about 6 inches thick. The next layer is pale brown silt loam about 10 inches thick. Below this is grayish brown and dark brown fine sandy loam about 16 inches thick. The lower subsoil is about 20 inches of yellowish brown and brown fine sandy loam. The underlying material to a depth of at least 60 inches is light olive brown, mottled fine sandy loam. In some places the silty mantle is thicker. In other places the subsoil has slightly more clay. In a few areas a thin layer of sandy material is between the silty mantle and the lower subsoil.

Typically, the Goodland soil has about 2 inches of organic litter at the surface. The surface layer is grayish brown silt loam about 3 inches thick. The upper subsoil is yellowish brown silt loam about 5 inches thick. The next layer is pale brown silt loam about 4 inches thick. Below this is about 6 inches of pale brown and light brownish gray loam mixed with yellowish brown fine sandy loam. The lower subsoil is about 16 inches of yellowish brown fine sandy loam and brown gravelly loamy coarse sand. The underlying material to a depth of at least 60 inches is yellowish brown and brown gravelly sand. In some places it has a higher content of coarse fragments. In other places the soil is shallow to sand and gravel.

Included with these soils in mapping are small areas of the poorly drained Shooker soils on nearly level slopes, the very poorly drained Talmoon soils in shallow depressions and drainageways, and the very poorly drained Cathro soils in the deeper depressions. Also included are a few areas of well drained soils that are sandy throughout. Included soils make up 2 to 10 percent of the mapped areas.

Permeability is moderate in the Itasca soil. It is moderate in the upper part of the Goodland soil and rapid in the lower part. Available water capacity is high in the Itasca soil and moderate or high in the Goodland soil. Surface runoff is medium on the Itasca soil and medium or rapid on the Goodland soil. Reaction is strongly acid to slightly acid in the surface layer and subsoil of both soils. The content of organic matter is moderate, and natural fertility is medium.

Most areas are forested. These soils are well suited to most upland tree species. Existing stands are mostly aspen and northern hardwoods. Most also have some

balsam fir, white spruce, and red pine and a few eastern white pine. Regeneration of aspen following clearcutting is rapid. If conversion to conifers is desired, white spruce and eastern white pine are suitable for planting. Red pine also is suitable if planted on the crest of slopes. Adequate site preparation and control of competing vegetation increase the seedling survival and early growth rates. The use of equipment is limited by the slope. It also is limited by soft conditions during wet periods, especially in early spring and after heavy rains. Operating the equipment along the contour reduces the hazard of water erosion.

These soils are generally unsuitable as cropland because of the slope. Pasture or hay crops can be grown in the less sloping areas. Excessive erosion can occur if these areas are overgrazed or are not protected by a plant cover.

Because of the slope, these soils are generally unsuitable as sites for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion.

The land capability classification is VIe. The woodland ordination symbol assigned to the Itasca soil is 8R, and that assigned to the Goodland soil is 6R.

871—Indus and Brickton soils. These nearly level, poorly drained soils are on glacial lake plains. Slopes are smooth and plane or are slightly convex or concave. Individual areas are irregularly shaped or elongated and range from about 15 to 600 acres in size. The Indus soil is dominant in most areas, but the Brickton soil is dominant in some areas.

Typically, the Indus soil has about 2 inches of forest litter at the surface. The surface layer is black clay about 3 inches thick. The subsurface layer is gray, mottled loam about 3 inches thick. The subsoil is dark gray and olive gray, mottled clay about 23 inches thick. The underlying material to a depth of at least 60 inches is olive gray and gray, mottled clay.

Typically, the Brickton soil has a surface layer of very dark gray silt loam about 4 inches thick. The subsurface layer is light brownish gray, mottled silt loam about 6 inches thick. The subsoil is about 15 inches of grayish brown, mottled silty clay loam and silty clay. The underlying material to a depth of at least 60 inches is light brownish gray and dark grayish brown, mottled silty clay loam and clay. In places the subsoil and underlying material have less clay.

Included with these soils in mapping are small areas of Dalbo, Dora, Taylor, and Wildwood soils. The very poorly drained Dora and Wildwood soils are in depressions. The moderately well drained Dalbo and Taylor soils are on rises. Included soils make up 2 to 15 percent of the mapped areas.

Permeability is slow in the Indus soil and moderately slow or slow in the Brickton soil. Available water capacity is moderate in the Indus soil and high in the Brickton soil. Surface runoff is slow on both soils. The seasonal high water table is at a depth of 0.5 foot to 3.0 feet in the Indus soil and 1.0 to 3.0 feet in the Brickton soil. The Indus soil is strongly acid to neutral in the surface layer and medium acid to moderately alkaline in the subsoil. The Brickton soil is medium acid to neutral in the surface layer and strongly acid to mildly alkaline in the subsoil. The organic matter content is moderate in both soils.

Most areas are forested. These soils are well suited to quaking aspen and balsam fir. Quaking aspen is the dominant species in most areas, but some stands are predominantly lowland hardwoods. Balsam fir and white spruce are in many stands. Regeneration of aspen following clearcutting is rapid. Planting is needed if a satisfactory stand of white spruce and white pine is to be established. Adequate site preparation and control of competing vegetation help to achieve satisfactory survival and early growth rates of planted species. Because of the seasonal wetness, the seedling mortality rate is high. It can be reduced by planting suitable species.

The use of logging equipment is limited by wetness during the spring and after heavy rains. Operating heavy equipment during these periods can result in excessive compaction and can reduce the potential for regeneration. Also, the equipment can become mired in the soil.

If drained, these soils are moderately suitable as cropland. The wetness is the main management concern. Tilling at the proper moisture content and returning crop residue to the soil help to maintain good tilth. Fall tillage generally allows for more timely seedbed preparation and planting in the spring.

Because of the wetness, these soils are generally unsuitable as sites for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by wetness, low strength, and shrinking and swelling.

The land capability classification is IIIw, and the woodland ordination symbol is 7W.

872—Pengilly-Winterfield association. These nearly level and gently sloping soils are on flood plains. They are flooded in the spring and after heavy rains. The poorly drained Pengilly soil is in the slightly lower, more frequently flooded areas. The somewhat poorly drained Winterfield soil is on the slightly higher rises. Individual areas are elongated and range from 15 to about 800 acres in size. They generally are about 60 percent Pengilly soil and 25 percent Winterfield soil. Along the

smaller rivers and streams, however, they are more than 70 percent Pengilly soil.

Typically, the Pengilly soil has a surface layer of very dark grayish brown, mottled loam about 4 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown, light brownish gray, dark gray, and dark brown, mottled, stratified silt loam, fine sandy loam, and loamy fine sand. In a few places thin strata contain more clay.

Typically, the Winterfield soil has about 3 inches of organic litter at the surface. The surface layer is very dark brown loamy fine sand about 3 inches thick. The upper part of the underlying material is dark brown and dark grayish brown loamy fine sand. The lower part to a depth of at least 60 inches is pale brown and brown, mottled fine sand and sand. In places the underlying material has a few loamy layers.

Included with these soils in mapping are small areas of the very poorly drained Bowstring, Cathro, and Sago soils in depressions. Also included are small areas of moderately well drained and well drained, sandy and loamy soils on gentle, convex slopes. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Pengilly soil and rapid in the Winterfield soil. Available water capacity is low in the Winterfield soil and moderate in the Pengilly soil. Surface runoff is slow on both soils. The seasonal high water table is 0.5 foot above to 2.0 feet below the surface of the Pengilly soil and is at a depth of 1 to 2 feet in the Winterfield soil. The Pengilly soil is medium acid to mildly alkaline in the surface layer and slightly acid to moderately alkaline in the underlying material. The Winterfield soil is medium acid to mildly alkaline throughout. The content of organic matter is moderate in the Pengilly soil and low in the Winterfield soil. Natural fertility is medium in the Pengilly soil and low in the Winterfield soil.

Most areas support a stand of native grasses and sedges or of aspen and lowland hardwoods, mainly black ash and American elm. These soils are poorly suited to lowland hardwoods. Seedling mortality is a problem because of the flooding, the seasonal wetness, plant competition, and the low fertility of the Winterfield soil. Planting suitable species and controlling competing vegetation help to overcome these limitations. Clearcutting rather than selective cutting improves stand regeneration and reduces the windthrow hazard. The use of heavy equipment is limited by the prolonged wetness and the flooding. The best periods for harvesting are those when the ground is frozen.

These soils are unsuitable as cropland. The flooding is a hazard, and the wetness is a limitation.

Because of the flooding, these soils are generally unsuitable as sites for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and frost action.

The land capability classification is VIIw. The woodland ordination symbol assigned to the Pengilly soil is 3W, and that assigned to the Winterfield soil is 5S.

995—Borosaprists, depressional. These nearly level, very poorly drained, organic soils are in bogs and swamps. They are ponded in the spring. Cathro, Lupton, Seelyeville, and Tawas are the major soils in the unit. The soils occur as areas so small and so intermixed that field checking each area is not practical. All of the soils in the unit have similar behavior characteristics. Individual areas are round or irregularly shaped and range from 5 to 20 acres in size.

Included with these soils in mapping are small areas of mineral soils on convex rises. These included soils are very poorly drained to well drained. They make up 0 to 15 percent of the mapped areas.

Permeability is moderately rapid to slow in the Borosaprists, and available water capacity is high or very high. The seasonal high water table is 1 foot above the surface to 2 feet below. The organic matter content is very high, and natural fertility is low.

These soils support a stand of grasses and sedges. In most areas they are well suited to wetland wildlife habitat. Because of the ponding, they are unsuitable as forest land, as cropland, and as sites for most engineering uses.

The land capability classification is VIw. No woodland ordination symbol is assigned.

1031—Histosols, ponded. These soils are in undrained, closed depressions and ponds that are covered by 1 to 3 feet of water. The unit includes scattered areas of open water. Individual areas are irregular in shape and range from about 5 to 120 acres in size.

These soils support cattails, rushes, reeds, sedges, and other water-tolerant plants. In most areas they are well suited to wetland wildlife habitat. Because of the ponding, they are unsuitable as forest land, as cropland, and as sites for most engineering uses.

The land capability classification is VIIIw. No woodland ordination symbol is assigned.

1033—Aquents, sandy. These gently sloping, poorly drained to moderately well drained soils are on beaches around the edge of large lakes. The beaches are as much as 500 feet wide. Individual areas are about 5 to 50 acres in size.

These soils consist of coarse textured, water-sorted material. They typically have no distinct soil layers. They are grayish brown, light brownish gray, or gray sand or coarse sand. In places they have loamy layers. In some areas they contain a considerable amount of gravel.

Included with these soils in mapping are small areas where the surface soil is organic material as much as 15 inches thick. Also included are areas of excessively drained sand and small areas where slopes are short and steep. Included soils make up 2 to 15 percent of the mapped areas.

Permeability is rapid in the Aquents, and available water capacity is very low. Surface runoff is slow. The depth to the seasonal high water table varies, depending on the lake level. Reaction is slightly acid to moderately alkaline. The organic matter content and natural fertility are low.

Most areas are unvegetated, particularly near the edge of the lake, but some have sparse cover of grasses, brush, or trees. These soils are unsuitable as forest land, cropland, and wildlife habitat. Because of the variability of the soil material, onsite investigation is needed to determine the suitability for engineering uses.

No land capability classification or woodland ordination symbol is assigned.

1041—Pits, mine. This map unit consists of excavations from which earth spoil and iron ore have been removed. These pits have very steep side slopes. They are about 50 to 500 feet deep. Some are being mined. Others have been abandoned, either temporarily or permanently. The abandoned pits contain water as much as 350 feet deep. Partially submerged mine dumps of low-grade iron ore are in some of the pits. Individual areas range from about 10 to 500 acres in size.

Unless major reclamation measures are applied, the pits are unsuitable for forestry and agricultural uses and community development. The material in the pits may be suited to some engineering uses. The pits containing water serve as open water areas for waterfowl and as habitat for aquatic wildlife.

No land capability classification or woodland ordination symbol is assigned.

1042—Dumps, mine. This map consists of piles of low-grade iron ore. The ore is mainly 3 to 10 inches in diameter but ranges from the size of pebbles to the size of boulders. The top of the piles is flat, but the sides are very steep. Some piles are as much as 200 feet high. Individual areas range from about 5 to 150 acres in size.

Unless major reclamation measures are applied, the dumps are generally unsuited to forestry and agricultural uses, wildlife habitat, and community development. The rock material has some potential for engineering uses.

Vegetating the dumps is very difficult, but some vegetation can be established if enough fine textured fill material is provided and if suitable grasses, legumes, or trees are selected for planting. Onsite investigation is needed to determine the best means of revegetating abandoned dumps. Special management is probably needed to establish a plant cover in these areas.

No land capability classification or woodland ordination symbol is assigned.

1043C—Udorthents, nearly level to rolling. These well drained and moderately well drained soils are mainly adjacent to iron mines and urban areas where soil material has been removed and redeposited by earth-moving machinery. The material typically is stratified, but it lacks soil horizons, except for those in the underlying buried soil. It is loamy or sandy material. In most areas it is glacial till, but some areas have low-grade iron ore ranging from the size of clay to the size of pebbles. Individual areas are irregular in shape and range from about 20 to 500 acres in size.

The upper 60 inches or more typically is pale brown to reddish brown, loamy, sandy, or mixed loamy and sandy material. In places the transported soil material is less than 60 inches thick. Some areas have stones, boulders, or miscellaneous nonsoil debris.

Included with these soils in mapping are small areas of natural soils, mainly Nashwauk and Itasca soils, on the slightly higher parts of the landscape. Also included are the very poorly drained Blackhoof and Cathro soils in some small depressions. Included soils make up less than 10 percent of the mapped areas.

Permeability is moderately rapid to slow in the Udorthents. Available water capacity ranges from high in the loamy material to low in the sandy material. Surface runoff is medium. The organic matter content is low, and natural fertility is low or medium.

Some areas have a sparse cover of quaking aspen, paper birch, or shrubs. A few support young stands of planted jack pine, red pine, or white spruce. The tree cover is designed mainly to control erosion. Onsite investigation and soil borings are needed to determine the suitability of these soils for specific uses.

No land capability classification or woodland ordination symbol is assigned.

1043F—Udorthents, very steep. These well drained to excessively drained soils are in mined areas where glacial till has been removed and ore-bearing rock has been exposed. The glacial till has been transported to adjacent areas and deposited in piles about 20 to 150 feet high. Most of the piles have a nearly level or undulating top and very steep sides. Some have been formed into containment dikes for slickens. Individual areas are irregular in shape and range from about 5 to 80 acres in size.

The upper 60 inches or more typically is pale brown, grayish brown, or reddish brown loam, sandy loam, or clay loam. A few areas have layers that are more sandy or more clayey. Some include low-grade iron ore.

Permeability is moderately rapid to slow in the Udorthents, and available water capacity is moderate or high. Surface runoff is medium on the top of piles and

very rapid on the sides. The organic matter content is low, and natural fertility is low or medium.

Most of the acreage is idle land that supports little or no vegetation. A few areas where the surface has not recently been disturbed support some vegetation. The naturally established vegetation is mainly aspen, paper birch, shrubs, and grasses. The vegetation on the side slopes generally is very sparse, especially on the south- and west-facing slopes. In a few areas conifers have been planted and some fairly successful stands established. The cover of planted trees is designed mainly to control erosion and to beautify the landscape.

Because of the variability of the soil material, onsite investigation and soil borings are needed to determine the suitability of these soils for engineering uses. The very steep side slopes are generally unsuitable as sites for buildings, local roads, and septic tank absorption fields, but the nearly level hilltops are suitable. In areas near side slopes, special measures commonly are needed to overcome the instability of the soil material.

No land capability classification or woodland ordination symbol is assigned.

1044—Slickens. This map unit consists of nearly level and gently sloping areas of mine tailings left over from the taconite concentration process. This material is in basins having containment dikes constructed from mine overburden. The taconite concentration waste is pumped into basins as a slurry. During this process, clay-sized material settles out farthest from the point of distribution and sand-sized material closest to the distribution point. Silt-sized material is deposited at an intermediate position. Some stratification occurs because of variations in the flow rate. In most areas, about half of the basin is predominantly sandy material, nearly half is predominantly silty material, and the rest is clayey material. Active basins are generally covered with water. Individual areas range from about 40 to 200 acres in size.

Included in this unit in mapping are areas of natural soils on the higher parts of the landscape. Most of these areas will be covered by tailings in the future.

Permeability is rapid to slow in the Slickens, and available water capacity is low to high. Surface runoff is slow. The organic matter content is low, and natural fertility is low or medium. The soil material is continuously wet when new material is being deposited.

Most areas support grasses, brush, or small aspen saplings. This map unit is poorly suited or moderately well suited to forage crops, depending upon the texture of the soil material. Higher forage production can be expected in the loamy and silty areas, where the available water capacity and natural fertility are higher. Soil blowing is a hazard in large open areas. It can be controlled by a protective plant cover. Establishing plants on the coarse textured material is difficult. The soil material becomes very warm in summer. As a result, even less water is available to plants.

Because of the variations in texture in this map unit, onsite inspection and soil borings are needed to determine the suitability for specific engineering uses.

No land capability classification or woodland ordination symbol is assigned.

1826B—Nashwauk-Menahga complex, 1 to 10 percent slopes. These nearly level to rolling soils are on convex and concave slopes on glacial moraines. The Nashwauk soil is well drained. It typically has a few stones and boulders on and below the surface. The Menahga soil is excessively drained. Individual areas are irregular in shape and range from about 15 to 500 acres in size. They are about 55 percent Nashwauk soil and 30 percent Menahga soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping is not practical.

Typically, the Nashwauk soil has about 1 inch of organic forest litter at the surface. The surface layer is very dark gray fine sandy loam about 1 inch thick. The next layer is grayish brown and yellowish brown fine sandy loam about 6 inches thick. Below this is firm, brittle, grayish brown fine sandy loam about 3 inches thick. The next 42 inches is firm, brittle, brown and light olive brown loam. The underlying material to a depth of at least 60 inches is brown silt loam. In some areas layers within the subsoil and underlying material have a higher content of clay. In places, the subsoil is thinner and the underlying material is sandy. In some areas the soil is moderately well drained.

Typically, the Menahga soil has about 1 inch of organic forest litter at the surface. The surface layer is dark gray and black loamy coarse sand about 1 inch thick. The subsurface layer is grayish brown loamy coarse sand about 2 inches thick. The subsoil is yellowish brown and brown sand about 35 inches thick. The underlying material to a depth of at least 60 inches is brown coarse sand. In a few places the soil has a thin surface layer of sandy loam or coarse sandy loam. In some areas the subsoil has thin layers of dark brown loamy sand and sandy loam. In a few areas the underlying material is loamy. In a few places the content of coarse fragments is higher.

Included with these soils in mapping are small areas of the somewhat poorly drained Keewatin and Sandwick soils in shallow drainageways. Also included are the very poorly drained Blackhoof, Cathro, and Roscommon soils in small depressions. Included soils make up 2 to 15 percent of the mapped areas.

Permeability is moderate to slow in the Nashwauk soil, and rapid in the Menahga soil. Available water capacity is moderate or low in the Nashwauk soil and low in the Menahga soil. Surface runoff is slow or medium on the Nashwauk soil and slow on the Menahga soil. The Nashwauk soil is very strongly acid to slightly acid in the

surface layer and strongly acid to neutral in the subsoil. The Menahga soil is very strongly acid to medium acid in the surface layer and very strongly acid to slightly acid in the subsoil. The organic matter content and natural fertility are low in both soils.

Most areas are forested. These soils are well suited to most upland tree species. Aspen, northern hardwoods, balsam fir, eastern white pine, red pine, and jack pine are the common trees. The deciduous trees are more common on the Nashwauk soil. Aspen is the most common species. In most areas it regenerates well after clearcutting. Balsam fir and most of the hardwoods commonly regenerate as understory species. Natural regeneration of other conifers seldom results in adequate stands. If conifers are planted, adequate site preparation is needed.

The Menahga soil is suited to all of the common upland conifers, but survival of red pine is poor on the Nashwauk soil. The Nashwauk soil is well suited to white spruce and balsam fir. Removal or control of competing vegetation increases the seedling survival and early growth rates. Because of droughtiness, the seedling mortality rate is high on the sandy Menahga soil. It can be reduced by careful planting of vigorous nursery stock. Trees on these soils are shallow rooted and are subject to windthrow during storms, particularly on the Nashwauk soil. Clearcutting rather than selective cutting reduces the windthrow hazard and improves regeneration. The use of heavy equipment on the Nashwauk soil can result in severe compaction and can adversely affect the root zone.

These soils are poorly suited to cultivated crops and small grain because of the hazard of erosion and the droughtiness. If row crops are grown, erosion can be controlled by contour farming and tillage methods that leave large amounts of crop residue on the surface. Removal of stones and boulders reduces the risk of damage to machinery.

Dwellings constructed on these soils should be designed so that they conform to the natural slope of the land, particularly in the rolling areas. Land shaping is necessary in some areas. Building local roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion. Providing well compacted, coarse textured base material helps to prevent the damage caused by frost action in the Nashwauk soil.

These soils are poorly suited to septic tank absorption fields. The Menahga soil does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. The Nashwauk soil does not readily absorb the effluent. If septic tank systems are installed in these soils, onsite investigation is needed to determine the soil type and the measures that can overcome the limitations.

The land capability classification is IVe. The woodland ordination symbol assigned to the Nashwauk soil is 6D, and that assigned to the Menahga soil is 7S.

1826D—Nashwauk-Menahga complex, 10 to 25 percent slopes. These rolling to steep soils are on concave and convex slopes on glacial moraines. The Nashwauk soil is well drained. It typically has a few stones and boulders on and below the surface. The Menahga soil is excessively drained. Individual areas are irregular in shape and range from about 15 to 200 acres in size. They are about 45 percent Nashwauk soil and 40 percent Menahga soil. The two soils occur as areas so small or so intricately mixed that separating them in mapping is not practical.

Typically, the Nashwauk soil has a surface layer of very dark gray fine sandy loam about 3 inches thick. The subsurface layer is grayish brown and very dark gray fine sandy loam about 1 inch thick. The next layer is yellowish brown fine sandy loam about 8 inches thick. The subsoil is about 46 inches thick. The upper part is yellowish brown and light brownish gray, firm, brittle sandy clay loam; the next part is yellowish brown clay loam; and the lower part is brown sandy clay loam. The underlying material to a depth of at least 60 inches is brown and pale brown fine sandy loam. In places the subsoil and underlying material have slightly more clay. In some areas in the central part of the county, the soil contains more sand and less silt and clay. In some areas the underlying material is sandy.

Typically, the Menahga soil has about 1 inch of organic forest litter at the surface. The surface layer is very dark gray and black loamy coarse sand about 1 inch thick. The subsurface layer is grayish brown loamy coarse sand about 2 inches thick. The subsoil is yellowish brown and brown sand about 35 inches thick. The underlying material to a depth of at least 60 inches is brown coarse sand. In some places the subsoil has thin layers of brown loamy sand or sandy loam. In other places the underlying material is loamy. In some areas the surface soil and subsoil have a higher content of coarse fragments.

Included with these soils in mapping are small areas of the somewhat poorly drained Keewatin and Sandwick soils on plane or concave slopes. Keewatin soils are loamy. Sandwick soils are sandy in the upper part and loamy in the lower part. Also included are small areas of the very poorly drained, loamy Blackhoof and poorly drained or very poorly drained, sandy Roscommon soils in depressions. Included soils make up about 5 to 15 percent of the mapped areas.

Permeability is moderate to slow in the Nashwauk soil and rapid in the Menahga soil. Available water capacity is moderate or low in the Nashwauk soil and low in the Menahga soil. Surface runoff is medium or slow on the Nashwauk soil and slow on the Menahga soil. The Nashwauk soil is very strongly acid to slightly acid in the

surface layer and strongly acid to neutral in the subsoil. The Menahga soil is very strongly acid to medium acid in the surface layer and very strongly acid to slightly acid in the subsoil. The organic matter content and natural fertility are low in both soils.

Most areas are forested. These soils are well suited to most upland tree species. Quaking aspen, northern hardwoods, and paper birch are the principal trees on the Nashwauk soil. Conifers, mainly red pine and jack pine, are more common on the Menahga soil. Balsam fir and white spruce grow on both soils. Regeneration of aspen following clearcutting is rapid. Natural regeneration generally does not result in dense stands of conifers. White spruce and white pine are suitable for planting on the Nashwauk soil if conversion to conifers is desired. If planted near the crest of slopes, red pine also is a suitable species.

Adequate site preparation and control of competing vegetation reduce seedling mortality rates and increase early growth rates. Because of droughtiness, the seedling mortality rate is higher on the Menahga soil than on the Nashwauk soil. The use of heavy equipment is limited primarily by the slope. Building logging roads and skid trails on the contour helps to control erosion. Damage to the root zone can result if heavy equipment is used when the Nashwauk soil is wet. Trees on these soils are shallow rooted and are subject to windthrow during storms. Clearcutting rather than selective cutting reduces the windthrow hazard.

These soils are unsuitable as cropland because of the slope and a severe hazard of erosion. The less sloping areas are poorly suited to forage crops. The steeper areas can be used only for grazing.

The slope is the main limitation if these soils are used as sites for dwellings or local roads. Extensive land shaping is generally needed. Buildings should be designed so that they conform to the natural slope of the land. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and establishing well suited vegetation on the roadbanks help to control erosion.

These soils are poorly suited to septic tank absorption fields. The Menahga soil does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. The Nashwauk soil does not readily absorb the effluent. If septic tank systems are installed in these soils, onsite investigation is needed to determine the soil type and the measures that can overcome the limitations.

The land capability classification is VIIe. The woodland ordination symbol assigned to the Nashwauk soil is 6R, and that assigned to the Menahga soil is 7R.

1883D—Nashwauk-Rock outcrop complex, 6 to 25 percent slopes. This map unit occurs as areas of a rolling to steep, well drained Nashwauk soil intermingled with areas of Rock outcrop. The Nashwauk soil is mainly downslope from the Rock outcrop. Individual areas are irregular in shape and range from about 15 to 1,200 acres in size. They are about 55 percent Nashwauk soil and 30 percent Rock outcrop. The Nashwauk soil and Rock outcrop occur as areas so small or so intricately mixed that separating them in mapping is not practical.

Typically, the Nashwauk soil has about 1 inch of organic forest litter at the surface. The surface layer is very dark gray fine sandy loam about 1 inch thick. The next layer is grayish brown and yellowish brown fine sandy loam about 6 inches thick. Below this is grayish brown, firm, brittle fine sandy loam about 3 inches thick. The next 6 inches is brown and light brownish gray, firm, brittle loam. The subsoil is brown and light olive brown, firm loam about 42 inches thick. The underlying material to a depth of about 60 inches is brown silt loam. In some places layers within the subsoil and underlying material have a higher content of clay. In other places bedrock is directly below the subsoil.

The Rock outcrop is mainly igneous rock, commonly granite, basalt, or greenstone schist. In places a thin layer of loamy material or leaf litter overlies the rock.

Included with this unit in mapping are small areas of the well drained Cutaway soils in landscape positions similar to those of the Nashwauk soil. Also included are small areas of the very poorly drained Blackhoof and Cathro soils in depressions and a few areas of loamy soils that are less than 20 inches deep over bedrock. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate to slow in the Nashwauk soil, and available water capacity is moderate or low. Surface runoff is medium or rapid. Reaction is very strongly acid to slightly acid in the surface layer and strongly acid to neutral in the subsoil. The organic matter content and natural fertility are low.

Most areas are forested. Trees grow well on the Nashwauk soil. Aspen, paper birch, balsam fir, and eastern white pine are the common trees. Aspen is the most common species. Regeneration of aspen following clearcutting is moderate. White spruce and eastern white pine are suitable for planting. In places conifers and birches are left uncut because of their esthetic value.

Limited accessibility hinders tree harvesting in some areas. Because of the Rock outcrop, planting by machine is impractical. Seedling survival and early growth rates can be increased by measures that control or remove competing vegetation. The slope is a major management concern. Disturbing the surface as little as possible and building logging roads and skid trails on the contour help to control erosion. The Nashwauk soil can be severely damaged and tree growth inhibited if heavy wheeled equipment is used during wet periods. Trees on this soil are shallow rooted and are subject to windthrow during storms. Clearcutting rather than selective cutting reduces the windthrow hazard and improves regeneration.

This map unit is unsuitable as cropland because of the slope, the hazard of erosion, and the Rock outcrop.

Because of the slope and the Rock outcrop, this map unit is generally unsuitable as a site for dwellings and sanitary facilities. Soils that are better suited to these uses are generally nearby. Extensive cutting and filling are generally needed on sites for local roads. Also, blasting of the bedrock is needed. If at all possible, better suited sites should be selected. If roads are constructed on this unit, building on the contour and establishing well suited grasses on the roadbanks help to control erosion.

The land capability classification is VIIe. The woodland ordination symbol assigned to the Nashwauk soil is 6R.

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 the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. 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 Soil Conservation Service.

About 607,000 acres in the survey area, or 36 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, but most are in associations 2, 3, and 4, which are described under the heading "General Soil Map Units." About 10,000 acres of this prime farmland is used for crops.

The map units in the survey area that are considered prime farmland are listed in this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

The map units that meet the requirements for prime farmland are:

32B Nebish very fine sandy loam, 2 to 6 percent slopes
72 Shooker very fine sandy loam (where drained)
147 Spooner silt loam (where drained)
167B Baudette silt loam, 0 to 5 percent slopes
240B Warba fine sandy loam, 1 to 8 percent slopes
243 Stuntz very fine sandy loam (where drained)
615 Cowhorn loamy very fine sand (where drained)
616 Effie loam (where drained)
617B Goodland silt loam, 1 to 10 percent slopes
618B Itasca silt loam, 1 to 10 percent slopes
619 Keewatin silt loam (where drained)
621 Morph very fine sandy loam (where drained)
622B Nashwauk fine sandy loam, 1 to 10 percent slopes
624B Rosy very fine sandy loam, 0 to 6 percent slopes
626B Suomi silt loam, 1 to 8 percent slopes
628 Talmoon silt loam (where drained)
629B Wawina loamy very fine sand, 0 to 10 percent slopes
655 Bearville loamy sand (where drained)
801B Taylor and Dalbo silt loams, 0 to 6 percent slopes
871 Indus and Brickton soils (where drained)

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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 of natural resources and the environment. Also, it can help avoid 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 behavior 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 forest land; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the 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

Terrance J. Weber, district conservationist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Approximately 86,500 acres in Itasca County is used as cropland, hayland, or pasture. In 1982, about 54,000 acres was used as hayland, 23,000 acres as improved pasture, 8,300 acres for small grain, and 1,200 acres for corn. Oats, rye, and wheat are the most common small grain crops. Most of the corn is used for silage. Wild rice is grown in some areas.

A typical cropping sequence that includes row crops is 1 or 2 years of corn followed by 1 year of small grain and 3 or more years of hay. Another typical sequence in the county is 1 or 2 years of small grain and 3 or more years of hay.

The county has a significant potential for increased crop production. On nearly 830,000 acres, the soils are suited to crop and forage production. Of this acreage, approximately 520,000 acres is considered prime farmland. Most of this potential prime farmland is forested. Very little effort has been made to convert it to cropland or pasture.

The main management concerns in the county are maintenance of fertility levels, soil drainage, erosion control, crop variety selection, and weed and brush control. Good soil management involves all of these factors.

The natural fertility of the soils in the county is very low to medium. The pH commonly ranges from about 5.1 to 6.5 in the surface soil. The acidity is a major problem affecting many crops. Applications of as much as 5 tons of lime per acre to correct the acidity problem are not uncommon.

Natural wetness is a problem in many of the soils in the county. On very poorly drained soils, such as Blackhoof, Sago, Talmoon, and Wildwood soils, crop or forage production is not feasible unless a drainage system is installed. On poorly drained soils, such as Cowhorn, Effie, Indus, and Spooner soils, crops and forage plants are damaged by wetness in most years. Poor drainage also can delay planting and harvesting, especially if corn is grown. Because the growing season

is short, cool, and moist, early maturing varieties of corn should be selected for planting.

The type of drainage system used to improve production in wet areas depends on the soil type. Tile drainage is effective in moderately permeable to rapidly permeable soils but is not widely used. In clayey soils, such as Brickton, Taylor, and Indus soils, drainage ditches are commonly used. Land smoothing and land grading increase the effectiveness of surface drains.

Soil blowing and water erosion are management concerns on about two-thirds of the cropland in the county. Failure to control erosion results in reduced productivity and pollution of nearby lakes and streams. Control of sheet and rill erosion is needed, especially on the steeper slopes. On Zimmerman, Cromwell, and Menahga soils, soil blowing is a major hazard. A conservation cropping system that includes a forage crop for 3 years in a 5-year rotation is effective in keeping soil losses within tolerable limits. On pasture and hayland, measures that keep the forage in good condition and prevent overgrazing are effective in controlling erosion.

Weed and brush control is another management consideration. Control of quackgrass is essential in establishing productive row crops, small grain, or forage species. A combination of tillage and applications of chemicals is the most effective and most popular method of controlling quackgrass. Other weeds are foxtail, thistle, daisy, buttercup, yellow rocket, and tansy.

The species selected for planting on hayland and pasture should be based on the soil type, drainage, and acidity. If alfalfa is grown, adequate drainage and a neutral pH are needed. Other legumes, such as red clover and birdsfoot trefoil, can withstand wetter conditions and pH levels as low as 5.5 to 6.0. Deep, well drained and moderately well drained soils, such as Itasca, Goodland, Taylor, and Suomi soils, are suited to the widest range of species, including alfalfa, red clover, birdsfoot trefoil, smooth bromegrass, timothy, orchardgrass, Kentucky bluegrass, and reed canarygrass.

Somewhat poorly drained to very poorly drained soils, including Indus, Shooker, Sago, Greenwood, and Tawas soils, are suited only to those species that can withstand wet conditions. Without a drainage system, these soils are too wet for high-quality legume hay. Also, they commonly cannot support harvesting machinery during wet periods. Adapted species include reed canarygrass, creeping foxtail, redtop, birdsfoot trefoil, alsike clover, and ladino clover. If drained, these soils are suitable for orchardgrass, timothy, smooth bromegrass, Kentucky bluegrass, and red clover.

Well drained to excessively drained soils, such as Nashwauk, Mahtomedi, and Menahga soils, usually produce forage in the spring and early summer and again in the fall, when precipitation is adequate. During the summer, droughty conditions limit production. Alfalfa, red clover, birdsfoot trefoil, smooth bromegrass, orchardgrass, timothy, and Kentucky bluegrass grow well when adequate moisture supplies are available. These soils are suited to warm-season grasses, including big bluestem, little bluestem, indiangrass, switchgrass, and sideoats grama. If grazing is properly managed, these species provide good forage during the summer. If grown along with the cool-season species, they help to provide a full season of grazing.

The most recent information about suitable species and varieties can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Measures that maintain the proper level of fertility, timely seeding, and seeding techniques that result in proper seed placement and good seed-soil contact help to establish grasses and legumes. In fields where erosion is a serious hazard, no-till drills or other types of interseeding equipment can be used to reestablish hayland and pasture. Good forage management includes applications of the proper kind and amount of lime and fertilizer; timely cutting or grazing, depending on the forage species; proper stocking rates; weed control; and measures that allow adequate regrowth prior to freezing weather.

Brush and weed control is a common problem, especially in permanent pastures. The major brush species to be controlled are willow, alder, hawthorn, and snowberry. Clipping overly mature plants after grazing improves the forage and helps to control brush and weeds. Spraying and good grazing management also help to control brush and weeds.

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 Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. 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 rangeland, for woodland, and 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 limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is 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, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Forest Management and Productivity

Robert Blackbourn, forester, Soil Conservation Service, helped prepare this section.

Table 6 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. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 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; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; and *F*, a high content of rock fragments in the soil. 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, D, C, S, and F.

In table 6, *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, fire lanes, and 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.

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 or season of use is 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. Additional information about equipment use is provided in table 7.

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, 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* 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. Some of the site index data used in table 6 was provided by the Blandin Paper Company, Grand Rapids, Minnesota, and by the U.S. Department of Agriculture, Forest Service, Duluth, Minnesota.

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 on a fully stocked, even-aged, unmanaged stand. All yields are in cubic feet at the age of culmination of the mean annual increment.

The yield data for quaking aspen, bigtooth aspen, balsam poplar, and eastern white pine were obtained from a technical bulletin published by the University of Minnesota (*3*); for red pine, jack pine, black spruce, and paper birch from a bulletin published by the Ontario Department of Lands and Forests (*9*); for balsam fir and white spruce from a bulletin published by the U.S. Department of Agriculture (*8*); for northern white-cedar from a publication of the U.S. Department of Agriculture, Forest Service (*5*); for northern red oak and American basswood from a publication of the U.S. Department of Agriculture, Forest Service, the Wisconsin Department of Conservation, and the University of Wisconsin (*4*); and for black ash and sugar maple from a bulletin published by the U.S. Department of Agriculture (*10*).

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the most important commercial species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Forestry Equipment Use

Table 7 can be used by woodland owners or forest managers as an aid in selecting the season during which forestry equipment can be used most efficiently. Only those soils suitable for wood crops are listed. These soils are rated for the most limiting season or seasons and for the preferred operating season or seasons. In Itasca County, the spring season normally is April through June, the summer season is July and August, the fall season is September through November, and the winter season is December through March.

On many soils spring is the most limiting season because of snowmelt and the alternating freezing and thawing of the surface layer. In winter reduced traction on snow-covered slopes is a limitation.

Wetness is a limitation that varies with the seasons. The water table in wet soils generally is closer to the

surface in the spring than in other seasons. Also, it is high for longer periods. It is deeper in the summer and is closer to the surface again in the fall. In some soils it is at or near the surface throughout the year. Wheel-track rutting results if trees are logged when the soils are wet. Rutting can impede the use of equipment and the growth of seedlings. Because of poor traction, logging is difficult when clayey soils are wet. Winter is often the preferred season of use on wet soils because the frozen ground can support logging equipment. On soils that have a surface layer of sand, coarse sand, or fine sand, traction tends to be poor during very dry periods.

Table 7 shows the degree and kind of soil limitations that affect the operations of wheeled logging equipment in logging areas and on skid trails, log landings, and haul roads. *Logging areas* and *skid trails* include areas where trees are logged and the trails over which the logs are dragged or hauled from the stump to a log landing. Equipment traffic is generally least intensive in the logging areas. The landscape is not altered in these areas. The chief soil properties and site features considered in rating the soils for logging areas and skid trails are slope, wetness, flooding, rock outcrops, and texture of the surface layer. A rating of *slight* indicates that operating the usual kinds of logging equipment is not limited or is limited only to a minor extent when normal logging procedures are used. A rating of *moderate* or *severe* indicates that equipment use is more seriously restricted by one or more soil or site factors during the season of use.

Log landings are areas where logs are assembled for transportation. Some modification of the landscape is needed to level the landings. Slope, rock outcrops, wetness, and flooding affect the ease of excavating and shaping the landings. Soil strength (as inferred from the engineering classification of the soil) and wetness affect the traffic-supporting capacity. Texture affects trafficability, which varies with moisture content. Measures that protect areas where flooding is a hazard are needed. A rating of *slight* indicates that soil properties or site features are generally favorable and limitations are minor and can be easily overcome. A rating of *moderate* indicates that soil properties and site features are not favorable and special planning, design, land shaping, or maintenance is needed to overcome or minimize the limitations. A rating of *severe* indicates that 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. If possible, sites rated severe should not be used as landings.

Haul roads serve as transportation routes from log landings to primary roads. Generally, haul roads are unpaved. Some are graveled. Cuts may be needed to reduce the road grade. The ratings are based on soil properties and site features. A high water table, flooding, rock outcrops, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil) and wetness affect the traffic-supporting capacity. Texture affects trafficability, which varies with moisture content. The limitations are considered *slight* if soil properties and site features are generally favorable and limitations are minor and can be easily overcome; *moderate* if soil properties or site features are not favorable 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 and increased maintenance are required.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

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

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

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

Recreation

Opportunities for recreation are plentiful throughout the year in Itasca County. Numerous lakes and streams provide many opportunities for water-based activities. The county has nearly 1,000 lakes. Of these, 26 are more than 1,000 acres in size. Lake Winnibigoshish, the largest, is nearly 70,000 acres, about 32,000 acres in Itasca County and the rest in Cass County. Major canoe routes are on the Bigfork and Mississippi Rivers. Canoe trips often begin on the tributary streams. Campgrounds and resorts are around many lakes. More rustic

campgrounds are at various intervals along the canoe routes.

The soil and water resources also provide opportunities for hunting many wildlife species. White-tailed deer and black bear are the most common big game species. Ruffed grouse, rabbits, and squirrels are the most common upland small game. Ducks and geese also are hunted.

The slopes of the Sugar Hills moraine provide opportunities for downhill skiing. Many forested areas in public or private ownership have trails for cross-country skiing. Numerous snowmobile trails are throughout the county. Many nature lovers enjoy the seasonal wild flowers and wild fruit produced in the forest and on the forest edges.

The soils of the survey area are rated in table 9 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 sewerlines. 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 recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, 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 by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

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 mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing 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

George L. Pollard, biologist, Soil Conservation Service, helped prepare this section.

The soil and water resources of Itasca County provide good habitat for many species of fish and wildlife. Because most of the county is dominated by a forested landscape, wildlife species are a forest or forest-edge type. Ruffed grouse, white-tailed deer, American woodcock, and snowshoe hare are the major upland game animals. Black bear also is common. Gray wolf, considered nationally as a threatened species, inhabits the county. The best habitat for ruffed grouse and woodcock is in forested areas where the trees are of various ages. Sites that support aspen are especially favorable. Habitat for white-tailed deer is improved where small agricultural areas are interspersed with forested areas. Habitat for woodcock and snowshoe hare is improved by even smaller forest openings, 0.5 acre to 2.0 acres in size. All four of these game species benefit from timber management centered on aspen production and regeneration.

Several species of migratory waterfowl frequent the marshes and lakes in the county. Common goldeneye, common merganser, ringed-neck duck, American widgeon, black duck, red-necked grebe, and common loon have some of their highest breeding densities within Itasca County. While the primary breeding range of the wood duck and mallard is outside of the county, these species are quite common and important in the county. Furbearers, such as muskrat, mink, otter, and beaver, also are important.

Nongame birds of the northern forest and marshes include common loon, red-necked grebe, osprey, broad-

winged hawk, barred owl, gray jay, purple finch, pine siskin, evening grosbeak, white-throated sparrow, Nashville warbler, and solitary vireo. Examples of nongame mammals are the southern-bog lemming, southern red-backed vole, red squirrel, northern flying squirrel, short-tailed shrew, and star-nosed mole.

The major fish species in the larger and deeper lakes are walleye, yellow perch, northern pike, and white suckers. Largemouth bass, bluegill, and black crappie are more common in the smaller, shallower lakes. A few lakes are inhabited by lake trout, lake whitefish, burbot, smallmouth bass, tullibee, and white sucker.

Soils affect the kind and amount of vegetation that is 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.

In table 10, 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.

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 flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. 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, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, 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 flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

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 oak, aspen, cherry, apple, hawthorn, dogwood, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive and crabapple.

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 tamarack.

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, 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, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include meadowlark, field sparrow, snowshoe hare, and coyote.

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, coyote, 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. The ratings are given in the following tables: 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 need to 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 to 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 kind 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 (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) 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 11 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 the 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, shrink-swell potential, 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 to 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, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials 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 12 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 12 also shows the suitability of the soils for use as daily cover for landfills. 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 12 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 due to rapid permeability of 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 needs to be considered.

The ratings in table 12 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 type 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 type 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 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 13 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 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, 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 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 the depth to the water table is 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. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, 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 low in content of soluble salts, 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, stones, or soluble salts, 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, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal 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 14 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 and for embankments, dikes, and levees. 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 boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

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 potential 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 or by toxic substances in the root zone, such as salts, sodium, or sulfur. 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 reduce 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, toxic substances such as salts or sodium, 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 characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 15 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 soil series under "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. "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 (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter 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 3 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 16 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, and 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 1/3 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, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

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 change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

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 0.05 to 0.69. 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. Soils are grouped according to the following distinctions:

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

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

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

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, 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 of 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

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils 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 permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, 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 or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 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; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

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 absence of distinctive horizons that form in soils that are not subject to flooding.

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 depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

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.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

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.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence 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 17 shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

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 creates a severe corrosion environment. 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.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*12*). 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 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten 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 Alfisol.

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 Boralf (*Bor*, meaning cold, plus *alf*, from Alfisol).

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; 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 Eutroboralfs (*Eutro*, meaning high base status, plus *boralfs*, the suborder of the Alfisols that have a frigid temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic 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 known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Eutroboralfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed Typic Eutroboralfs.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the underlying material can differ within a series.

Soil Series and Their Morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other 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* (*11*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*12*). Unless otherwise stated, 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 are described in the section "Detailed Soil Map Units."

Baudette Series

The Baudette series consists of deep, moderately well drained, moderately permeable soils on glacial lake plains. These soils formed in silty lacustrine sediments. Slopes range from 0 to 5 percent.

Typical pedon of Baudette silt loam, 0 to 5 percent slopes, 500 feet south and 100 feet east of the northwest corner of sec. 9, T. 54 N., R. 23 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) silt loam, light brownish gray (10YR 6/2) dry; weak fine and very

fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

E—7 to 9 inches; grayish brown (2.5Y 5/2) silt loam; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B/E—9 to 11 inches; yellowish brown (10YR 5/4) silt loam (Bt) with interfingers and ped coatings of grayish brown (2.5Y 5/2) silt loam (E); common fine faint light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bt1—11 to 19 inches; brown (10YR 5/3) and yellowish brown (10YR 5/4) silt loam; moderate fine and medium subangular blocky structure; friable; many thin and few moderately thick dark grayish brown (10YR 4/2) clay films on faces of peds; light brownish gray (10YR 6/2) and pale brown (10YR 6/3) uncoated sand or silt grains on the upper part of peds; medium acid; gradual smooth boundary.

Bt2—19 to 33 inches; grayish brown (10YR 5/2) and brown (10YR 5/3) silty clay loam; few fine faint yellowish brown (10YR 5/4 and 5/6) mottles; moderate fine and medium subangular blocky structure; friable; common thin dark brown (10YR 4/3) clay films on faces of peds; medium acid; clear wavy boundary.

BC—33 to 36 inches; grayish brown (10YR 5/2), brown (10YR 5/3), yellowish brown (10YR 5/4), and light olive brown (2.5Y 5/4) silt loam; weak medium and coarse subangular blocky structure; friable; few fine soft black (7.5YR 2/1) manganese nodules; slight effervescence; mildly alkaline; gradual smooth boundary.

C—36 to 60 inches; grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) silt loam; few fine soft black (5YR 2/1) manganese nodules; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates are 24 to 36 inches. Some pedons have an A1 horizon. The Ap horizon has value of 3 to 5 and chroma of 1 or 2. The E horizon has value of 4 to 6 and chroma of 1 or 2. The A and E horizons are very fine sandy loam or silt loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is silt loam, loam, silty clay loam, or clay loam. The C horizon has hue of 2.5Y, value of 5 to 7, and chroma of 2 to 4. It is silt loam, very fine sandy loam, loam, or loamy very fine sand.

Bearville Series

The Bearville series consists of deep, poorly drained soils on the edges of glacial lake plains and on deltas on the lake plains. These soils formed in a sandy outwash mantle and in the underlying loamy and clayey sediments. Permeability is rapid in the upper part of the profile, moderately slow in the middle part, and slow in the lower part. Slopes are 0 to 2 percent.

Typical pedon of Bearville loamy sand, about 2,500 feet south and 200 feet west of the northeast corner of sec. 12, T. 61 N., R. 22 W.

A—0 to 2 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak medium granular structure; very friable; many roots; strongly acid; abrupt smooth boundary.

E1—2 to 10 inches; grayish brown (10YR 5/2) loamy sand; few fine distinct light olive brown (2.5Y 5/4) mottles; weak coarse subangular blocky structure; very friable; many roots; strongly acid; gradual smooth boundary.

E2—10 to 16 inches; light brownish gray (2.5Y 6/2) sand; many large distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak very coarse subangular blocky structure; very friable; many roots; strongly acid; abrupt wavy boundary.

2Btg1—16 to 25 inches; grayish brown (2.5Y 5/2) sandy clay loam; many medium distinct yellowish brown (10YR 5/6) and few fine prominent yellowish red (5YR 5/6) mottles; moderate coarse angular blocky structure; firm; many moderately thick dark grayish brown (2.5Y 4/2) clay bridges between sand grains; few thin clay films on faces of peds; few roots; medium acid; abrupt wavy boundary.

3Btg2—25 to 28 inches; grayish brown (2.5Y 5/2) clay; common medium distinct yellowish brown (10YR 5/4) mottles; moderate coarse subangular blocky structure parting to strong fine and very fine subangular blocky; firm; many thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; few roots; slightly acid; clear wavy boundary.

3BCg—28 to 35 inches; grayish brown (2.5Y 5/2) clay; few medium faint light olive brown (2.5Y 5/4) mottles; weak coarse blocky structure parting to moderate fine and very fine subangular blocky; firm; few thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; few roots; mildly alkaline; clear smooth boundary.

3Cg—35 to 60 inches; grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) clay; common medium distinct light yellowish brown (2.5Y 6/4) mottles; weak very coarse subangular blocky structure parting to moderate fine and very fine subangular blocky; friable; strong effervescence; moderately alkaline.

The solum ranges from 24 to 46 inches in thickness. The sandy mantle ranges from 10 to 20 inches in thickness. The loamy subsoil layer is 3 to 18 inches thick. Some pedons do not have free carbonates in the 3C horizon.

The A and E horizons have hue of 10YR or 2.5Y, value of 3 to 6, and chroma of 1 or 2. They are strongly

acid to slightly acid. They are loamy sand, loamy coarse sand, loamy fine sand, fine sand, sand, or coarse sand. The 2Bt horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 2. It typically is sandy clay loam or loam but in some pedons has subhorizons of sandy loam. The C horizon has hue of 2.5Y, value of 5 or 6, and chroma of 1 or 2. The 3C horizon is typically clay or silty clay but in some pedons has subhorizons of silty clay loam or clay loam. It has mottles of high chroma.

Blackhoof Series

The Blackhoof series consists of deep, very poorly drained, very slowly permeable or slowly permeable soils on glacial till plains and moraines. These soils formed in a thin layer of organic material and in the underlying loamy glacial till. Slopes are 0 to 2 percent.

Typical pedon of Blackhoof muck, 600 feet north and 100 feet west of the southeast corner of sec. 14, T. 57 N., R. 23 W.

Oa—0 to 8 inches; black (10YR 2/1), broken face and rubbed, sapric material; about 10 percent herbaceous fiber, a trace rubbed; weak fine granular structure; very friable; about 25 percent mineral material; common roots; medium acid; abrupt wavy boundary.

A—8 to 11 inches; black (N 2/0) loam; massive; firm; about 5 percent coarse fragments; medium acid; abrupt irregular boundary.

Bg1—11 to 15 inches; dark gray (2.5Y 4/1) and dark grayish brown (2.5Y 4/2) loam; weak and moderate medium and thick platy structure; friable; about 5 percent coarse fragments; medium acid; clear smooth boundary.

Bg2—15 to 30 inches; gray (5Y 5/1) loam; many fine prominent yellowish brown (10YR 5/8) mottles; moderate medium platy structure parting to weak very fine angular blocky; friable; about 2 percent coarse fragments; few thin dark gray (5Y 4/1) clay films on faces of peds and in pores; slightly acid; clear smooth boundary.

Bg3—30 to 43 inches; olive gray (5Y 5/2) loam; many medium distinct yellowish brown (10YR 5/6) and light olive brown (2.5Y 5/6) mottles; moderate medium platy structure parting to weak very fine angular blocky; friable; about 5 percent coarse fragments; neutral; clear smooth boundary.

C—43 to 63 inches; grayish brown (2.5Y 5/2) loam; common medium distinct yellowish brown (10YR 5/6) and few medium distinct gray (5Y 5/1) mottles; weak thin platy structure; friable; about 3 percent coarse fragments; few light gray (2.5Y 7/2) carbonate threads; slight effervescence; mildly alkaline.

The histic epipedon ranges from 8 to 16 inches in thickness. The solum, including the histic epipedon, ranges from 30 to 60 inches in thickness. The depth to free carbonates ranges from 40 to more than 60 inches. The content of coarse fragments in the A, B, and C horizons is 1 to 8 percent. The organic surface layer is sapric or hemic material, or both.

The A horizon has hue of 10YR to 5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2 or 3. It is silt loam, silty clay loam, loam, or clay loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 3. The B and C horizons are loam or clay loam.

Bowstring Series

The Bowstring series consists of deep, very poorly drained, moderately rapidly permeable to moderately slowly permeable soils on narrow flood plains. These soils formed in highly decomposed organic material that has thin strata of sandy or loamy alluvium. Slopes are 0 to 1 percent.

Typical pedon of Bowstring muck, in an area of the Seelyeville-Bowstring association, 2,500 feet south and 2,300 feet west of the northeast corner of sec. 26, T. 59 N., R. 27 W.

Oa1—0 to 11 inches; dark reddish brown (5YR 2/2), broken face and rubbed, sapric material, dark brown (7.5YR 3/2) pressed; about 30 percent fiber, 10 percent rubbed; weak medium subangular blocky structure; friable; many roots; herbaceous fiber; about 5 percent mineral material; very strongly acid; clear smooth boundary.

Oa2—11 to 17 inches; very dark grayish brown (10YR 3/2), broken face, rubbed, and pressed, sapric material; about 7 percent fiber, 2 percent rubbed; massive; very friable; common roots; primarily herbaceous fiber; about 40 percent mineral material; strongly acid; abrupt smooth boundary.

Oa3—17 to 28 inches; dark reddish brown (5YR 2/2), broken face and rubbed, sapric material, dark brown (7.5YR 3/2) pressed; about 30 percent fiber, 10 percent rubbed; weak medium subangular blocky structure; friable; few roots; primarily herbaceous fiber; about 5 percent woody coarse fragments; about 5 percent mineral material; strongly acid; gradual wavy boundary.

Oa4—28 to 38 inches; very dark gray (10YR 3/1), broken face, sapric material, very dark grayish brown (10YR 3/2) rubbed and dark grayish brown (10YR 4/2) pressed; about 7 percent fiber, 2 percent rubbed; massive; very friable; primarily herbaceous fiber; about 65 percent mineral material; strongly acid; gradual smooth boundary.

C—38 to 43 inches; gray (5Y 5/1) mucky sand; massive; very friable; strongly acid; clear smooth boundary.

Oa5—43 to 50 inches; very dark gray (10YR 3/1), broken face and rubbed, sapric material, very dark grayish brown (10YR 3/2) pressed; about 10 percent fiber, 2 percent rubbed; massive; very friable; primarily herbaceous fiber; about 5 percent woody coarse fragments; about 50 percent mineral material; strongly acid; clear smooth boundary.
Cg1—50 to 52 inches; gray (5Y 5/1) mucky sand; massive; very friable; about 10 percent woody coarse fragments; strongly acid; clear smooth boundary.
Oa6—52 to 56 inches; very dark gray (10YR 3/1), broken face and rubbed, sapric material, very dark grayish brown (10YR 3/2) pressed; about 10 percent fiber, 2 percent rubbed; massive; very friable; primarily woody organic material; about 20 percent woody coarse fragments; about 55 percent mineral material; strongly acid; clear smooth boundary.
Cg2—56 to 60 inches; gray (5Y 5/1) mucky sand; massive; friable; strongly acid.

The organic material is dominantly herbaceous fiber, but woody fiber makes up nearly 50 percent in some pedons. The fiber is typically sapric, but some pedons have hemic layers that total as much as 10 inches thick in the control section. The sapric material has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has value of 2 and chroma of 0.

The C horizon generally consists of one or more sandy or loamy layers, each 2 to 12 inches thick, alternating with the organic layers. In some pedons, however, it consists of two or more thin, contiguous layers in the control section. It has hue of 10YR to 5Y, value of 3 to 6, and chroma of 1 or 2. The depth to the C horizon commonly is 24 to 40 inches but ranges from 2 to 48 inches.

Brickton Series

The Brickton series consists of deep, poorly drained, moderately slowly permeable or slowly permeable soils on glacial lake plains. These soils formed in clayey and silty lacustrine sediments. Slopes are 0 to 2 percent.

Typical pedon of Brickton silt loam, in an area of Indus and Brickton soils, 2,450 feet south and 900 feet west of the northeast corner of sec. 20, T. 56 N., R. 26 W.

A—0 to 4 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate medium and fine crumb structure; friable; neutral; clear wavy boundary.
E—4 to 10 inches; light brownish gray (2.5Y 6/2) silt loam; few fine faint light olive brown (2.5Y 5/4) and light yellowish brown (2.5Y 6/4) mottles; weak and moderate medium and thin platy structure; friable in the upper part and firm in the lower part; neutral; clear smooth boundary.
Btg—10 to 19 inches; grayish brown (2.5Y 5/2) silty clay; few fine distinct light olive brown (2.5Y 5/6) mottles; continuous thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; moderate medium to very fine angular blocky structure; firm; slightly acid; clear smooth boundary.
BC—19 to 25 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine faint light olive brown (2.5Y 5/4) mottles; weak fine and very fine angular blocky structure; firm; mildly alkaline; abrupt wavy boundary.
Cg1—25 to 41 inches; light brownish gray (2.5Y 6/2) silty clay loam; common large distinct yellowish brown (10YR 5/6 and 5/4) mottles; weak fine and medium prismatic structure parting to moderate fine and medium angular blocky; friable; strong effervescence; mildly alkaline; abrupt smooth boundary.
Cg2—41 to 60 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) clay; common fine distinct light yellowish brown (2.5Y 6/4) mottles; massive; firm; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 35 inches. The A horizon has value of 2 or 3. It is silt loam or silty clay loam. The E horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. The Btg and BC horizons have value of 4 or 5 and have a dominant chroma of 1 or 2. They are mottled in some parts or throughout. They are silty clay loam, silty clay, or clay. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 2 or 3. It has textures similar to those of the Btg horizon. In some pedons, however, it has thin strata that contain less clay.

Cathro Series

The Cathro series consists of deep, very poorly drained soils that formed in highly decomposed organic material over loamy mineral material. These soils are on glacial lake plains and ground moraines. The organic material is moderately rapidly permeable to moderately slowly permeable, and the mineral material is moderately permeable or moderately slowly permeable. Slopes are 0 to 2 percent.

Typical pedon of Cathro muck, 1,400 feet west and 300 feet south of the northeast corner of sec. 15, T. 56 N., R. 25 W.

Oa1—0 to 5 inches; black (10YR 2/1), broken face, rubbed, and pressed, sapric material; about 20 percent fiber, 5 percent rubbed; weak medium granular structure; primarily herbaceous fiber; slightly acid; clear smooth boundary.
Oe—5 to 14 inches; very dark brown (7.5YR 2/2), broken face, hemic material, dark brown (7.5YR 3/2) rubbed and pressed; about 65 percent fiber, 25 percent rubbed; weak medium and coarse granular

structure; primarily herbaceous fiber; 15 to 20 percent woody fragments; slightly acid; clear smooth boundary.

Oa2—14 to 39 inches; black (7.5YR 2/1), broken face, rubbed, and pressed, sapric material; about 25 percent fiber, 5 percent rubbed; weak medium granular structure; primarily herbaceous fiber; about 2 percent woody fragments; slightly acid; abrupt smooth boundary.

Cg—39 to 60 inches; dark gray (5Y 4/1) loam; massive; neutral.

The depth to the C horizon ranges from 16 to 50 inches. The organic part of the control section is dominantly sapric herbaceous material. It has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. In some pedons it has layers that are dominantly woody fibers. It ranges from strongly acid to mildly alkaline.

The C horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. It is sandy loam, loam, silt loam, clay loam, or silty clay loam.

Cowhorn Series

The Cowhorn series consists of deep, somewhat poorly drained, moderately rapidly permeable soils on glacial lake plains, deltas, and river terraces. These soils formed in sandy glaciolacustrine sediments. Slopes range from 0 to 3 percent.

Typical pedon of Cowhorn loamy very fine sand, 1,680 feet east and 70 feet south of the northwest corner of sec. 20, T. 53 N., R. 24 W.

Ap—0 to 8 inches; grayish brown (10YR 5/2) loamy very fine sand, light gray (10YR 6/1) dry; weak fine and very fine granular and weak fine subangular blocky structure; very friable; abundant roots; few black (10YR 2/1) and very dark gray (10YR 3/1) worm casts; strongly acid; abrupt wavy boundary.

Bw1—8 to 9 inches; light yellowish brown (10YR 6/4), yellowish brown (10YR 5/4), and light brownish gray (10YR 6/2) loamy very fine sand; weak medium and fine subangular blocky structure; very friable; abundant roots; strongly acid; abrupt wavy boundary.

Bw2—9 to 15 inches; pale brown (10YR 6/3) and brown (10YR 5/3) loamy very fine sand; few fine distinct yellowish brown (10YR 5/8) mottles; weak medium and coarse subangular blocky structure; very friable; abundant roots; medium acid; clear wavy boundary.

Bw3—15 to 36 inches; light gray (2.5Y 7/2) and light brownish gray (2.5Y 6/3) loamy very fine sand; common fine distinct yellowish brown (10YR 5/6 and 5/4) and few medium faint brown (10YR 5/3) mottles; weak medium and coarse subangular blocky structure; very friable; few roots; few fine black (5YR 2/1) soft nodules; strongly acid; gradual smooth boundary.

Bw4—36 to 51 inches; light brownish gray (2.5Y 6/2) and light olive gray (5Y 6/2) loamy very fine sand; common large distinct brownish yellow (10YR 6/8) and common medium prominent strong brown (7.5YR 5/8) mottles; weak medium and coarse subangular blocky structure; very friable; few roots; few fine black (5YR 2/1) soft nodules; few narrow pipestem formations; medium acid; gradual smooth boundary.

C—51 to 62 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) very fine sand; few coarse prominent yellowish brown (10YR 5/6) and few medium prominent strong brown (7.5YR 5/8) mottles; massive; very friable; moderately alkaline.

The thickness of the solum ranges from 35 to 68 inches. The depth to free carbonates ranges from 40 to more than 70 inches.

The Ap horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 or 2. Pedons in uncultivated areas have A and E horizons. The A horizon is loamy very fine sand or very fine sandy loam. The upper part of the Bw horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 or 4. The lower part has hue of 2.5Y or 5Y and value of 4 to 7. It has a dominant chroma of 2 but in some pedons has chroma of 3 or 4. The B horizon is mainly loamy very fine sand or very fine sand, but thin layers of very fine sandy loam, silt loam, loamy fine sand, or fine sand are common. The C horizon has hue of 2.5Y or 5Y, value of 5 to 7, and chroma of 1 or 2. It has textures similar to those of the B horizon.

Cromwell Series

The Cromwell series consists of deep, excessively drained soils that are moderately permeable in the upper part and rapidly permeable in the lower part. These soils are on outwash plains. They formed in a mantle of loamy sediments and in the underlying sandy glacial outwash. Slopes range from 1 to 25 percent.

Typical pedon of Cromwell fine sandy loam, 1 to 10 percent slopes, 700 feet south and 25 feet east of the northwest corner of sec. 22, T. 53 N., R. 25 W.

O—1 inch to 0; organic litter, mainly leaves and twigs.

A—0 to 3 inches; very dark gray (10YR 3/1) fine sandy loam; weak very fine granular structure; very friable; abundant roots; slightly acid; abrupt wavy boundary.

E—3 to 5 inches; gray (10YR 5/1) and grayish brown (10YR 5/2) fine sandy loam; weak thin platy structure; very friable; abundant roots; medium acid; abrupt wavy boundary.

Bw1—5 to 16 inches; yellowish brown (10YR 5/4) and brown (10YR 5/3) sandy loam; weak medium and fine subangular blocky structure; very friable; abundant roots; medium acid; clear wavy boundary.

2Bw2—16 to 20 inches; yellowish brown (10YR 5/4) loamy sand; weak medium and fine subangular blocky structure; very friable; about 10 percent coarse fragments; thin colloidal coatings on sand grains; abundant roots; medium acid; abrupt wavy boundary.
2Bw3—20 to 38 inches; yellowish brown (10YR 5/4) and brown (10YR 5/3) coarse sand; single grain; loose; thin colloidal coatings on about half of the sand grains; about 10 percent coarse fragments; few roots; medium acid; clear wavy boundary.
2C—38 to 60 inches; brown (10YR 5/3) and yellowish brown (10YR 5/4) coarse sand; single grain; loose; few roots; medium acid.

The thickness of the solum ranges from 26 to 50 inches. The mantle of coarse-loamy sediments ranges from 10 to 20 inches in thickness. The content of coarse fragments typically is 0 to 15 percent in the solum and the 2C horizon. In some pedons, however, it is as much as 35 percent in the 2C horizon. The texture between depths of 10 and 40 inches is loamy sand or coarse sand.

The A horizon has value of 2 or 3. The E horizon has value of 4 or 5 and chroma of 1 or 2. The A and E horizons are sandy loam or fine sandy loam. The Bw and 2Bw horizons have hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 3 or 4. The Bw horizon is sandy loam or fine sandy loam. The fine-earth fraction of the 2Bw horizon is loamy sand, sand, or coarse sand. The 2C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 or 4. It is sand or coarse sand or the gravelly analogs of these textures.

Cutaway Series

The Cutaway series consists of deep, well drained soils on glacial uplands. These soils formed in a sandy mantle and in the underlying loamy till. Permeability is rapid in the upper part of the profile and moderately slow or slow in the lower part. Slopes range from 0 to 8 percent.

Typical pedon of Cutaway loamy sand, 0 to 8 percent slopes, about 400 feet west and 700 feet south of the northeast corner of sec. 3, T. 57 N., R. 26 W.

E—0 to 4 inches; grayish brown (10YR 5/2) loamy sand, light gray (10YR 7/2) dry; weak medium subangular blocky structure; very friable; many fine roots; medium acid; clear smooth boundary.
Bw1—4 to 8 inches; dark brown (7.5YR 4/4) loamy sand; weak medium subangular blocky structure; very friable; many fine roots; strongly acid; clear smooth boundary.
Bw2—8 to 14 inches; yellowish brown (10YR 5/4) sand; single grain; loose; many fine roots; strongly acid; clear smooth boundary.
Bw3—14 to 31 inches; pale brown (10YR 6/3) and brown (10YR 5/3) coarse sand; single grain; loose; common roots; strongly acid; abrupt wavy boundary.
E'—31 to 35 inches; light brownish gray (10YR 6/2) loamy coarse sand; weak medium and thick platy structure; firm; common roots; about 1 percent coarse fragments; common vesicular pores; strongly acid; clear wavy boundary.
2B/E—35 to 39 inches; brown (10YR 4/3) clay loam (Bt) with tongues, interfingers, and ped coatings of light brownish gray (10YR 6/2) loamy sand (E); moderate medium and coarse subangular blocky structure; firm; common thin dark brown (10YR 3/3 and 4/3) clay films on faces of peds; few roots; about 5 percent coarse fragments; medium acid; clear smooth boundary.
2Bt—39 to 51 inches; light olive brown (2.5Y 5/4) clay loam; moderate medium and coarse subangular blocky structure; firm; continuous moderately thick dark brown (10YR 3/3 and 4/3) clay films on faces of peds; few roots; about 5 percent coarse fragments; slightly acid; clear wavy boundary.
2BC—51 to 56 inches; light olive brown (2.5Y 5/4) loam; weak coarse prismatic structure parting to weak and moderate medium and coarse subangular blocky; firm; many thin dark brown (10YR 3/3 and 4/3) clay films on faces of peds; few fine soft yellowish red (5YR 4/6) nodules; about 5 percent coarse fragments; neutral; clear wavy boundary.
2C—56 to 60 inches; light olive brown (2.5Y 5/3) loam; massive; friable; few fine soft yellowish red (5YR 4/6) nodules; about 5 percent coarse fragments; slight effervescence; moderately alkaline.

The solum is 36 to 60 inches thick. The sandy mantle is 20 to 40 inches thick. Some pedons do not have free carbonates in the 2C horizon.

The E horizon has hue of 7.5YR or 10YR. It has value of 5 to 7 and chroma of 1 to 3 or has value of 4 and chroma of 1 or 2. The Bw horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 5. The E' horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 or 3. The 2Bt horizon has hue of 7.5YR to 2.5Y, value of 4 or 5, and chroma of 3 or 4. The 2C horizon has hue of 7.5YR to 2.5Y, value of 4 to 7, and chroma of 2 to 4. The 2Bt, 2BC, and 2C horizons generally are loam, clay loam, sandy loam, fine sandy loam, or silt loam. In some pedons, however, the 2C horizon is sandy clay loam.

Dalbo Series

The Dalbo series consists of deep, moderately well drained, moderately slowly permeable or slowly permeable soils on glacial lake plains. These soils formed in calcareous, clayey and silty lacustrine sediments. Slopes range from 0 to 6 percent.

Typical pedon of Dalbo silt loam, in an area of Taylor and Dalbo silt loams, 0 to 6 percent slopes, 1,350 feet east and 100 feet south of the northwest corner of sec. 14, T. 150 N., R. 27 W.

O—1 inch to 0; partly decomposed organic litter, mainly leaves, twigs, and grass.
A—0 to 1 inch; very dark gray (10YR 3/1) silt loam; moderate medium and fine granular structure; friable; abundant roots; medium acid; abrupt smooth boundary.
E—1 to 6 inches; gray (10YR 6/1) and light brownish gray (10YR 6/2) silt loam; weak medium and thick platy structure; firm; abundant roots; common very fine vesicular pores; medium acid; abrupt wavy boundary.
B/E—6 to 9 inches; dark brown (10YR 4/3) silty clay loam (Bt); moderate medium blocky structure; firm; interfingers and ped coatings of grayish brown (10YR 5/2) silt loam (E); weak medium platy structure; firm; abundant roots; strongly acid; abrupt wavy boundary.
Bt1—9 to 15 inches; dark yellowish brown (10YR 4/4) clay; strong medium to very fine angular blocky structure; firm; common thin dark brown (10YR 4/3) clay films on faces of peds; abundant roots; strongly acid; clear wavy boundary.
Bt2—15 to 21 inches; dark brown (10YR 4/3) clay; few fine faint dark grayish brown (10YR 4/2) mottles; strong fine and very fine angular blocky structure; firm; many thin dark brown (10YR 3/3) and very dark grayish brown (10YR 3/2) clay films on faces of peds; few fine roots; neutral; clear smooth boundary.
BC—21 to 35 inches; brown (10YR 5/3) silty clay; few fine faint yellowish brown (10YR 5/4) mottles; moderate medium and weak fine and very fine angular blocky structure; firm; common thin dark brown (10YR 4/3), dark grayish brown (10YR 4/2), and very dark grayish brown (10YR 3/2) clay films on faces of peds; few roots; mildly alkaline; gradual smooth boundary.
C—35 to 60 inches; light olive brown (2.5Y 5/3) silty clay loam; common fine faint light brownish gray (2.5Y 6/2) and few fine distinct gray (5Y 6/1) mottles; weak coarse angular blocky structure parting to weak thick platy; firm; few very dark grayish brown (10YR 3/2) clay films on faces of peds in the upper part; slight effervescence; moderately alkaline.

The thickness of solum and the depth to free carbonates range from 20 to 42 inches. The A horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 4 to 6 and chroma of 1 or 2. The A and E horizons typically are silt loam but in some pedons are loam, silty clay loam, very fine sandy loam, or fine sandy loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. Mottles with chroma of 2 or less are in some part of the upper 10 inches of the argillic horizon. This horizon is clay, silty clay, or silty clay loam. Some pedons do not have a BC horizon. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4. It is silty clay loam, silty clay, clay, or silt loam.

Dora Series

The Dora series consists of deep, very poorly drained soils that formed in highly decomposed herbaceous material and in the underlying clayey sediments. These soils are in depressions on lake plains, till plains, and moraines. The organic material is moderately permeable or moderately rapidly permeable, and the clayey sediments are very slowly permeable. Slopes are less than 1 percent.

Typical pedon of Dora mucky peat, 1,300 feet east and 700 feet north of the southwest corner of sec. 11, T. 57 N., R. 27 W.

Oe—0 to 12 inches; black (10YR 2/1), broken face, rubbed, and pressed, hemic material; about 50 percent fiber, 20 percent rubbed; weak medium blocky structure; very friable; primarily herbaceous fiber; medium acid; clear smooth boundary.
Oa1—12 to 26 inches; black (10YR 2/1), broken face, rubbed, and pressed sapric material; about 10 percent fiber, 3 percent rubbed; moderate medium blocky structure parting to moderate fine subangular blocky and granular; very friable; primarily herbaceous fiber; medium acid; clear wavy boundary.
Oa2—26 to 32 inches; black (10YR 2/1), broken face, rubbed, and pressed, sapric material; about 7 percent fiber, 2 percent rubbed; moderate medium and coarse blocky structure; very friable; primarily herbaceous fiber; about 10 percent mineral material; medium acid; clear smooth boundary.
A—32 to 36 inches; black (10YR 2/1) mucky silty clay loam; about 20 percent organic material; massive; firm; slightly acid; clear wavy boundary.
Cg1—36 to 42 inches; gray (5Y 5/1) and dark gray (5Y 4/1) silty clay loam; common medium prominent strong brown (7.5YR 5/6) and few fine distinct yellowish brown (10YR 5/4) mottles; massive; firm; slightly acid; gradual wavy boundary.
Cg2—42 to 52 inches; olive gray (5Y 4/2) silty clay; common medium strong brown (7.5YR 5/6) and yellowish red (5YR 4/6) mottles; massive; firm; slightly acid; gradual wavy boundary.
Cg3—52 to 60 inches; gray (5Y 5/1) silty clay; few fine and medium prominent yellowish red (5YR 4/6) mottles; massive; firm; slightly effervescence; mildly alkaline.

The thickness of the organic material ranges from 16 to 50 inches. Fibers are dominantly herbaceous, but in some pedons nearly half are of woody origin. The content of woody coarse fragments ranges from 0 to 15 percent. The upper 12 inches is sapric or hemic material, or both. Some pedons have a thin fibric (sphagnum) surface layer. The organic material below a depth of 12 inches is sapric material that includes less than 10 inches of hemic material in some pedons.

The sapric and hemic material has hue of 10YR to 5YR, value of 2 or 3, and chroma of 0 to 2. A few pedons have a thin limnic layer directly above the mineral material. Some do not have an A horizon. The C horizon has hue of 5YR to 5Y, value of 4 to 6, and chroma of 1 to 6. It is silty clay, clay, silty clay loam, clay loam, or sandy clay.

Effie Series

The Effie series consists of deep, poorly drained, slowly permeable soils on glacial moraines and till plains. These soils formed in loamy glacial till. Slopes are 0 to 2 percent.

Typical pedon of Effie loam, 800 feet south and 1,950 feet west of the northeast corner of sec. 24, T. 62 N., R. 27 W.

Oi—2 inches to 0; black (N 2/0) decomposed organic material, principally leaf litter; many roots; clear smooth boundary.

E—0 to 5 inches; light brownish gray (2.5Y 6/2) and gray (2.5Y 5/1) loam, light gray (2.5Y 7/1 and 7/2) dry; common medium distinct light olive brown (2.5Y 5/4 and 5/6) mottles; moderate medium platy structure; friable; many roots; few pores; few very dark gray (2.5Y 3/1) coatings in old root channels; slightly acid; clear smooth boundary.

B/E—5 to 8 inches; grayish brown (2.5Y 5/2) clay loam (Bt), light brownish gray (2.5Y 6/2) dry; moderate medium angular blocky structure; firm; interfingers and ped coatings of light brownish gray (2.5Y 6/2) and gray (2.5Y 6/1) loam (E), light gray (2.5Y 7/2 and 7/1) dry; massive; friable; many roots; few pores; common fine distinct yellowish brown (10YR 5/4) mottles; strongly acid; clear smooth boundary.

Btg1—8 to 15 inches; grayish brown (2.5Y 5/2) clay loam; common fine distinct yellowish brown (10YR 5/4 and 5/6) and light olive brown (2.5Y 5/4 and 5/6) mottles; moderate medium angular blocky structure; firm; common roots; few pores; continuous thin dark grayish brown (2.5Y 4/2) clay films on faces of peds and continuous thin very dark grayish brown (10YR 3/2) clay films in pores and root channels; strongly acid; clear smooth boundary.

Btg2—15 to 19 inches; grayish brown (2.5Y 5/2) and dark grayish brown (2.5Y 4/2) clay loam; few fine distinct light olive brown (2.5Y 5/4 and 5/6) mottles; weak medium and moderate fine angular blocky structure; firm; few roots; few pores; common thin dark grayish brown (2.5Y 4/2) clay films on faces of peds and continuous thin very dark grayish brown (10YR 3/2) clay films in pores and old root channels; slight effervescence; mildly alkaline; clear smooth boundary.

Cg1—19 to 32 inches; light brownish gray (2.5Y 6/2) and grayish brown (2.5Y 5/2) silty clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; weak fine and medium angular blocky structure; firm; few roots; thin very dark grayish brown (10YR 3/2) clay films in old root channels; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—32 to 60 inches; light brownish gray (2.5Y 6/2) clay loam; common medium distinct light olive brown (2.5Y 5/4) and few fine prominent yellowish red (5YR 5/6) mottles; weak fine prismatic structure parting to weak and moderate fine and medium angular blocky; firm; few roots; few dark reddish brown (5YR 2/2) organic coatings on faces of peds; lime disseminated throughout and a few concentrations of white rounded medium-sized soft masses; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 14 to 26 inches. The depth to free carbonates ranges from 13 to 32 inches. The content of coarse fragments is 0 to 5 percent.

Some pedons have an A horizon. The E horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. The A and E horizons are loam, fine sandy loam, sandy loam, or silt loam. The Bt horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam, clay, silty clay loam, or silty clay. The C horizon has hue of 2.5Y or 5Y, value of 4 to 7, and chroma of 1 or 2. It has textures similar to those of the B horizon.

Emmert Series

The Emmert series consists of deep, excessively drained, very rapidly permeable soils on eskers and outwash plains. These soils formed in sandy and gravelly glacial outwash. Slopes range from 12 to 50 percent.

Typical pedon of Emmert gravelly loamy coarse sand, in an area of Mahtomedi and Emmert soils, 12 to 50 percent slopes, 1,700 feet east and 300 feet south of the northwest corner of sec. 10, T. 62 N., R. 24 W.

Oe—1 inch to 0; very dark brown (10YR 2/2) decomposed leaves, fine roots, and twigs.

A—0 to 1 inch; very dark brown (10YR 2/2) gravelly loamy coarse sand; weak fine granular structure; very friable; about 25 percent coarse fragments; abundant fine to coarse roots; strongly acid; abrupt smooth boundary.

E—1 to 3 inches; grayish brown (10YR 5/2) gravelly loamy coarse sand; weak thin platy structure; very friable; about 25 percent coarse fragments; abundant fine to coarse roots; strongly acid; clear smooth boundary.
Bw—3 to 9 inches; dark yellowish brown (10YR 4/4) gravelly loamy coarse sand; weak medium subangular blocky structure; very friable; about 25 percent coarse fragments; abundant fine to coarse roots; strongly acid; clear smooth boundary.
BC—9 to 17 inches; yellowish brown (10YR 5/4) very gravelly coarse sand; single grain; loose; about 50 percent coarse fragments; few fine to coarse roots; strongly acid; gradual wavy boundary.
C—17 to 60 inches; brown (10YR 5/3) very gravelly coarse sand; single grain; loose; about 50 percent coarse fragments; medium acid.

The thickness of the solum ranges from 12 to 30 inches. Between depths of 10 and 40 inches, the content of coarse fragments is 35 to 90 percent. The coarse fragments are mainly pebbles and cobblestones.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Some pedons do not have an A horizon. The E horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 1 or 2. The A and E horizons are sandy loam, coarse sandy loam, loamy sand, or loamy coarse sand or the gravelly or very gravelly analogs of these textures. The B horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 2 to 4. It is loamy coarse sand, loamy sand, coarse sand, or sand or the gravelly or very gravelly analogs of these textures. The C horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is very gravelly sand or very gravelly coarse sand.

Goodland Series

The Goodland series consists of deep, well drained soils that are moderately permeable in the upper part and rapidly permeable in the lower part. These soils are on glacial moraines and till plains. They formed in moderately thick layers of silty and loamy sediments and in the underlying sandy material (fig. 11). Slopes range from 1 to 25 percent.

Typical pedon of Goodland silt loam, 1 to 10 percent slopes, about 5 miles south and 4 miles west of Grand Rapids, 3,100 feet east and 200 feet south of the northwest corner of sec. 14, T. 54 N., R. 26 W.

O—2 inches to 0; organic litter, mainly leaves and twigs.
E—0 to 3 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; weak thin platy structure parting to weak fine and very fine subangular blocky; very friable; abundant roots; common fine and very fine vesicular pores; about 1 percent small pebbles; medium acid; clear wavy boundary.
Bw—3 to 8 inches; yellowish brown (10YR 5/4) silt loam, very pale brown (10YR 7/3 and 7/4) dry; weak fine and very fine subangular blocky structure; very friable; many roots; common fine and very fine

Figure 11.—Profile of Goodland silt loam, which formed in silty and loamy sediments and in the underlying sandy material.

vesicular pores; about 1 percent small pebbles; medium acid; clear wavy boundary.
E'—8 to 12 inches; pale brown (10YR 6/3) silt loam; massive; very friable; many roots; many fine and very fine vesicular pores; about 1 percent small pebbles; medium acid; clear smooth boundary.
2E/B—12 to 18 inches; pale brown (10YR 6/3) and light brownish gray (10YR 6/2) loam (E) tonguing into yellowish brown (10YR 5/4) sandy loam (B); weak thin platy and weak fine angular blocky structure; friable; about 5 percent coarse fragments; many roots; many fine and very fine vesicular pores; medium acid; clear wavy boundary.
2Bt—18 to 28 inches; yellowish brown (10YR 5/4) fine sandy loam; weak medium subangular blocky structure; firm; many thin brown (7.5YR 4/3) clay films on faces of peds; about 8 percent coarse fragments; many roots; medium acid; clear wavy boundary.
3BC—28 to 34 inches; brown (7.5YR 4/3 and 4/4) gravelly loamy coarse sand; weak medium and fine subangular blocky structure; friable; moderately thick clay bridges between sand grains; few thin clay films on faces of peds; about 20 percent coarse fragments; common roots; medium acid; abrupt wavy boundary.
3C—34 to 60 inches; yellowish brown (10YR 5/4) and brown (10YR 5/3) gravelly sand; single grain; loose; few roots; about 18 percent coarse fragments; neutral.

The thickness of solum ranges from 23 to 50 inches. The depth to the 3BC horizon ranges from 20 to 40 inches. The depth to free carbonates is more than 60 inches.

Some pedons have an A horizon. The E horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. The Bw horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 6. The A, E, and Bw horizons are silt loam, very fine sandy loam, or loam. The E' or 2E' horizon has hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 2 or 3. Pedons have an E/B horizon or a B/E horizon, or both. These horizons formed in loamy or silty material.

The 2Bt horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is fine sandy loam, sandy loam, or loam. It grades gradually or abruptly to a 3BC horizon, which is coarser textured and commonly has a higher content of coarse fragments. The 3C horizon has hue of 7.5YR or 10YR, value of 4 to 7, and chroma of 2 to 6. It is gravelly sand or gravelly coarse sand.

Graycalm Series

The Graycalm series consists of deep, somewhat excessively drained, rapidly permeable soils on outwash plains and glacial moraines. These soils formed in sandy glacial outwash. Slopes range from 0 to 10 percent.

Typical pedon of Graycalm loamy sand, in an area of Menahga and Graycalm soils, 0 to 8 percent slopes, 900 feet south and 860 feet east of the northwest corner of sec. 9, T. 147 N., R. 27 W.

Oi—2 inches to 0; organic litter, mainly leaves and twigs.
A—0 to 1 inch; discontinuous black (10YR 2/1) loamy sand; weak very fine granular structure; very friable; common fine and many medium and coarse roots; strongly acid; abrupt smooth boundary.
E—1 to 3 inches; light brownish gray (10YR 6/2) loamy sand; weak coarse subangular blocky structure parting to weak very fine granular; very friable; common fine and many medium and coarse roots; strongly acid; abrupt wavy boundary.
Bw1—3 to 7 inches; yellowish brown (10YR 5/4) loamy sand; weak very fine granular structure; very friable; common fine and many medium and coarse roots; strongly acid; clear wavy boundary
Bw2—7 to 17 inches; yellowish brown (10YR 5/4) sand; single grain; loose; few fine and common medium and coarse roots; medium acid; gradual wavy boundary.
E'1—17 to 26 inches; light brownish gray (10YR 6/2) loamy sand; single grain; loose; few fine and common medium roots; medium acid; clear wavy boundary.
E'2—26 to 33 inches; light brownish gray (10YR 6/2) loamy sand; single grain; loose; few fine and common medium and coarse roots; slightly acid; abrupt wavy boundary.
E&Bt—33 to 58 inches; brown (10YR 5/3 and 4/3) and light brownish gray (10YR 6/2) sand (E'2); single grain; loose; lamellae of dark brown (7.5YR 4/4 and 4/3), yellowish brown (10YR 5/4), and brown (10YR 5/3) very fine sandy loam and sandy loam (Bt) 0.25 inch to 2 inches thick, with a total thickness of about 5.5 inches; massive; firm; few fine and common medium and coarse roots; many continuous thin and moderately thick clay films bridging sand grains in the bands; slightly acid; clear wavy boundary.
C—58 to 72 inches; pale brown (10YR 6/3) sand; single grain; loose; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 40 to more than 60 inches. The A horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 6 or 7 and chroma of 1 to 3. The A and E horizons are sand, loamy sand, or loamy coarse sand. The Bw horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4. It is sand or loamy sand. The E' horizon has value of 6 and chroma of 2 to 4. The Bt lamellae are loamy coarse sand to very fine sandy loam. They are 1/16 inch to 2 inches thick. Their cumulative thickness is less than 6 inches within a depth of 60 inches. The C horizon has value of 5 to 7 and chroma of 3. It is sand or coarse sand. In some pedons it does not have free carbonates.

Greenwood Series

The Greenwood series consists of deep, very poorly drained, moderately rapidly permeable, organic soils in depressional areas on glacial moraines. These soils formed in herbaceous material more than 51 inches thick. Slopes are 0 to 1 percent.

Typical pedon of Greenwood peat, 1,000 feet south and 2,000 feet east of the northwest corner of sec. 32, T. 56 N., R. 25 W.

Oi—0 to 15 inches; light brownish gray (10YR 6/2), broken face, fibric material, very pale brown (10YR 7/3) rubbed and pressed; about 95 percent fiber, 80 percent rubbed; massive; primarily live roots and sphagnum moss; extremely acid; clear smooth boundary.

Oe1—15 to 48 inches; dark reddish brown (5YR 3/2), broken face, rubbed, and pressed, hemic material; about 70 percent fiber, 30 percent rubbed; massive; primarily herbaceous fiber; extremely acid; clear smooth boundary.

Oe2—48 to 72 inches; dark brown (7.5YR 3/2), broken face, rubbed, and pressed, hemic material; about 60 percent fiber, 30 percent rubbed; massive; primarily herbaceous fiber; extremely acid.

The surface tier typically is fibric material derived from sphagnum moss. Some pedons, however, have stratified sapric, hemic, and fibric material derived from both herbaceous plants and sphagnum moss.

The hemic material has hue of 5YR or 7.5YR and value and chroma of 2 to 4. In some pedons the lower two tiers have layers of fibric or sapric material that total less than 10 inches thick. Most pedons have some woody coarse fragments in thin layers or dispersed throughout. Woody fibers make up less than 50 percent of the organic volume after rubbing.

Indus Series

The Indus series consists of deep, poorly drained, slowly permeable soils on glacial lake plains. These soils formed in clayey lacustrine sediments. Slopes are 0 to 2 percent.

Typical pedon of Indus clay, in an area of Indus and Brickton soils, 310 feet north and 550 feet west of the southeast corner of sec. 31, T. 62 N., R. 25 W.

Oe—2 inches to 0; organic litter, mainly leaves and twigs.

A—0 to 3 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; strong very fine and fine subangular blocky structure; friable, slightly hard; strongly acid; abrupt wavy boundary.

Eg—3 to 6 inches; gray (5Y 6/1) loam, light gray (5Y 7/1) dry; many fine prominent olive (5Y 4/3) and black (5Y 2/1) mottles; moderate medium platy structure; firm, hard; strongly acid; abrupt wavy boundary.

B/E—6 to 7 inches; dark gray (5Y 4/1) clay (B), gray (5Y 6/1) dry; moderate medium and coarse angular blocky structure; firm, hard; interfingers of gray (5Y 6/1) loam (E), light gray (5Y 7/1) dry; massive; firm, hard; few fine prominent yellowish brown (10YR 5/6) mottles; strongly acid; clear wavy boundary.

Btg1—7 to 9 inches; dark gray (5Y 4/1) clay; few fine prominent yellowish brown (10YR 5/8) mottles; strong fine and moderate medium angular blocky structure; firm; many thin dark gray (5Y 4/1) and very dark gray (5Y 3/1) clay films on faces of peds; thin interfingers of gray (5Y 6/1) E material on faces of peds in the upper part; strongly acid; clear smooth boundary.

Btg2—9 to 18 inches; dark gray (5Y 4/1) and olive gray (5Y 4/2) clay; few fine prominent strong brown (7.5YR 5/8) and few fine distinct light olive brown (2.5Y 5/4) mottles; weak coarse prismatic structure parting to strong fine and very fine angular blocky; firm; many thin and moderately thick very dark gray (5Y 3/1) clay films on faces of peds; medium acid; clear wavy boundary.

BCg—18 to 29 inches; dark gray (5Y 4/1) clay; few fine prominent strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky and weak very coarse prismatic structure; common thin very dark gray (5Y 3/1) and dark gray (5Y 4/1) clay films on faces of peds; neutral; clear smooth boundary.

Cg1—29 to 54 inches; olive gray (5Y 5/2) clay; common medium prominent light yellowish brown (10YR 6/4) mottles; massive; friable; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—54 to 62 inches; gray (5Y 5/1) clay; few medium prominent yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 32 inches. The depth to free carbonates ranges from 20 to 30 inches.

The A horizon has value of 2 or 3. The E horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 1 or 2. The A and E horizons are loam, silt loam, clay loam, silty clay loam, silty clay, or clay. The Btg and BCg horizons have hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 3. It typically is clay or silty clay but in some pedons has strata of silt loam or silty clay loam. It is mildly alkaline or moderately alkaline.

Itasca Series

The Itasca series consists of deep, well drained, moderately permeable soils on glacial moraines and till plains. These soils formed in a moderately thin silty

mantle and in the underlying loamy glacial till. Slopes range from 1 to 25 percent.

Typical pedon of Itasca silt loam, 1 to 10 percent slopes, about 3 miles south and 4 miles west of Grand Rapids; 1,320 feet west and 1,055 feet north of the southeast corner of sec. 2, T. 54 N., R. 26 W.

Oi—1.5 inches to 0; organic litter, mainly leaves and twigs.

E—0 to 3 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/1) dry; weak very fine crumb and weak very thin platy structure; very friable; many roots; medium acid; clear wavy boundary.

Bw—3 to 9 inches; yellowish brown (10YR 5/4) silt loam, very pale brown (10YR 7/4) dry; weak thin platy structure parting to weak very fine subangular blocky; very friable; many roots; medium acid; clear wavy boundary.

E'—9 to 19 inches; pale brown (10YR 6/3) silt loam; weak medium and fine subangular blocky structure; very friable; many roots; common vesicular pores; medium acid; clear smooth boundary.

2E/B—19 to 24 inches; about 80 percent grayish brown (10YR 5/2) fine sandy loam (E') and 20 percent dark brown (10YR 4/3) and dark yellowish brown (10YR 4/4) fine sandy loam (Bt); weak medium and fine angular blocky structure; very friable; many roots; common vesicular pores; about 3 percent coarse fragments; medium acid; clear wavy boundary.

2B/E—24 to 35 inches; about 70 percent dark brown (10YR 4/3) fine sandy loam (Bt) and 30 percent tongues and interfingers of grayish brown (10YR 5/2) fine sandy loam (E'); weak medium and coarse angular blocky structure; firm; thin patchy dark brown (10YR 3/3 and 4/3) clay films on faces of peds; about 5 percent coarse fragments; common roots; medium acid; gradual wavy boundary.

2Bt1—35 to 43 inches; yellowish brown (10YR 5/4) fine sandy loam; moderate coarse and medium angular blocky structure parting to weak thin platy; firm; many moderately thick dark brown (10YR 3/3) clay films on faces of blocky peds; few dark reddish brown (5YR 3/2) coatings; about 5 percent coarse fragments; common roots; neutral; clear wavy boundary.

2Bt2—43 to 55 inches; brown (10YR 5/3) fine sandy loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak very coarse angular blocky structure parting to weak thin platy; firm; common thin dark brown (10YR 4/3) clay films on faces of peds; few dark reddish brown (5YR 3/2) coatings; about 5 percent coarse fragments; common roots; neutral; gradual smooth boundary.

2C—55 to 68 inches; light olive brown (2.5Y 5/4) fine sandy loam; few fine prominent yellowish red (5YR 5/8) mottles; weak thin and medium platy structure; friable; few fine yellowish red (5YR 5/8) soft nodules; about 5 percent coarse fragments; few roots; few light gray (10YR 7/2) lime threads; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 42 to 65 inches. The depth to free carbonates ranges from 48 to more than 72 inches. The thickness of the silty mantle ranges from 10 to 32 inches. In some pedons a thin lag line of gravelly material is between the silty mantle and the till. The content of coarse fragments in the till is 2 to 10 percent.

The E horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 or 3. The Bw horizon has hue of 7.5YR or 10YR, value of 3 to 6, and chroma of 3 or 4. The A, E, and Bw horizons are silt loam, very fine sandy loam, or fine sandy loam that has a high content of silt. The E' horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 or 3. Pedons have a 2E/B horizon or a 2B/E horizon, or both. The 2Bt horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is fine sandy loam, sandy loam, or loam. The 2C horizon has hue of 7.5YR, 2.5Y, or 10YR, value of 4 or 5, and chroma of 3 or 4. It has textures similar to those of the 2Bt horizon.

Keewatin Series

The Keewatin series consists of deep, somewhat poorly drained, slowly permeable soils on glacial till plains and moraines. These soils formed in firm, loamy till. Slopes are 0 to 2 percent.

Typical pedon of Keewatin silt loam, 1,490 feet east and 170 feet south of the northwest corner of sec. 32, T. 60 N., R. 22 W.

Oe—1 inch to 0; organic litter, mainly decomposed leaves and twigs.

A—0 to 1 inch; very dark gray (10YR 3/1) and black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; many roots; strongly acid; abrupt smooth boundary.

E1—1 to 6 inches; light brownish gray (2.5Y 6/2) and grayish brown (2.5Y 5/2) fine sandy loam, light gray (2.5Y 7/2) dry; few fine distinct dark yellowish brown (10YR 3/4) mottles; weak medium platy structure; very friable; many roots; about 1 percent coarse fragments; strongly acid; clear smooth boundary.

E2—6 to 11 inches; light brownish gray (2.5Y 6/2) and grayish brown (2.5Y 5/2) fine sandy loam; few medium faint light yellowish brown (2.5Y 6/4) and few fine distinct yellowish brown (10YR 5/4) mottles; weak medium and thin platy structure; very friable; many roots; strongly acid; abrupt smooth boundary.

E3—11 to 16 inches; light brownish gray (2.5Y 6/2) sandy loam; few medium faint light yellowish brown (10YR 6/4) and common medium distinct yellowish

brown (10YR 5/6) mottles; massive; firm; few roots; many very fine and fine vesicular pores; strongly acid; clear wavy boundary.

B/E—16 to 26 inches; grayish brown (2.5Y 5/2), brown (10YR 5/3), and yellowish brown (10YR 5/4) loam (Bt); few fine prominent yellowish red (5YR 5/8) mottles; weak medium angular and subangular blocky structure; firm; few thin grayish brown (2.5Y 5/2) clay films on faces of peds; tongues and interfingers of light brownish gray (2.5Y 6/2) sandy loam (E); massive; brittle; few roots; common fine and very fine vesicular pores; about 2 percent coarse fragments; strongly acid; clear wavy boundary.

Bt1—26 to 47 inches; brown (10YR 5/3) and grayish brown (10YR 5/2) loam; few medium faint yellowish brown (10YR 5/4) mottles; weak coarse prismatic structure parting to moderate coarse and medium angular blocky; firm; few roots; common thin dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) clay films on vertical faces of prisms and in tubular pores; continuous thin grayish brown (2.5Y 5/2) and dark grayish brown (10YR 4/2) clay films on faces of blocky peds; few narrow tongues of light brownish gray (2.5Y 6/2) sandy loam; about 6 percent coarse fragments; medium acid; gradual smooth boundary.

Bt2—47 to 60 inches; brown (10YR 5/3) loam; common fine distinct yellowish brown (10YR 5/8) and common medium prominent yellowish red (5YR 5/8) mottles; weak very coarse prismatic structure parting to weak coarse angular blocky; firm; common thin very dark grayish brown (2.5Y 3/2) clay films on faces of prisms and in tubular pores; many thin dark grayish brown (2.5Y 4/2) clay films on faces of blocky peds; very few tongues of gray (2.5Y 6/1) sandy loam; about 5 percent coarse fragments; slightly acid; gradual smooth boundary.

C—60 to 65 inches; brown (10YR 5/3) and grayish brown (10YR 5/2) loam; common fine and medium prominent yellowish red (5YR 5/6 and 5/8) and few fine prominent dark reddish brown (5YR 2/2) mottles; massive; firm; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 36 to 65 inches. The depth to free carbonates ranges from 50 to more than 100 inches. The content of coarse fragments is 2 to 10 percent throughout the profile. Some pedons have a few boulders.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 10YR or 2.5Y and value of 5 or 6. It generally has chroma of 1 or 2, but some subhorizons have chroma of 3. The A and E horizons are silt loam, very fine sandy loam, loam, fine sandy loam, or sandy loam. Some pedons have an E/B horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. It typically is loam, but in some pedons it has layers of clay loam, sandy clay loam, silty clay loam, or sandy loam. The C horizon has colors and textures similar to those of the Bt horizon. In some pedons it does not have free carbonates.

Lobo Series

The Lobo series consists of deep, very poorly drained, rapidly permeable, organic soils on lake plains, outwash plains, and glacial moraines. These soils formed in a layer of fibric material, mostly sphagnum moss fiber, and in the underlying hemic material, which is mainly herbaceous fiber. Slopes are 0 to 1 percent.

Typical pedon of Lobo peat, in an area of Lobo and Waskish peats, 2,600 feet south and 1,300 feet east of the northwest corner of sec. 32, T. 60 N., R. 23 W.

Oi1—0 to 6 inches; dark brown (10YR 4/3), broken face, fibric material, light yellowish brown (10YR 6/4) pressed; about 95 percent fiber, 90 percent rubbed; massive; nonplastic and nonsticky; primarily sphagnum fiber; about 6 percent mineral material; extremely acid; clear wavy boundary.

Oi2—6 to 12 inches; dark brown (10YR 4/3), broken face, brown (10YR 5/3), pressed, fibric material; about 95 percent fiber, 85 percent rubbed; weak thick platy structure; nonplastic and nonsticky; primarily sphagnum fiber; about 3 percent mineral material; extremely acid; clear wavy boundary.

Oi3—12 to 24 inches; dark brown (10YR 4/3), broken face, fibric material, brown (10YR 5/3) pressed; about 80 percent fiber, 70 percent rubbed; weak thick platy structure; nonplastic and nonsticky; sphagnum fiber; about 3 percent mineral material; extremely acid; clear wavy boundary.

Oi4—24 to 30 inches; dark brown (10YR 4/3), broken face, brown (10YR 5/3), pressed, fibric material; about 90 percent fiber, 70 percent rubbed; weak thick platy structure; nonplastic and nonsticky; primarily sphagnum fiber; about 6 percent mineral material; extremely acid; clear wavy boundary.

Oi5—30 to 36 inches; dark brown (10YR 4/3), broken face, fibric material, pale brown (10YR 6/3) pressed; about 90 percent fiber, 60 percent rubbed; weak thick platy structure; nonplastic and nonsticky; primarily sphagnum fiber; about 5 percent mineral material; extremely acid; clear wavy boundary.

Oi6—36 to 44 inches; dark brown (10YR 4/3), broken face, brown (10YR 5/3), pressed, fibric material; about 95 percent fiber, 80 percent rubbed; weak thick platy structure; nonplastic and nonsticky; primarily sphagnum fiber; about 4 percent mineral material; extremely acid; clear wavy boundary.

Oe1—44 to 52 inches; dark brown (7.5YR 3/2), broken face and pressed, hemic material; about 70 percent fiber, 30 percent rubbed; weak medium platy

structure; nonplastic and nonsticky; primarily herbaceous and sphagnum fiber; about 5 percent mineral material; extremely acid; gradual wavy boundary.

Oe2—52 to 65 inches; dark reddish brown (5YR 2/2 and 3/2), broken face and pressed, hemic material; about 55 percent fiber, 25 percent rubbed; weak medium platy structure; nonplastic and nonsticky; primarily herbaceous fiber; about 5 percent mineral material; extremely acid; gradual wavy boundary.

Oe3—65 to 72 inches; dark reddish brown (5YR 2/2), broken face and pressed, hemic material; about 60 percent fiber, 30 percent rubbed; weak medium platy structure; nonplastic and nonsticky; primarily herbaceous fiber; about 5 percent mineral material; extremely acid.

The organic material is more than 63 inches thick. Except for the thin layers of hemic or sapric material which total about 5 inches thick, fibric material extends from the surface to a depth of 35 to 53 inches. Hemic material underlies the fibric material.

The fibric material has hue of 5YR to 10YR, value of 3 to 7, and chroma of 2 to 4. The content of fiber ranges from 70 to nearly 100 percent before rubbing and from 40 to about 95 percent after rubbing. The hemic material has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The content of fiber ranges from 35 to 70 percent before rubbing and from 20 to 45 percent after rubbing. The content of mineral material ranges from 3 to 10 percent in the entire pedon. The content of woody fibers and fragments ranges from 0 to 10 percent.

Loxley Series

The Loxley series consists of deep, very poorly drained, moderately slowly permeable to moderately rapidly permeable, organic soils in bogs on glacial moraines and outwash plains. These soils formed in herbaceous material more than 51 inches thick. Slopes are 0 to 1 percent.

Typical pedon of Loxley peat, 100 feet south and 100 feet east of the northwest corner of sec. 13, T. 58 N., R. 25 W.

Oi—0 to 8 inches; brown (10YR 4/3), broken face, fibric material, very pale brown (10YR 7/3) rubbed; about 95 percent fiber, 75 percent rubbed; massive; very friable; many fine roots; mainly sphagnum fiber; about 5 percent woody material; about 10 percent mineral material; extremely acid; abrupt smooth boundary.

Oe1—8 to 12 inches; very dark grayish brown (10YR 3/2), broken face, hemic material; about 65 percent fiber, 35 percent rubbed; weak thick platy structure; very friable; few fine roots; mainly sphagnum and herbaceous fiber; about 5 percent woody fragments; about 15 percent mineral material; extremely acid; clear smooth boundary.

Oa1—12 to 16 inches; dark brown (7.5YR 3/2), broken face, sapric material; about 30 percent fiber, 10 percent rubbed; weak thick platy structure; very friable; few fine roots; mainly herbaceous fiber; about 5 percent woody fragments; about 20 percent mineral material; extremely acid; abrupt smooth boundary.

Oe2—16 to 18 inches; dark brown (7.5YR 3/2), broken face, hemic material; about 70 percent fiber, 50 percent rubbed; weak thin platy structure; very friable; mainly herbaceous and sphagnum fiber; about 10 percent mineral material; extremely acid; clear smooth boundary.

Oa2—18 to 65 inches; very dark brown (10YR 2/2), broken face, sapric material; about 25 percent fiber, 10 percent rubbed; massive; very friable; mainly herbaceous fiber; about 20 percent mineral material; extremely acid.

The surface tier is dominantly hemic material but in some pedons has sapric layers. Some pedons have a surface covering of sphagnum moss as much as 18 inches thick. The subsurface and bottom tiers are dominantly sapric material, but they include hemic layers that total less than 10 inches thick and fibric layers that total less than 5 inches thick. The layers within the control section have hue of 5YR to 10YR, value of 2 to 5, and chroma of 2 to 4.

Lupton Series

The Lupton series consists of deep, very poorly drained, moderately slowly permeable to moderately rapidly permeable, organic soils in bogs on lake plains, outwash plains, and glacial moraines. These soils formed mainly in sapric material that is more than 51 inches thick and has dominantly woody fiber. Slopes are 0 to 2 percent.

Typical pedon of Lupton mucky peat, in an area of Mooselake and Lupton mucky peats, 1,600 feet north and 900 feet west of the southeast corner of sec. 32, T. 145 N., R. 25 W.

Oi—0 to 2 inches; pale brown (10YR 6/3), broken face and rubbed, fibric material, light gray (10YR 7/2) pressed; about 95 percent fiber, 90 percent rubbed; weak medium platy structure; loose; primarily sphagnum moss fiber; about 12 percent mineral material; strongly acid; clear wavy boundary.

Oe—2 to 8 inches; black (10YR 2/1), broken face and rubbed, hemic material, very dark brown (10YR 2/2) pressed; about 55 percent fiber, 35 percent rubbed; moderate medium and coarse granular structure; friable; primarily woody fiber; about 29 percent mineral material; neutral; clear wavy boundary.

Oa1—8 to 39 inches; black (10YR 2/1), broken face, sapric material, very dark brown (10YR 2/2) rubbed and pressed; about 30 percent fiber, 12 percent rubbed; moderate fine subangular blocky structure; firm; primarily woody fiber; about 18 percent mineral material; slightly acid; gradual smooth boundary.
Oa2—39 to 65 inches; black (10YR 2/1), broken face, sapric material, very dark brown (10YR 2/2) rubbed and pressed; about 15 percent fiber, 7 percent rubbed; weak fine and medium subangular blocky structure; firm; herbaceous and woody fiber; about 17 percent mineral material; slightly acid.

The surface tier is mainly sapric or hemic material. It has hue of 5YR to 10YR, value of 2, and chroma of 1 or 2, or it is neutral in hue and has value of 2 and chroma of 0. Some pedons do not have a thin surface layer of fibric material. If it occurs, this layer has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 2 to 4. When pressed, the fibric material has colors that are 1 or more units higher in value or chroma, or both. The subsurface and bottom tiers are mainly sapric material, but they include hemic layers that total less than 10 inches thick and fibric layers that total less than 5 inches thick. The content of woody coarse fragments is as much as 30 percent in some pedons.

Mahtomedi Series

The Mahtomedi series consists of deep, excessively drained, rapidly permeable soils on outwash plains and glacial moraines. These soils formed in sandy outwash. Slopes range from 1 to 40 percent.

Typical pedon of Mahtomedi loamy sand, in an area of Mahtomedi and Emmert soils, 12 to 50 percent slopes, 350 feet north and 1,400 feet east of the southwest corner of sec. 4, T. 147 N., R. 27 W.

Oi—1 inch to 0; organic litter, mainly leaves and twigs.
A—0 to 3 inches; black (10YR 2/1) loamy sand; weak medium granular structure; very friable; about 10 percent coarse fragments; slightly acid; abrupt smooth boundary.
Bw1—3 to 7 inches; dark yellowish brown (10YR 3/4) loamy coarse sand; weak fine subangular blocky structure; very friable; about 15 percent coarse fragments; slightly acid; clear smooth boundary.
Bw2—7 to 16 inches; dark yellowish brown (10YR 4/4) gravelly loamy coarse sand; weak medium subangular blocky structure; very friable; about 25 percent coarse fragments; slightly acid; gradual smooth boundary.
Bw3—16 to 33 inches; brown (7.5YR 4/4) gravelly coarse sand; single grain; loose; about 35 percent coarse fragments; slightly acid; gradual smooth boundary.
C1—33 to 45 inches; brown (7.5YR 4/4) gravelly coarse sand; single grain; loose; about 20 percent coarse fragments; neutral; gradual smooth boundary.
C2—45 to 60 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grain; loose; about 30 percent coarse fragments; neutral.

The solum is 20 to 40 inches thick. The content of coarse fragments between depths of 10 and 40 inches ranges from 10 to 35 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Some pedons have an E horizon. This horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 1 or 2. The Bw horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 4 to 6. The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 or 4.

Meehan Series

The Meehan series consists of deep, somewhat poorly drained, rapidly permeable soils on outwash plains and glacial lake plains. These soils formed in sandy deposits. Slopes range from 0 to 3 percent.

Typical pedon of Meehan loamy sand, 1,400 feet south and 1,000 feet west of the northeast corner of sec. 6, T. 56 N., R. 24 W.

Oi—2 inches to 0; organic litter, mainly leaves and twigs.
A—0 to 1 inch; black (10YR 2/1) loamy sand; weak very fine subangular blocky structure; very friable; medium acid; abrupt broken boundary.
E—1 to 5 inches; light brownish gray (10YR 6/2) loamy sand; weak fine and medium subangular blocky structure; very friable; medium acid; clear wavy boundary.
Bw1—5 to 9 inches; dark yellowish brown (10YR 4/4) loamy sand; common fine faint yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; very friable; strongly acid; clear smooth boundary.
Bw2—9 to 15 inches; brown (10YR 5/3) loamy sand; common medium faint grayish brown (10YR 5/2) and many medium distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; very friable; strongly acid; clear smooth boundary.
Bw3—15 to 35 inches; dark brown (7.5YR 4/4) sand; many medium distinct light brownish gray (10YR 6/2) and few coarse faint reddish brown (5YR 4/4) mottles; weak medium subangular blocky structure; very friable; medium acid; abrupt smooth boundary.
C—35 to 60 inches; light brownish gray (10YR 6/2) coarse sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grain; loose; medium acid.

The solum ranges from 24 to 48 inches in thickness. The control section is loamy sand, sand, or coarse sand.

The content of coarse fragments ranges from 0 to 15 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 4 to 6 and chroma of 2 or 3. The Bw horizon has hue of 7.5YR, 10YR, or 5YR, value of 4 to 6, and chroma of 2 to 5. Some part of this horizon has mottles with chroma of 2 or less. The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 to 4.

Menahga Series

The Menahga series consists of deep, excessively drained, rapidly permeable soils on glacial outwash plains. These soils formed in sandy glacial outwash. Slopes range from 0 to 30 percent.

Typical pedon of Menahga loamy coarse sand, in an area of Menahga and Graycalm soils, 0 to 8 percent slopes, 1,100 feet south and 650 feet east of the northwest corner of sec. 26, T. 59 N., R. 23 W.

Oi—1 inch to 0; organic litter, mainly pine needles and twigs.
A—0 to 1 inch; very dark gray (10YR 3/1) and black (10YR 2/1) loamy coarse sand; single grain; loose; uncoated light gray (10YR 7/1) sand grains in the matrix; strongly acid; abrupt smooth boundary.
E—1 to 3 inches; grayish brown (10YR 5/2) loamy coarse sand; single grain; loose; strongly acid; abrupt smooth boundary.
Bw1—3 to 12 inches; yellowish brown (10YR 5/4) sand; single grain; loose; strongly acid; gradual wavy boundary.
Bw2—12 to 28 inches; yellowish brown (10YR 5/4) sand; single grain; loose; medium acid; clear wavy boundary.
BC—28 to 38 inches; brown (10YR 5/3) and yellowish brown (10YR 5/4) sand; single grain; loose; slightly acid; gradual wavy boundary.
C—38 to 70 inches; brown (10YR 5/3) coarse sand; single grain; loose; slightly acid.

The solum ranges from 20 to 40 inches in thickness. In most places the average texture between depths of 10 and 40 inches is sand or loamy coarse sand. In some pedons the content of coarse fragments is as much as 15 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The thin E horizon has value of 4 or 5 and chroma of 1 or 2. The B horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 6. The C horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 3 to 5.

Mooselake Series

The Mooselake series consists of deep, very poorly drained, moderately rapidly permeable, organic soils in bogs on glacial moraines, outwash plains, and lake plains. These soils formed mainly in hemic material that is more than 51 inches thick and has dominantly woody fiber. Slopes are 0 to 1 percent.

Typical pedon of Mooselake mucky peat, in an area of Mooselake and Lupton mucky peats, 2,550 feet south and 1,900 feet east of the northwest corner of sec. 10, T. 146 N., R. 25 W.

Oi—0 to 3 inches; pale brown (10YR 6/3), broken face and rubbed, fibric material, light gray (10YR 7/2) pressed; about 95 percent fiber, 85 percent rubbed; fibrous structure; loose; mainly sphagnum moss fiber; about 15 percent mineral material; strongly acid; clear wavy boundary.
Oe1—3 to 15 inches; black (5YR 2/1), broken face, hemic material, dark reddish brown (5YR 2/2) rubbed and pressed; about 55 percent fiber, 25 percent rubbed; weak medium granular structure; friable; mainly woody material; about 16 percent mineral material; slightly acid; clear smooth boundary.
Oe2—15 to 44 inches; dark reddish brown (5YR 3/2, 2/2, and 3/3), broken face, rubbed, and pressed, hemic material; about 60 percent fiber, 25 percent rubbed; weak fine and medium subangular blocky structure; friable; mainly woody material; about 10 percent woody coarse fragments; about 13 percent mineral material; medium acid; clear smooth boundary.
Oe3—44 to 71 inches; dark reddish brown (5YR 3/3 and 2/2), broken face, rubbed, and pressed, hemic material; about 50 percent fiber, 20 percent rubbed; weak fine and medium subangular blocky structure; friable; mainly woody and herbaceous material; about 14 percent mineral material; medium acid.

The surface tier is mainly hemic or sapric material. It has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The thin surface layer of fibric material has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 2 to 4. Some pedons do not have this layer. The subsurface and bottom tiers have hue of 5YR to 10YR and value and chroma of 2 or 3. They are mainly hemic material, but they include sapric layers that total less than 10 inches thick and fibric layers that also total less than 10 inches thick. The content of woody coarse fragments is as much as 10 percent in some pedons. The control section is very strongly acid to neutral.

Morph Series

The Morph series consists of deep, poorly drained, moderately permeable soils on lake plains and outwash plains. These soils formed in stratified glaciofluvial or lacustrine sediments. Slopes are 0 to 2 percent.

Typical pedon of Morph very fine sandy loam, about 2 miles north and 7.5 miles west of the community of

Squaw Lake; about 2,400 feet west and 75 feet south of the northeast corner of sec. 7, T. 148 N., R. 28 W.

A—0 to 4 inches; very dark gray (10YR 3/1) very fine sandy loam, dark gray (10YR 4/1) dry; moderate very fine and fine subangular blocky structure; very friable; many roots; slightly acid; clear wavy boundary.

E—4 to 13 inches; grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) very fine sandy loam, light gray (2.5Y 7/2) dry; common medium prominent strong brown (7.5YR 5/6) mottles; moderate thin platy structure; very friable; many roots; medium acid; clear smooth boundary.

B/E—13 to 23 inches; grayish brown (2.5Y 5/2) fine sandy loam (B2t); common medium prominent strong brown (7.5YR 5/6) mottles; moderate medium and coarse angular blocky structure; firm; interfingers and ped coatings of light brownish gray (2.5Y 6/2) loamy fine sand (E); massive; very friable; many roots; few pores; common thin grayish brown (2.5Y 5/2) clay films on faces of peds and in pores; strongly acid; clear smooth boundary.

Bt1—23 to 30 inches; grayish brown (2.5Y 5/2) fine sandy loam; few fine prominent yellowish brown (10YR 5/8) and common medium distinct light olive brown (2.5Y 5/6 and 5/4) mottles; weak coarse angular blocky structure; firm; common roots; common thin dark gray (5Y 4/1) clay films on faces of peds; slightly acid; abrupt wavy boundary.

Bt2—30 to 33 inches; olive gray (5Y 5/2) loam; common fine prominent yellowish brown (10YR 5/6 and 5/8) and common medium distinct light olive brown (2.5Y 5/4) mottles; moderate medium and fine angular blocky structure; firm; common roots; many moderately thick dark gray (5Y 4/1) clay films on faces of peds; continuous thick very dark gray (5Y 3/1) clay films in pores and root channels; neutral; abrupt wavy boundary.

BC—33 to 40 inches; grayish brown (2.5Y 5/2) sandy loam; few medium faint light olive brown (2.5Y 5/4) mottles; weak coarse and very coarse subangular blocky structure; friable; common roots; discontinuous clay films; slight effervescence; mildly alkaline; clear wavy boundary.

C1—40 to 46 inches; grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) very fine sandy loam; common large and medium faint light olive brown (2.5Y 5/4) mottles; massive; friable; few roots; few medium soft rounded light gray (2.5Y 7/2) lime masses; strong effervescence; moderately alkaline; abrupt wavy boundary.

C2—46 to 55 inches; light brownish gray (2.5Y 6/2) and grayish brown (2.5Y 5/2) loamy fine sand; common medium light olive brown (2.5Y 5/4) mottles; friable; strong effervescence; moderately alkaline; abrupt wavy boundary.

C3—55 to 60 inches; light brownish gray (2.5Y 6/2 and 6/1) and grayish brown (2.5Y 5/2) silt loam; common medium faint light olive brown (2.5Y 5/4) and prominent yellowish brown (10YR 5/6 and 5/8) mottles; massive; firm; many light gray (2.5Y 7/2) and white (2.5Y 8/2) soft rounded masses of carbonates; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 26 to 50 inches. The depth to free carbonates ranges from 22 to more than 60 inches. Some pedons have a small amount of gravel.

The A horizon has hue of 10YR or 2.5Y, value or 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2 and chroma of 0. The E horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. The A and E horizons typically are very fine sandy loam but in some pedons are sandy loam or loam. The Bt and BC horizons have hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 to 7, and chroma of 1 or 2. The BC and C horizons are stratified loamy sand to silty clay loam. The content of clay in these horizons averages less than 27 percent.

Nashwauk Series

The Nashwauk series consists of deep, well drained, slowly permeable soils on till plains and glacial moraines. These soils formed in firm, loamy glacial till. Slopes range from 1 to 35 percent.

Typical pedon of Nashwauk fine sandy loam, 1 to 10 percent slopes, about 6.5 miles north and 1 mile west of Keewatin; 2,200 feet east and 2,000 feet north of the southwest corner of sec. 23, T. 58 N., R. 22 W.

Oe—0.5 inch to 0; organic litter, mainly decomposed leaves and twigs.

A—0 to 1 inch; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 5/1) dry; moderate fine and very fine granular structure; friable; many roots; about 2 percent coarse fragments; strongly acid; abrupt wavy boundary.

E—1 to 4 inches; grayish brown (10YR 5/2) fine sandy loam, light gray (10YR 7/1) dry; moderate fine and very fine granular structure; friable; many roots; about 2 percent coarse fragments; strongly acid; clear wavy boundary.

Bw—4 to 7 inches; yellowish brown (10YR 5/4) fine sandy loam, very pale brown (10YR 7/3) dry; weak fine and very fine granular structure; friable; many roots; about 3 percent coarse fragments; strongly acid; clear wavy boundary.

E'—7 to 10 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; massive; brittle; few roots; about 3 percent coarse fragments; many fine vesicular pores; strongly acid; clear wavy boundary.

B/E—10 to 16 inches; brown (10YR 5/3) loam (Bt); moderate medium and coarse subangular blocky structure; firm; few roots; common fine vesicular pores; tongues and interfingers of grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) loam (E'); massive; brittle; few roots; common fine vesicular pores; about 2 percent coarse fragments; very strongly acid; gradual smooth boundary.

Bt1—16 to 29 inches; brown (10YR 5/3) loam; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; firm; common roots; many thin dark brown (10YR 4/3) clay films on faces of peds; about 2 percent coarse fragments; very strongly acid; gradual smooth boundary.

Bt2—29 to 58 inches; light olive brown (2.5Y 5/3) loam; few medium faint yellowish brown (10YR 5/4) mottles; weak coarse prismatic structure parting to moderate coarse subangular blocky; firm; few roots; many thin dark brown (10YR 4/3) clay films on faces of peds; about 2 percent coarse fragments; slightly acid; gradual smooth boundary.

BC—58 to 72 inches; brown (10YR 5/3) silt loam; weak very coarse prismatic structure parting to weak coarse subangular blocky; firm; few roots; common thin dark brown (10YR 4/3) clay films on faces of peds; about 2 percent coarse fragments; neutral.

The thickness of the solum ranges from 50 to 82 inches. The depth to free carbonates ranges from 50 to more than 120 inches. The content of coarse fragments ranges from 2 to 10 percent throughout the profile. Some pedons have a few boulders.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 4 to 6 and chroma of 1 or 2. The Bw horizon has hue of 7.5YR or 10YR and value of 4 to 6. The A, E, and Bw horizons are fine sandy loam, very fine sandy loam, sandy loam, loam, or silt loam. The E' horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 to 3. It is sandy loam, fine sandy loam, very fine sandy loam, or loam. Some pedons have an E/B horizon. The Bt horizon has hue of 7.5YR to 2.5Y, value of 4 or 5, and chroma of 3 or 4. It commonly is loam, sandy clay loam, or clay loam, but in some pedons it has layers of silty clay loam or silt loam. Some pedons have a C horizon. The BC and C horizons have colors and textures similar to those of the Bt horizon.

Nebish Series

The Nebish series consists of deep, well drained, moderately permeable soils on glacial till plains and moraines. These soils formed in calcareous, loamy glacial till. Slopes range from 2 to 25 percent.

Typical pedon of Nebish very fine sandy loam, 2 to 6 percent slopes, 1,300 feet north and 100 feet east of the southwest corner of sec. 7, T. 149 N., R. 29 W.

A—0 to 2 inches; very dark gray (10YR 3/1) very fine sandy loam, gray (10YR 6/1) dry; weak fine granular structure; very friable; many roots; common fine vesicular pores; about 2 percent coarse fragments; neutral; abrupt wavy boundary.

E—2 to 8 inches; grayish brown (10YR 5/2) very fine sandy loam, light gray (10YR 7/2) dry; weak and moderate thin platy structure; very friable; many roots; common fine vesicular pores; about 2 percent coarse fragments; neutral; clear wavy boundary.

B/E—8 to 12 inches; dark yellowish brown (10YR 4/4) clay loam (B); weak fine and medium subangular blocky structure; firm; interfingers and ped coatings of grayish brown (10YR 5/2) very fine sandy loam (E); massive; friable; common roots; few fine and very fine vesicular pores; about 2 percent coarse fragments; medium acid; clear wavy boundary.

Bt1—12 to 22 inches; yellowish brown (10YR 5/4) and brown (10YR 5/3) loam; moderate and strong medium and fine angular blocky structure; firm; common roots; continuous thin dark brown (10YR 4/3) clay films on faces of peds; about 2 percent coarse fragments; medium acid; clear wavy boundary.

Bt2—22 to 28 inches; brown (10YR 5/3) loam; weak and moderate medium and coarse angular blocky structure; firm; common roots; continuous thin and moderately thick dark brown (10YR 4/3 and 3/3) clay films on faces of peds; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

Bt3—28 to 39 inches; brown (10YR 5/3) and light olive brown (2.5Y 5/3) loam; weak coarse prismatic structure parting to weak and moderate medium and coarse angular blocky; friable; common roots; common thin dark brown (10YR 4/3 and 3/3) clay films on faces of peds; dark reddish brown (5YR 3/2) organic stains in roots channels; about 2 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

C—39 to 64 inches; light olive brown (2.5Y 5/3) and light yellowish brown (2.5Y 6/3) loam; weak medium platy structure; friable; few roots; common white (2.5Y 8/1) threads and soft masses of lime; about 4 percent coarse fragments; strong effervescence; moderately alkaline.

The solum is 26 to 42 inches thick. The content of coarse fragments is 2 to 8 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 4 to 6 and chroma of 2 or 3. The A and E horizons are very fine sandy loam, fine sandy loam, sandy loam, loam, or silt loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. It is clay loam, sandy clay loam, or loam. The C horizon has value of 5 or 6. It is dominantly loam but in some pedons is sandy loam.

Pengilly Series

The Pengilly series consists of deep, poorly drained, moderately permeable soils that formed in stratified alluvium on flood plains. Slopes are 0 to 2 percent.

Typical pedon of Pengilly loam, in an area of the Pengilly-Winterfield association, 2,500 feet east and 800 feet north of the southwest corner of sec. 28, T. 54 N., R. 23 W.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; common fine distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; slightly acid; abrupt wavy boundary.

C1—4 to 14 inches; dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) silt loam; few fine distinct strong brown (7.5YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; common roots; slightly acid; abrupt wavy boundary.

C2—14 to 60 inches; dark gray (5Y 4/1), dark grayish brown (2.5Y 4/2), light brownish gray (2.5Y 6/2), and dark brown (10YR 4/3), stratified silt loam to loamy fine sand; few fine prominent yellowish red (5YR 5/6) and common fine faint grayish brown (2.5Y 5/2) mottles; massive; very friable and friable; slightly acid.

The A horizon has value of 2 to 5 and chroma of 1 or 2. It is very fine sandy loam, fine sandy loam, loam, silt loam, loamy very fine sand, or sandy loam. The C horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of dominantly 1 or 2. It generally is stratified silt loam to loamy fine sand. In some pedons, however, it has layers of silty clay loam, clay loam, or sandy clay loam below a depth of 40 inches. Some pedons have free carbonates below a depth of 30 inches.

Rifle Series

The Rifle series consists of deep, very poorly drained, moderately permeable or moderately rapidly permeable, organic soils in bogs on glacial moraines, outwash plains, till plains, and glacial lake plains. These soils formed in moderately decomposed, dominantly herbaceous material more than 51 inches thick. Slopes are 0 to 2 percent.

Typical pedon of Rifle mucky peat, 1,550 feet south and 1,200 feet west of the northeast corner of sec. 12, T. 53 N., R. 23 W.

Oe1—0 to 4 inches; black (5YR 2/1), broken face and rubbed, hemic material; about 45 percent fiber, 22 percent rubbed; weak medium granular structure; friable; primarily herbaceous fiber; strongly acid; clear smooth boundary.

Oe2—4 to 10 inches; dark reddish brown (5YR 2/2, 3/2, and 3/3), broken face and rubbed, hemic material; about 60 percent fiber, 35 percent rubbed; weak medium granular structure; friable; primarily herbaceous fiber; strongly acid; clear smooth boundary.

Oe3—10 to 21 inches; dark reddish brown (5YR 3/2), broken face, hemic material, dark brown (7.5YR 4/2) rubbed; about 65 percent fiber, 40 percent rubbed; weak thick platy structure; friable; primarily herbaceous fiber; strongly acid; clear smooth boundary.

Oe4—21 to 46 inches; dark reddish brown (5YR 2/2), broken face, hemic material, dark reddish gray (5YR 4/2) rubbed; about 60 percent fiber, 35 percent rubbed; weak thick platy structure; friable; strongly acid; clear smooth boundary.

Oe5—46 to 60 inches; dark brown (7.5YR 3/2), broken face and rubbed, hemic material; about 65 percent fiber, 25 percent rubbed; weak thick platy structure; friable; strongly acid.

In some pedons the content of woody coarse fragments is as much as 15 percent. The control section ranges from strongly acid to neutral.

The surface tier consists of hemic material or hemic and fibric material. The fibric material is mainly sphagnum peat. The surface tier has hue of 5YR to 10YR, value of 2 to 6, and chroma of 1 to 4. The higher values and chromas commonly are in the more fibrous layers. The subsurface and bottom tiers have hue of 5YR to 10YR and value and chroma of 2 to 4. They are mainly hemic material, but they include sapric layers that total less than 10 inches thick and fibric layers that also total less than 10 inches thick.

Roscommon Series

The Roscommon series consists of deep, poorly drained or very poorly drained, rapidly permeable soils in depressions and nearly level, low areas on glacial outwash plains and lake plains. These soils formed in glacial outwash and lacustrine sediments. Slopes are 0 to 2 percent.

Typical pedon of Roscommon mucky loamy sand, in an area of Sago and Roscommon soils, 950 feet north and 1,200 feet east of the southwest corner of sec. 16, T. 149 N., R. 25 W.

A—0 to 6 inches; black (10YR 2/1) mucky loamy sand; weak fine granular structure; very friable; medium acid; abrupt smooth boundary.

Cg1—6 to 19 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) loamy sand; common fine prominent yellowish brown (10YR 5/8) mottles; massive; very friable; slightly acid; abrupt smooth boundary.

Cg2—19 to 32 inches; light olive gray (5Y 6/2) and light gray (5Y 6/1) loamy coarse sand; few fine faint light

olive brown (2.5Y 5/4) mottles; massive; very friable; neutral; abrupt wavy boundary.
Cg3—32 to 60 inches; light gray (5Y 6/1) sand; single grain; loose; mildly alkaline.

Pedons in undisturbed areas have as much as 6 inches of muck on the surface. The A horizon has value of 2 and chroma of 1 or 2 or has value of 3 and chroma of 1. It is mucky loamy sand, sand, or mucky sand. The C horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 to 3. It is sand, coarse sand, loamy sand, or loamy coarse sand. Some pedons do not have free carbonates within a depth of 60 inches.

Rosy Series

The Rosy series consists of deep, moderately well drained, moderately permeable soils on glacial lake plains and outwash plains. These soils formed in stratified, loamy and sandy glaciofluvial or lacustrine sediments. Slopes range from 0 to 6 percent.

Typical pedon of Rosy very fine sandy loam, 0 to 6 percent slopes, about 2 miles north and 3.5 miles west of the community of Squaw Lake; about 1,570 feet east and 940 feet north of the southwest corner of sec. 3, T. 148 N., R. 28 W.

O—2 inches to 0; organic litter of fresh and well decomposed leaves, twigs, and fine roots.
E1—0 to 2 inches; dark gray (10YR 4/1) and dark grayish brown (10YR 4/2) very fine sandy loam, grayish brown (10YR 5/2) dry; weak thin platy structure; very friable; many roots; strongly acid; clear wavy boundary.
E2—2 to 9 inches; grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) fine sandy loam, light gray (10YR 7/2) dry; weak and moderate thin and medium platy structure; very friable; many roots; strongly acid; clear wavy boundary
B/E—9 to 12 inches; yellowish brown (10YR 5/4) and brown (10YR 5/3) loam (Bt); moderate fine and medium angular blocky structure; firm; tongues and interfingers of grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) very fine sandy loam (E); weak thin platy structure; friable; many roots; few thin clay films on faces of blocky peds; strongly acid; clear wavy boundary.
Bt—12 to 20 inches; yellowish brown (10YR 5/4) loam; moderate and strong fine and medium angular blocky structure; firm; many roots; few fine faint grayish brown (10YR 5/2) mottles; many thin and moderately thick brown (10YR 5/3) clay films on faces of peds; few grayish brown (10YR 5/2) very fine sand coatings on the tops and sides of peds in the upper part; medium acid; abrupt wavy boundary.
E&Bt—20 to 50 inches; stratified yellowish brown (10YR 5/4) and brown (10YR 5/3) sandy loam, fine sandy loam, loam, and silt loam (Bt); few medium faint grayish brown (10YR 5/2) mottles; weak fine and medium angular blocky structure; friable; separated by layers of grayish brown (10YR 5/2), light brownish gray (10YR 6/2), and pale brown (10YR 6/3) loamy sand (E); massive; very friable; common roots; common or many thin clay films on faces of peds; medium acid; abrupt wavy boundary.
C1—50 to 56 inches; light olive brown (2.5Y 5/4) and grayish brown (2.5Y 5/2) stratified loamy fine sand, sandy loam, and silt loam; massive; friable; few roots; many sand grains with thin colloidal coatings; neutral; abrupt wavy boundary.
C2—56 to 64 inches; light brownish gray (2.5Y 6/2) and grayish brown (2.5Y 5/2) stratified loamy fine sand, loamy very fine sand, and silt loam; massive; friable; few fine light olive brown (2.5Y 5/4) mottles; strong effervescence; moderately alkaline.

The solum is 30 to more than 60 inches thick. The depth to carbonates ranges from 28 to more than 60 inches. The argillic horizon is at least 6 inches thick and in many pedons is more than 20 inches thick. It consists mainly of lamellae in most pedons.

Some pedons have an A horizon. The E horizon has value of 4 to 6 and chroma of 1 or 2. The B/E horizon consists of Bt material penetrated by tongues of E material. The Bt horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. The C horizon has hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 2 to 4.

Sago Series

The Sago series consists of deep, very poorly drained, moderately permeable soils on glacial lake plains and river terraces. These soils formed in sapric material and in the underlying stratified, sandy and loamy sediments. Slopes are 0 to 2 percent.

Typical pedon of Sago muck, in an area of Sago and Roscommon soils, about 6.5 miles south and 1 mile east of Warba; 1,180 feet north and 150 feet east of the southwest corner of sec. 34, T. 53 N., R. 23 W.

Oa—0 to 13 inches; black (10YR 2/1) and very dark brown (10YR 2/2), broken face, rubbed, and pressed, sapric material; about 10 percent fiber, 2 percent rubbed; weak medium and fine granular structure; very friable; many roots; primarily herbaceous fiber; medium acid; abrupt wavy boundary.
A—13 to 15 inches; black (5Y 2/1) and very dark gray (5Y 3/1) silt loam; few fine prominent yellowish red (5YR 5/8) mottles; massive; friable; many roots; medium acid; abrupt wavy boundary.
Bg1—15 to 28 inches; olive gray (5Y 5/2) loamy very fine sand; common fine prominent yellowish brown (10YR 5/6 and 5/8) mottles; weak medium platy

structure; very friable; common roots; slightly acid; clear wavy boundary.

Bg2—28 to 41 inches; gray (5Y 5/1) very fine sandy loam; common medium prominent yellowish brown (10YR 5/6 and 5/8) mottles; massive; very friable; few roots; neutral; clear wavy boundary.

Cg—41 to 60 inches; gray (5Y 6/1) stratified very fine sand to silt loam; common medium prominent yellowish brown (10YR 5/6 and 5/8) and few fine prominent yellowish red (5YR 5/8) mottles; massive; very friable; few light gray (5Y 7/1) and white (5Y 8/1) soft calcium carbonate threads; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 50 inches. The histic epipedon is 6 to 16 inches thick. It is sapric material or hemic and sapric material. The mineral soil material is stratified to a depth of at least 60 inches. It is sand to silty clay loam.

The A horizon has hue of 10YR to 5Y, value of 2, and chroma of 1, or it is neutral in hue and has value of 2 and chroma of 0. The Bg horizon has hue of 2.5Y or 5Y, value of 4 to 7, and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 8, and chroma of 1 or 2, or it is neutral in hue and has value of 4 to 8.

Sandwick Series

The Sandwick series consists of deep, somewhat poorly drained soils that are rapidly permeable in the upper part and moderately slowly permeable in the lower part. These soils are on glacial moraines and till plains. They formed in a sandy mantle and in the underlying loamy material. Slopes are 0 to 2 percent.

Typical pedon of Sandwick loamy fine sand, 8 miles north and about 1.75 miles east of Grand Rapids; about 1,500 feet west and 1,000 feet north of the southeast corner of sec. 3, T. 56 N., R. 25 W.

E—0 to 4 inches; light brownish gray (10YR 6/2) loamy fine sand, light gray (10YR 7/2) dry; common fine distinct yellowish brown (10YR 5/6) and common medium gray (10YR 5/1) mottles; weak medium platy structure; very friable; many roots; medium acid; abrupt wavy boundary.

Bw—4 to 10 inches; brown (10YR 5/3) loamy fine sand; many medium faint yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; very friable; less than 1 percent coarse fragments; few roots; medium acid; clear wavy boundary.

E'1—10 to 22 inches; light brownish gray (2.5Y 6/2) loamy fine sand; common fine distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; very friable; less than 1 percent coarse fragments; few roots; slightly acid; abrupt smooth boundary.

2E'2—22 to 25 inches; light brownish gray (2.5Y 6/2) loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; about 5 percent coarse fragments; few roots; slightly acid; clear wavy boundary.

2E/B—25 to 28 inches; light brownish gray (2.5Y 6/2) loam (E); few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; E material surrounding and tonguing into grayish brown (2.5Y 5/2) loam (Btg); few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; few thin grayish brown (2.5Y 5/2) clay films on faces of peds and in old root channels (Btg); few roots; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

2Btg1—28 to 34 inches; grayish brown (2.5Y 5/2) loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; common thin dark grayish brown (2.5Y 4/2) clay films on faces of peds and in old root channels; few roots; about 5 percent coarse fragments; slightly acid; gradual smooth boundary.

2Btg2—34 to 38 inches; grayish brown (2.5Y 5/2) loam; few medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few thin grayish brown (2.5Y 5/2) clay films on faces of peds; about 5 percent coarse fragments; neutral; gradual smooth boundary.

2Cg—38 to 60 inches; grayish brown (2.5Y 5/2) loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; mildly alkaline.

The solum is 32 to 56 inches thick. The sandy mantle is 20 to 40 inches thick. The sandy mantle is loamy fine sand to coarse sand. The horizons below the mantle are loam, clay loam, sandy clay loam, fine sandy loam, or sandy loam. Reaction is strongly acid to neutral in the solum and slightly acid to moderately alkaline in the 2C horizon.

Some pedons have an A horizon. The E horizon has hue of 10YR or 2.5Y. It has value of 5 or 6 and chroma of 1 to 3 or has value of 4 and chroma of 1 or 2. The Bw horizon has hue of 5Y to 2.5YR, value of 3 to 6, and chroma of 2 to 4. The E' and 2E' horizons have hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 or 2. The 2Btg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 or 3. The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 7, and chroma of 1 or 2.

Seelyeville Series

The Seelyeville series consists of deep, very poorly drained, moderately permeable or moderately slowly

permeable, organic soils in bogs on glacial outwash plains, valley trains, and glacial moraines. These soils formed mainly in herbaceous sapric material more than 51 inches thick. Slopes are 0 to 2 percent.

Typical pedon of Seelyeville muck, in an area of the Seelyeville-Bowstring association, 2,600 feet south and 1,250 feet east of the northwest corner of sec. 15, T. 147 N., R. 27 W.

Oa1—0 to 28 inches; very dark brown (10YR 2/2), broken face and rubbed, sapric material; about 20 percent fiber, 7 percent rubbed; weak fine granular structure; very friable; primarily herbaceous fiber; very strongly acid; abrupt smooth boundary.

Oe—28 to 37 inches; dark brown (7.5YR 3/2), broken face, hemic material, very dark brown (10YR 2/2) rubbed; about 55 percent fiber, 25 percent rubbed; massive; friable; primarily herbaceous fiber; strongly acid; clear smooth boundary.

Oa2—37 to 52 inches; very dark brown (10YR 2/2), broken face and rubbed, sapric material; about 20 percent fiber, 8 percent rubbed; massive; friable; primarily herbaceous fiber; strongly acid; gradual smooth boundary.

Oa3—52 to 70 inches; very dark brown (10YR 2/2), broken face and rubbed, sapric material; about 25 percent fiber, 8 percent rubbed; massive; friable; primarily herbaceous fiber; about 10 percent small woody coarse fragments; strongly acid.

Reaction is very strongly acid to slightly acid in the control section. The content of mineral material ranges from 10 to 40 percent. This material is disseminated throughout the subsurface and bottom tiers. The surface tier is sapric or hemic material, or both. The subsurface and bottom tiers are mainly sapric material, but they include hemic layers that total less than 10 inches thick. The sapric material has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. The hemic material has hue of 7.5YR or 10YR and value and chroma of 2 or 3.

Shooker Series

The Shooker series consists of deep, poorly drained, moderately permeable soils on glacial moraines and till plains. These soils formed in loamy glacial till. Slopes are 0 to 2 percent.

Typical pedon of Shooker very fine sandy loam, 1,550 feet south and 2,600 feet east of the northwest corner of sec. 19, T. 150 N., R. 29 W.

A—0 to 2 inches; very dark gray (10YR 3/1) very fine sandy loam, dark gray (10YR 4/1) dry; weak and moderate fine crumb structure; friable; about 2 percent coarse fragments; medium acid; abrupt wavy boundary.

E—2 to 9 inches; light brownish gray (2.5Y 6/2) very fine sandy loam; few fine faint grayish brown (2.5Y 5/2) and distinct yellowish brown (10YR 5/4) mottles; moderate thin platy structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

B/E—9 to 11 inches; grayish brown (2.5Y 5/2) sandy clay loam (Bt); firm; less than 15 percent light brownish gray (2.5Y 6/2) very fine sandy loam (E); friable; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; about 2 percent coarse fragments; neutral; clear smooth boundary.

Btg1—11 to 14 inches; grayish brown (2.5Y 5/2) sandy clay loam; few fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; moderate very fine to medium angular blocky structure; firm; continuous thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; about 2 percent coarse fragments; neutral; clear wavy boundary.

Btg2—14 to 23 inches; grayish brown (2.5Y 5/2) and olive gray (5Y 5/2) clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; moderate and strong fine and medium subangular blocky structure; firm; continuous thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; about 2 percent coarse fragments; neutral; clear smooth boundary.

Btg3—23 to 27 inches; grayish brown (2.5Y 5/2) sandy clay loam; few fine distinct yellowish brown (10YR 5/4) and few fine prominent reddish brown (5YR 4/4) mottles; weak fine and medium blocky structure; firm; common thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; few dolomite pebbles and about 2 percent other coarse fragments; mildly alkaline; clear wavy boundary.

Cg1—27 to 48 inches; grayish brown (2.5Y 5/2) fine sandy loam; common fine distinct yellowish brown (10YR 5/4) and few fine faint light olive brown (2.5Y 5/4) mottles; massive; friable; about 8 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

Cg2—48 to 60 inches; light olive gray (5Y 6/2) loam; many fine and medium distinct yellowish brown (10YR 5/4) mottles; massive; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 48 inches. The A horizon has value of 2 or 3. The Ap horizon has value of 4 and chroma of 1 or 2. The E horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. The A and E horizons are very fine sandy loam, fine sandy loam, sandy loam, loam, or silt loam. The Bt horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, clay loam, or sandy clay loam. The C horizon has hue of 2.5Y or 5Y, value or 5 or 6, and chroma of 2 to 4. It is loam, sandy clay loam, fine sandy loam, or sandy loam.

Spooner Series

The Spooner series consists of deep, poorly drained, moderately permeable soils on glacial lake plains. These soils formed in silty lacustrine sediments. Slopes are 0 to 2 percent.

Typical pedon of Spooner silt loam, 350 feet south and 1,400 feet east of the northwest corner of sec. 33, T. 54 N., R. 23 W.

O—1 inch to 0; organic litter, mainly leaves and twigs.
A—0 to 4 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 6/1) dry; moderate fine and medium granular structure; friable; medium acid; clear wavy boundary.
E—4 to 9 inches; light brownish gray (2.5Y 6/2) silt loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak thin platy structure; friable; medium acid; clear wavy boundary.
B/E—9 to 11 inches; grayish brown (2.5Y 5/2) and dark grayish brown (2.5Y 4/2) clay loam (Bt); weak coarse subangular blocky structure; interfingers and ped coatings of light brownish gray (2.5Y 6/2) silt loam (E); weak thin platy structure; few fine distinct light olive brown (2.5Y 5/4 and 5/6) mottles; firm; slightly acid; clear wavy boundary.
Bt—11 to 16 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; firm; continuous thin dark grayish brown (2.5Y 4/2) and very dark grayish brown (2.5Y 3/2) clay films on faces of peds; neutral; clear wavy boundary.
BC—16 to 20 inches; grayish brown (10YR 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak coarse angular blocky structure; firm; common thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; slight effervescence; mildly alkaline; clear wavy boundary.
Cg1—20 to 34 inches; light brownish gray (2.5Y 6/2) silt loam; common medium distinct light olive brown (2.5Y 5/6) mottles; weak thin and medium platy structure; friable; few fine white (2.5Y 8/1) lime threads; strong effervescence; moderately alkaline; clear smooth boundary.
Cg2—34 to 43 inches; light olive gray (5Y 6/2) silt loam; common large distinct light olive brown (2.5Y 5/6) mottles; moderate medium platy structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.
Cg3—43 to 60 inches; light brownish gray (2.5Y 6/2) silt loam; common medium distinct light olive brown (2.5Y 5/4 and 5/6) mottles; massive; firm; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 16 to 40 inches. Free carbonates are leached to the lower part of the solum in most pedons but to directly below the solum in some pedons.

The A horizon has value of 2 or 3. The Ap horizon, if it occurs, has value of 3 to 5 and chroma of 1 or 2. The E horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. The A and E horizons are silt loam, very fine sandy loam, loam, or loamy very fine sand. The Bt horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. It is clay loam, silty clay loam, silt loam, loam, very fine sandy loam, or sandy clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 3. It has textures similar to those of the B horizon.

Stuntz Series

The Stuntz series consists of deep, somewhat poorly drained, moderately slowly permeable soils on till plains and glacial moraines. These soils formed in loamy till. Slopes range from 0 to 3 percent.

Typical pedon of Stuntz very fine sandy loam, 300 feet east and 100 feet south of the northwest corner of sec. 32, T. 55 N., R. 23 W.

Oi—1.5 inches to 0; organic litter, mainly leaves and twigs.
A—0 to 1 inch; very dark gray (10YR 3/1) very fine sandy loam; weak very fine granular structure; very friable; medium acid; abrupt smooth boundary.
E1—1 to 4 inches; light gray (10YR 6/1) very fine sandy loam; few fine distinct yellowish brown (10YR 5/5) mottles; weak very fine subangular blocky structure; very friable; strongly acid; abrupt smooth boundary.
E2—4 to 11 inches; light brownish gray (2.5Y 6/2) very fine sandy loam; many fine distinct yellowish brown (10YR 5/6) mottles; weak thin platy structure; very friable; strongly acid; abrupt smooth boundary.
E/B—11 to 13 inches; light brownish gray (2.5Y 6/2) very fine sandy loam (E); massive; very friable; E material surrounding and tonguing into olive brown (2.5Y 4/3) clay loam (Bt); common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; strongly acid; gradual smooth boundary.
B/E—13 to 23 inches; olive brown (2.5Y 4/3) clay loam (Bt); common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; firm; tongues and interfingers of light brownish gray (10YR 6/2) and pale brown (10YR 6/3) very fine sandy loam (E); massive; friable; strongly acid; clear smooth boundary.
Bt1—23 to 29 inches; light olive brown (2.5Y 5/3) clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; strong medium angular blocky structure; firm; many moderately thick dark grayish brown (2.5Y 4/2) clay films on faces of peds; continuous thick clay films in root channels; strongly acid; clear smooth boundary.

Bt2—29 to 35 inches; olive brown (2.5Y 4/3) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; strong coarse and medium angular blocky structure; firm; many thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; continuous thick clay films in root channels; strongly acid; clear smooth boundary.
Bt3—35 to 43 inches; light olive brown (2.5Y 5/3) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; common thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; continuous thick clay films in root channels; slightly acid; gradual smooth boundary.
C—43 to 60 inches; light olive brown (2.5Y 5/3) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium and coarse subangular blocky structure; friable; neutral.

The thickness of the solum ranges from 35 to 52 inches. The depth to free carbonates ranges from 32 to more than 60 inches.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2. The E horizon has hue of 10YR or 2.5Y. It has value of 5 or 6 and chroma of 1 to 3 or has value of 4 and chroma of 1 or 2. The A and E horizons are very fine sandy loam, silt loam, fine sandy loam, or loam. The Bt horizon has hue of dominantly 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. In some pedons, however, it has hue of 5Y in the lower part. It is sandy clay loam, clay loam, or loam. The C horizon has hue of 10YR to 5Y, value of 5 to 7, and chroma of 2 to 4. It is clay loam, sandy clay loam, loam, or fine sandy loam.

Suomi Series

The Suomi series consists of deep, moderately well drained, slowly permeable soils on glacial moraines and till plains. These soils formed in silty and clayey glacial till. Slopes range from 1 to 25 percent.

Typical pedon of Suomi silt loam, 1 to 8 percent slopes, 12 miles north and 4 miles east of Deer River; 3,300 feet east and 30 feet south of the northwest corner of sec. 19, T. 58 N., R. 26 W.

O—0.5 inch to 0; organic litter, mainly leaves and twigs.
A—0 to 3 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; about 1 percent coarse fragments; many roots; slightly acid; clear smooth boundary.
E—3 to 9 inches; dark gray (10YR 4/1) silt loam, light gray (10YR 7/1) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; many roots; medium acid; clear smooth boundary.
E/B—9 to 12 inches; grayish brown (10YR 5/2) silt loam (E) tonguing into and surrounding dark brown (10YR 3/3) clay (Bt); moderate coarse subangular blocky structure parting to weak fine subangular blocky; friable; about 2 percent coarse fragments; common roots; medium acid; clear smooth boundary.
Bt1—12 to 21 inches; dark brown (10YR 3/3) and dark yellowish brown (10YR 3/4) clay; few fine faint dark grayish brown (10YR 4/2) mottles in the lower part; strong coarse subangular blocky structure parting to strong fine subangular blocky; firm; about 2 percent coarse fragments; common roots; many thin clay films on faces of peds and in tubular pores; slightly acid; gradual smooth boundary.
Bt2—21 to 30 inches; dark grayish brown (10YR 4/2) clay; moderate medium subangular blocky structure; very firm; about 2 percent coarse fragments; common roots; many thin clay films on faces of peds and in tubular pores; neutral; clear smooth boundary.
Bt3—30 to 36 inches; dark grayish brown (10YR 4/2) clay; weak fine subangular blocky structure; firm; about 2 percent coarse fragments; common roots; few thin clay films on faces of peds; slight effervescence; mildly alkaline; clear smooth boundary.
C—36 to 60 inches; grayish brown (10YR 5/2) and dark grayish brown (10YR 4/2) clay; massive; firm; about 3 percent coarse fragments; few roots; few light gray (10YR 7/1) lime concretions; strong effervescence; moderately alkaline.

The solum ranges from 20 to 43 inches in thickness. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has value of 2. The E horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. The A and E horizons are silt loam, loam, silty clay loam, or very fine sandy loam. Some pedons have a B/E or BE horizon. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. It is silty clay, clay, silty clay loam, or clay loam. The C horizon has hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 1 to 4. It is silty clay, clay, silty clay loam, or clay loam.

Talmoon Series

The Talmoon series consists of deep, very poorly drained, moderately slowly permeable soils in shallow depressions and swales on glacial till uplands. These soils formed in loamy glacial till. Slopes are 0 to 2 percent.

Typical pedon of Talmoon silt loam, 2,500 feet north and 250 feet west of the southeast corner of sec. 21, T. 146 N., R. 25 W.

A—0 to 6 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak and moderate very fine and fine subangular blocky structure; very friable; many roots; medium acid; abrupt wavy boundary.

E1—6 to 9 inches; gray (10YR 5/1) and dark gray (10YR 4/1) silt loam; few medium distinct light olive brown (2.5Y 5/4) mottles; weak medium and fine subangular blocky structure; very friable; many roots; slightly acid; abrupt wavy boundary.

E2—9 to 16 inches; grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) very fine sandy loam; common medium faint light yellowish brown (2.5Y 6/4) and few fine faint light olive brown (2.5Y 5/4) mottles; weak coarse subangular blocky structure parting to weak medium and thin platy; very friable; many roots; slightly acid; clear wavy boundary.

Btg—16 to 33 inches; olive gray (5Y 5/2) sandy clay loam; many medium prominent yellowish brown (10YR 5/6) mottles; moderate medium and coarse subangular blocky structure; firm; continuous thin olive gray (5Y 4/2) clay films on faces of peds; common roots; about 5 percent coarse fragments, mainly of soft gray shale; slightly acid; clear wavy boundary.

BCg—33 to 42 inches; olive gray (5Y 5/2) loam; common medium prominent yellowish brown (10YR 5/6) and few medium distinct light olive brown (2.5Y 5/4) mottles; weak coarse subangular blocky structure; firm; few thin olive gray (5Y 4/2) clay films on faces of peds; few roots; about 5 percent coarse fragments, mostly of soft gray shale; neutral; clear smooth boundary.

Cg—42 to 60 inches; light olive gray (5Y 6/2) and olive gray (5Y 5/2) loam; common medium distinct light yellowish brown (2.5Y 6/4) mottles; massive; friable; about 5 percent coarse fragments, mostly of soft gray shale; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 18 to 44 inches. The content of coarse fragments is 0 to 10 percent in the B and C horizons. Some pedons have a thin lag line of gravelly material.

Some pedons have an O horizon. This horizon is 0 to 6 inches thick. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2, or it is neutral in hue and has value of 2 and chroma of 0. It is silt loam, loam, very fine sandy loam, fine sandy loam, or sandy loam. Some pedons have an Ap horizon. The E horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2 and has distinct or prominent mottles. It has textures similar to those of the A horizon.

Some pedons have a BE horizon. The Btg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2 and has distinct or prominent mottles. It is clay loam, sandy clay loam, silty clay loam, or loam.

The Cg horizon has hue of 2.5Y or 5Y, value of 5 to 7, and chroma of 1 or 2 and has distinct or prominent mottles. It has textures similar to those of the B horizon. It is mildly alkaline or moderately alkaline.

Tawas Series

The Tawas series consists of deep, very poorly drained, moderately slowly permeable to moderately rapidly permeable, organic soils in bogs on outwash plains and glacial lake plains. These soils formed in highly decomposed, dominantly woody material over sandy outwash. Slopes are 0 to 2 percent.

Typical pedon of Tawas muck, 1,650 feet north and 1,000 feet west of the southeast corner of sec. 19, T. 145 N., R. 25 W.

Oa1—0 to 13 inches; black (5YR 2/1), broken face, rubbed, and pressed, sapric material; about 30 percent fiber, 10 percent rubbed; weak medium granular structure; very friable; primarily woody fiber; slightly acid; abrupt smooth boundary.

Oa2—13 to 26 inches; dark reddish brown (5YR 3/2), broken face, rubbed, and pressed, sapric material; about 20 percent fiber, 5 percent rubbed; weak coarse subangular blocky structure parting to weak coarse granular; very friable; primarily woody fiber; about 3 percent woody coarse fragments; charcoal line 0.5 inch thick at a depth of 23 inches; slightly acid; clear smooth boundary.

Oa3—26 to 30 inches; dark reddish brown (5YR 3/2), broken face, rubbed, and pressed, sapric material; about 15 percent fiber, 5 percent rubbed; massive; very friable; primarily woody fiber; slightly acid; abrupt smooth boundary.

Oa4—30 to 31 inches; black (5YR 2/1), broken face, rubbed, and pressed, sapric material; about 25 percent fiber, 10 percent rubbed; massive; friable; primarily woody fiber; about 50 percent mineral material; slightly acid; abrupt smooth boundary.

2Cg1—31 to 37 inches; olive gray (5Y 5/2) loamy sand; massive; friable; slight effervescence; mildly alkaline; clear smooth boundary.

2Cg2—37 to 60 inches; light olive gray (5Y 6/2) coarse sand; common medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; single grain; loose; slightly acid.

The thickness of the organic material ranges from 16 to 50 inches. The surface tier has hue of 5YR to 10YR, value of 2, and chroma of 1 or 2, or it is neutral and has value of 2. The organic material is sapric or hemic. Some pedons have a thin surface layer of fibric material. The organic material below a depth of 12 inches has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 to 3. It is dominantly sapric material, but it includes hemic layers that total less than 10 inches thick.

The 2C horizon has value of 5 or 6 and chroma of 1 or 2. It is sand, loamy sand, fine sand, loamy fine sand, coarse sand, or loamy coarse sand. Some pedons do not have free carbonates. Others have free carbonates throughout the 2C horizon.

Taylor Series

The Taylor series consists of deep, moderately well drained, slowly permeable soils that formed in silty and clayey sediments on glacial lake plains. Slopes range from 0 to 6 percent.

Typical pedon of Taylor silt loam, in an area of Taylor and Dalbo silt loams, 0 to 6 percent slopes, 1,720 feet south and 125 feet west of the northeast corner of sec. 26, T. 57 N., R. 27 W.

Oi—1 inch to 0; organic litter, mainly leaves and twigs.
A—0 to 2 inches; very dark gray (10YR 3/1) silt loam; moderate fine and medium granular structure; firm; slightly acid; abrupt wavy boundary.
E—2 to 6 inches; grayish brown (10YR 5/2) silt loam; moderate thin and medium platy structure; firm; common very fine manganese nodules; medium acid; clear smooth boundary.
Bt1—6 to 11 inches; brown (10YR 4/3) and dark yellowish brown (10YR 4/4) clay; weak medium and coarse prismatic structure parting to moderate and strong fine and medium subangular blocky; firm; continuous thin dark brown (10YR 4/3) and dark grayish brown (10YR 4/2) clay films on faces of peds; medium acid; clear smooth boundary.
Bt2—11 to 18 inches; dark grayish brown (10YR 4/2) clay; weak medium and coarse prismatic structure parting to moderate and strong fine and very fine subangular blocky; firm; continuous thin dark grayish brown (10YR 4/2) and few very dark grayish brown (10YR 3/2) clay films on faces of peds; slightly acid; clear smooth boundary.
BC—18 to 21 inches; dark grayish brown (10YR 4/2) clay; weak coarse prismatic structure parting to weak and moderate fine and very fine subangular blocky; firm; mildly alkaline; slight effervescence; clear wavy boundary.
C1—21 to 43 inches; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) clay; common medium distinct yellowish brown (10YR 5/4) and light yellowish brown (10YR 6/4) mottles; weak and moderate fine and very fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear wavy boundary.
C2—43 to 60 inches; grayish brown (2.5Y 5/2) and olive gray (5Y 5/2) clay; common large distinct light yellowish brown (10YR 6/4) mottles; weak and moderate fine subangular blocky structure; firm; strong effervescence; moderately alkaline.

The thickness of the solum is 18 to 36 inches. The depth to free carbonates is 15 to 36 inches.

The A horizon has value of 2 or 3. The E horizon has value of 4 or 5 and chroma of 1 or 2 or has value of 5 and chroma of 3. The A and E horizons are silt loam or silty clay loam. Some pedons have a thin BE horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. In some pedons it has chroma of 2 and has no mottles. Pedons having a dominant chroma of more than 2 have mottles with chroma of 2 or less in the upper 10 inches of the Bt horizon. The C horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 2 to 4. It is typically clay, but in some pedons it is silty clay and in others it has thin layers ranging from very fine sandy loam to silty clay loam.

Thistledew Series

The Thistledew series consists of deep, moderately well drained soils on the margins of glacial lake plains and on deltas on the lake plains. These soils formed in a mantle of sandy outwash and in the underlying loamy and clayey sediments. Permeability is rapid in the sandy material, moderately slow in the loamy material, and slow in the clayey underlying material. Slopes range from 1 to 6 percent.

Typical pedon of Thistledew loamy fine sand, 0 to 6 percent slopes, 1,350 feet north and 250 feet east of the southwest corner of sec. 2, T. 61 N., R. 22 W.

Oa—1 inch to 0; black (5YR 2/1) well decomposed forest litter; weak fine and very fine granular structure; very friable; strongly acid; abrupt wavy boundary.
E—0 to 2 inches; gray (10YR 5/1) loamy fine sand, light gray (10YR 7/1) dry; weak very fine and fine subangular blocky structure; very friable; many roots; strongly acid; clear wavy boundary.
Bw1—2 to 7 inches; yellowish brown (10YR 5/4) fine sandy loam, light brownish gray (10YR 6/2) dry; weak medium and coarse subangular blocky structure; very friable; many roots; medium acid; clear smooth boundary.
Bw2—7 to 16 inches; brown (10YR 5/3) loamy fine sand; weak coarse and medium subangular blocky structure; very friable; many roots; medium acid; clear smooth boundary.
E'—16 to 23 inches; light brownish gray (10YR 6/2) fine sand; weak coarse subangular blocky structure; very friable; many roots; medium acid; abrupt wavy boundary.
2Bt—23 to 38 inches; brown (10YR 5/3) and dark yellowish brown (10YR 4/4) sandy clay loam; few fine distinct light brownish gray (2.5Y 6/2) mottles; weak coarse and very coarse subangular blocky structure; firm; few roots; many thin and moderately thick dark brown (10YR 4/3) clay bridges between sand grains; common thin clay films on faces of peds; slightly acid; abrupt wavy boundary.
3BC—38 to 46 inches; dark grayish brown (2.5Y 4/2) clay; few fine faint light olive brown (2.5Y 5/4) mottles; strong very fine and fine subangular blocky structure; firm; few thin clay films on faces of peds; neutral; clear wavy boundary.

3C—46 to 60 inches; grayish brown (2.5Y 5/2) clay; common medium faint light olive brown (2.5Y 5/4) and few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and very fine subangular blocky structure; firm; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates are 26 to 52 inches. The sandy mantle is 14 to 36 inches thick. The loamy sediment is 3 to 18 inches thick.

Some pedons have an A horizon. The A, E, Bw, and E' horizons are loamy fine sand, loamy sand, fine sand, loamy coarse sand, sand, or coarse sand. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It typically is sandy clay loam or loam but in some pedons has thin subhorizons of sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2.

Warba Series

The Warba series consists of deep, well drained, moderately slowly permeable soils on glacial moraines and glacial till plains. These soils formed in loamy glacial till. Slopes range from 1 to 25 percent.

Typical pedon of Warba fine sandy loam, 1 to 8 percent slopes, 1,000 feet south and 750 feet west of the northeast corner of sec. 14, T. 58 N., R. 25 W.

Oi—1 inch to 0; organic litter, mainly leaves and twigs.
A—0 to 1 inch; very dark gray (10YR 3/1) fine sandy loam; weak very fine granular structure; friable; medium acid; abrupt smooth boundary.
E1—1 to 4 inches; grayish brown (10YR 5/2) fine sandy loam; moderate thin platy structure; friable, slightly hard; many roots; strongly acid; clear smooth boundary.
E2—4 to 7 inches; light brownish gray (10YR 6/2) fine sandy loam; moderate medium platy structure; friable, slightly hard; many roots; strongly acid; clear smooth boundary.
E/B—7 to 12 inches; light brownish gray (10YR 6/2) fine sandy loam (E); massive; friable; E material surrounding and tonguing into dark brown (10YR 4/3) clay loam (Bt); weak medium subangular blocky structure; firm, hard; many roots; strongly acid; clear wavy boundary.
Bt1—12 to 16 inches; light olive brown (2.5Y 5/4) clay loam; moderate fine and medium angular blocky structure; firm, hard; few roots; continuous thin and moderately thick dark brown (10YR 4/3) clay films on faces of peds; patchy light brownish gray (10YR 6/2) sand coatings on vertical faces of peds in the upper part; strongly acid; gradual smooth boundary.
Bt2—16 to 30 inches; light olive brown (2.5Y 5/4) clay loam; moderate coarse prismatic structure parting to strong fine and medium angular blocky; firm, hard; few roots; continuous thin and moderately thick dark brown (10YR 4/3) clay films on faces of peds; many very dark brown (10YR 2/2) organic stains on faces of peds; medium acid; gradual smooth boundary.
Bt3—30 to 48 inches; light olive brown (2.5Y 5/4) clay loam; moderate coarse subangular blocky structure; firm, hard; few roots; continuous thin and few moderately thick brown (10YR 5/3) clay films on faces of peds; many very dark grayish brown (10YR 3/2) organic stains on faces of peds; neutral; clear wavy boundary.
C—48 to 60 inches; light olive brown (2.5Y 5/4) sandy clay loam; massive; friable, slightly hard; few roots; about 3 percent coarse shale fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 32 to 51 inches. The depth to free carbonates ranges from 34 to 70 inches.

The A horizon has value of 2 or 3. Some pedons do not have an A horizon. The E horizon has value of 4 to 6 and chroma of 2 or 3. The A and E horizons are fine sandy loam, very fine sandy loam, loam, or silt loam. Pedons have an E/B horizon or a B/E horizon, or both. The B horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 or 4. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 or 4. The B and C horizons are clay loam, sandy clay loam, or loam.

Waskish Series

The Waskish series consists of deep, very poorly drained, rapidly permeable soils that formed primarily in slightly decomposed sphagnum moss. These soils are in bogs on outwash plains and glacial moraines. Slopes are 0 to 1 percent.

Typical pedon of Waskish peat, in an area of Lobo and Waskish peats, 2,500 feet north and 1,000 feet east of the southwest corner of sec. 24, T. 146 N., R. 25 W.

Oi1—0 to 7 inches; light yellowish brown (10YR 6/4), broken face, fibric material, very pale brown (10YR 7/3 and 8/3) rubbed and pressed; about 95 percent fiber, 85 percent rubbed; massive; loose; primarily sphagnum fiber; about 7 percent mineral material; extremely acid; clear wavy boundary.
Oi2—7 to 12 inches; dark brown (7.5YR 3/2), broken face, rubbed, and pressed, fibric material; about 80 percent fiber, 70 percent rubbed; weak thin platy structure; nonplastic and nonsticky; primarily sphagnum fiber; about 10 percent mineral material; extremely acid; clear smooth boundary.
Oi3—12 to 26 inches; brown (7.5YR 5/4 and 4/4), broken face and rubbed, fibric material, light brown (7.5YR 6/4) pressed; about 85 percent fiber, 70 percent rubbed; weak thin platy structure; nonplastic and nonsticky; primarily sphagnum fiber; about 8

percent mineral material; extremely acid; clear smooth boundary.
Oe—26 to 32 inches; dark brown (7.5YR 3/2), broken face and rubbed, hemic material, brown (7.5YR 4/2) pressed; about 65 percent fiber, 30 percent rubbed; weak coarse subangular blocky structure; nonplastic and nonsticky; primarily sphagnum and herbaceous fiber; about 7 percent mineral material; extremely acid; clear smooth boundary.
Oi4—32 to 67 inches; reddish brown (5YR 4/4), broken face and rubbed, fibric material, light brown (7.5YR 6/4) pressed; about 95 percent fiber, 75 percent rubbed; weak thick platy structure; nonplastic and nonsticky; primarily sphagnum fibers; about 7 percent mineral material; extremely acid.

The organic material is more than 63 inches thick. It commonly is 10 to 20 feet thick. It has hue of 5YR to 10YR, value of 3 to 7, and chroma of 2 to 4. The content of fiber ranges from about 75 to more than 90 percent before rubbing and from 60 to 90 percent after rubbing. The content of woody coarse fragments ranges from 0 to 10 percent. The content of mineral material is 7 to 10 percent.

Wawina Series

The Wawina series consists of deep, well drained, moderately rapidly permeable soils that formed in sandy sediments on glacial lake plains, deltas, and river terraces. Slopes range from 0 to 10 percent.

Typical pedon of Wawina loamy very fine sand, 0 to 10 percent slopes, 1,450 feet north and 75 feet west of the center of sec. 22, T. 53 N., R. 22 W.

Oi—1 inch to 0; organic litter, mainly leaves and small twigs.
E1—0 to 2 inches; dark gray (10YR 4/1) loamy very fine sand, light gray (10YR 6/1) dry; weak very fine granular structure; very friable; many fine roots; medium acid; abrupt wavy boundary.
E2—2 to 3 inches; dark grayish brown (10YR 4/2) loamy very fine sand, light brownish gray (10YR 6/2) dry; weak very fine granular structure; very friable; many fine roots; medium acid; abrupt wavy boundary.
Bw—3 to 9 inches; yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) very fine sand; weak fine and medium subangular blocky structure; very friable; common fine roots; medium acid; clear wavy boundary.
BC—9 to 31 inches; pale brown (10YR 6/3) very fine sand; weak coarse prismatic structure; very friable; few fine roots; slightly acid; clear smooth boundary.
C—31 to 65 inches; light olive brown (2.5Y 5/4) very fine sand; few medium and fine faint yellowish brown (10YR 5/4) mottles; massive; very friable; one discontinuous yellowish brown (10YR 5/4) loamy very fine sand lamella, 0.25 inch thick, at a depth of about 47 inches; slightly acid.

The thickness of the solum ranges from 16 to 43 inches. The part of the profile between depths of 10 and 40 inches is dominantly very fine sand or loamy very fine sand, but it commonly includes thin layers of fine sand, loamy fine sand, or very fine sandy loam. Between depths of 24 and 60 inches, many pedons have thin lamellae of dark brown to yellowish brown material in which the content of clay is slightly higher. The total thickness of the lamellae is less than 6 inches.

Some pedons have a thin A horizon. The E horizon has value of 4 to 7 and chroma of 1 or 2. The Bw horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 2 to 4.

Wildwood Series

The Wildwood series consists of deep, very poorly drained, slowly permeable soils on glacial lake plains. These soils formed in a thin layer of organic material and in the underlying clayey lacustrine sediments (fig. 12). Slopes are 0 to 1 percent.

Typical pedon of Wildwood muck, 2,400 feet east and 275 feet south of the northwest corner of sec. 22, T. 150 N., R. 26 W.

Oa1—0 to 10 inches; dark reddish brown (5YR 2/2) sapric material; weak fine and medium granular structure; friable; many fine and very fine roots; strongly acid; abrupt wavy boundary.
Oa2—10 to 12 inches; black (5YR 2/1) sapric material; weak medium platy structure; friable; many fine roots; strongly acid; abrupt wavy boundary.
A—12 to 17 inches; black (10YR 2/1) silty clay; weak coarse subangular blocky structure; firm; many fine roots; medium acid; clear irregular boundary.
Bg—17 to 24 inches; dark gray (5Y 4/1) and very dark gray (5Y 3/1) clay; strong fine subangular blocky structure; firm; few fine roots; medium acid; clear wavy boundary.
Cg1—24 to 30 inches; gray (5Y 5/1) clay; common fine distinct light olive brown (2.5Y 5/6) mottles; moderate fine subangular blocky structure; firm; slight effervescence; moderately alkaline; gradual smooth boundary.
Cg2—30 to 60 inches; gray (5Y 5/1 and 6/1) clay; common large prominent yellowish brown (10YR 5/8) mottles; moderate fine subangular blocky structure; friable; strong effervescence; moderately alkaline.

The thickness of the solum, including the histic epipedon, and the depth to free carbonates range from

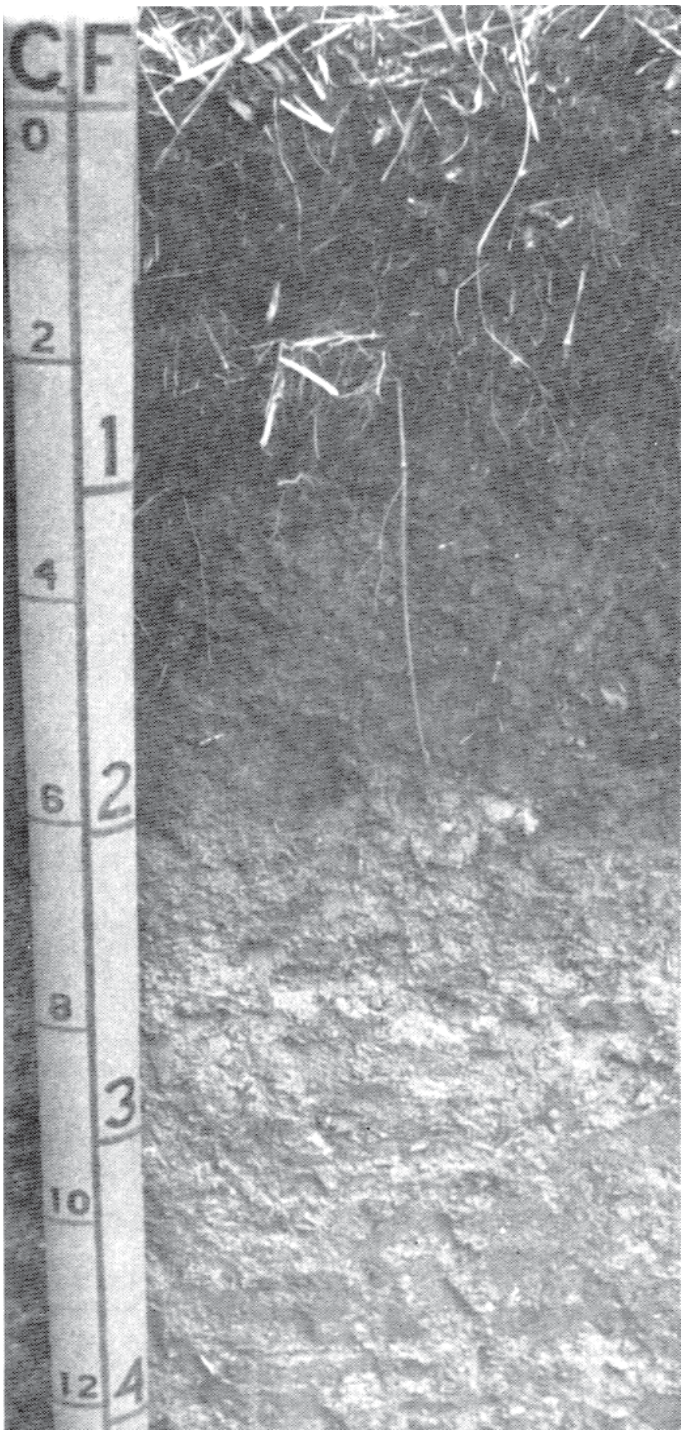

Figure 12.—Profile of Wildwood muck, which formed in organic material and in the underlying lacustrine sediments.

18 to 30 inches. The histic epipedon is sapric or hemic material, or both.

The A horizon has hue of 10YR to 5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2 or 3. It is typically clay or silty clay but in some pedons has thin layers of silty clay loam or clay loam. The B horizon has value of 4 to 6 and chroma of 1 or 2. It typically is clay but in some pedons has thin layers of silty clay. The C horizon has colors and textures similar to those of the B horizon. Some pedons have subhorizons of clay loam or silty clay loam below a depth of 40 inches. In some of these subhorizons, the content of coarse fragments is as much as 10 percent.

Winterfield Series

The Winterfield series consists of deep, somewhat poorly drained, rapidly permeable soils on flood plains. These soils formed in sandy alluvium. Slopes range from 0 to 4 percent.

Typical pedon of Winterfield loamy fine sand, in an area of Pengilly-Winterfield association, 3,500 feet east and 1,800 feet north of the southwest corner of sec. 17, T. 54 N., R. 24 W.

Oi—3 inches to 0; organic litter, mainly well decomposed leaves, fine roots, and twigs.

A—0 to 3 inches; very dark brown (10YR 2/2) loamy fine sand; weak fine and medium granular structure; very friable; many roots; neutral; clear smooth boundary.

C1—3 to 14 inches; dark brown (10YR 4/3) and dark grayish brown (10YR 4/2) loamy fine sand; weak medium and coarse subangular blocky structure; very friable; many roots; medium acid; gradual wavy boundary.

C2—14 to 38 inches; pale brown (10YR 6/3) and brown (10YR 5/3) fine sand; common fine faint light brownish gray (2.5Y 6/2) and few fine distinct strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky structure; very friable; few roots; medium acid; clear smooth boundary.

C3—38 to 52 inches; pale brown (10YR 6/3) sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grain; loose; medium acid; gradual smooth boundary.

C4—52 to 60 inches; pale brown (10YR 6/3) sand; few fine distinct yellowish brown (10YR 5/6) and many large faint light brownish gray (10YR 6/2) mottles; single grain; loose; medium acid.

The A horizon has hue of 7.5YR or 10YR and value of 2 or 3. The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 or 4. Mottles that have chroma of 2 or less are within a depth of 40 inches. The A and C horizons are loamy fine sand, fine sand, loamy sand, or sand.

Zimmerman Series

The Zimmerman series consists of deep, excessively drained, rapidly permeable soils on glacial outwash plains. These soils formed in sandy outwash (fig. 13). Slopes range from 0 to 8 percent.

Typical pedon of Zimmerman loamy fine sand, 1 to 8 percent slopes, about 2.5 miles east and 2 miles south of Grand Rapids; 2,080 feet south and 1,230 feet west of the northeast corner of sec. 35, T. 55 N., R. 25 W.

Oi—1 inch to 0; organic litter of fresh and partly decomposed pine needles, twigs, and leaves.

E—0 to 3 inches; dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), and dark gray (10YR 4/1) loamy fine sand, light brownish gray (10YR 6/2) dry; weak fine and very fine subangular blocky structure; very friable; many roots; strongly acid; clear wavy boundary.

Bw1—3 to 11 inches; dark yellowish brown (10YR 4/4) loamy fine sand, brown (10YR 5/3) dry; weak medium subangular blocky structure; very friable; many roots; strongly acid; clear smooth boundary.

Bw2—11 to 23 inches; yellowish brown (10YR 5/4) fine sand; weak medium subangular blocky structure; very friable; many roots; medium acid; gradual smooth boundary.

E'—23 to 36 inches; light gray (10YR 7/2) and pale brown (10YR 6/3) fine sand; single grain; loose; many roots; medium acid; abrupt wavy boundary.

E&Bt—36 to 63 inches; light gray (10YR 7/2) and pale brown (10YR 6/3) fine sand (E'); single grain; loose; several brown (7.5YR 4/4) loamy fine sand (Bt) lamellae 0.25 inch to 1.5 inches thick, with a total thickness of about 4 inches; weak medium and coarse subangular blocky structure; firm; moderately thick clay bridges between sand grains; common thin clay films on faces of peds; many roots; medium acid; abrupt wavy boundary.

C—63 to 75 inches; pale brown (10YR 6/3) fine sand; single grain; loose; few roots; slightly acid.

The thickness of the solum ranges from 40 to 70 inches. The depth to the uppermost lamella is 24 to 60 inches.

The E horizon has hue of 7.5YR or 10YR. It has value of 4 to 6 and chroma of 2 or has value of 5 or 6 and chroma of 3. The Bw horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 or 4. In individual pedons it is at least 1 unit higher in chroma or 1 unit lower in value, or both, than the overlying E horizon and the underlying E' horizon. The E' horizon has hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 2 or 3.

The Bt horizon consists of one or more irregular, continuous or discontinuous lamellae. Individual lamellae are 0.25 inch to 4 inches thick. Their total thickness is less than 6 inches. The lamellae have hue of 5YR to 10YR, value of 3 to 5, and chroma of 4 or 5. They are loamy fine sand, fine sand, fine sandy loam, loamy very fine sand, or very fine sand. They are separated by E' material. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 2 to 4.

Figure 13.—Profile of Zimmerman loamy fine sand, which formed in sandy outwash. This soil has textural bands in the lower part.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

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.

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.

Association, soil. A group of soils 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—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

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, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

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.

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.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil 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 are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

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. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious

layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

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.

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 the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not 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, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action (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 (geology). 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 (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

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 and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

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 (geology). Water filling all the unblocked pores of underlying 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.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. 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. The major horizons 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, any plowed or disturbed surface layer.

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 O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon 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) granular, 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 horizon. 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.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but 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-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

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.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

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.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

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.

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 strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

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, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

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 matter. Plant and animal residue in the soil in various stages of decomposition.

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.*

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 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

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 permeability the soil may not adequately filter effluent from a waste disposal system.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

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 degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rooting depth (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.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. 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. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

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.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multipled by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into 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.

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 of separates recognized in the United States are as follows:

	Millimeters
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 underlying material. 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.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. 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).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 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. 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 too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

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, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

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Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-74 at Grand Rapids, Minnesota]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	16.9	-5.2	5.9	42	-40	0	0.75	0.31	1.10	3	10.7
February---	24.7	-.1	12.3	47	-34	0	.60	.16	.95	2	7.4
March------	36.0	12.6	24.3	59	-27	0	1.20	.49	1.76	4	10.9
April------	52.2	28.5	40.4	80	5	11	2.10	1.10	2.91	5	6.6
May--------	65.9	39.5	52.7	86	21	143	3.37	1.82	4.63	8	1.2
June-------	75.1	49.4	62.3	90	30	369	3.52	1.70	4.99	7	.0
July-------	79.3	54.2	66.8	91	38	521	4.08	2.35	5.48	8	.0
August-----	77.3	52.3	64.8	90	35	459	3.23	1.47	4.65	7	.0
September--	66.4	43.4	54.9	86	24	166	3.03	1.43	4.32	6	.0
October----	56.3	35.0	45.7	81	13	64	2.12	.72	3.23	5	1.4
November---	36.4	20.7	28.5	61	-10	0	1.21	.55	1.73	3	6.9
December---	22.9	4.5	13.7	46	-31	0	1.01	.48	1.43	3	11.9
Yearly:											
Average--	50.8	28.3	39.4	---	---	---	---	---	---	---	---
Extreme--	---	---	---	92	-40	---	---	---	---	---	---
Total----	---	---	---	---	---	1,733	26.22	22.43	29.82	61	57.0

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-74 at Grand Rapids, Minnesota]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 12	May 27	June 11
2 years in 10 later than--	May 8	May 23	June 6
5 years in 10 later than--	Apr. 28	May 15	May 28
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 21	Sept. 9	Sept. 6
2 years in 10 earlier than--	Sept. 26	Sept. 15	Sept. 10
5 years in 10 earlier than--	Oct. 7	Sept. 26	Sept. 16

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-74 at Grand Rapids, Minnesota]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	140	111	95
8 years in 10	147	119	101
5 years in 10	161	133	111
2 years in 10	175	147	121
1 year in 10	182	154	127

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
32B	Nebish very fine sandy loam, 2 to 6 percent slopes	64,560	3.8
32D	Nebish fine sandy loam, 10 to 25 percent slopes	9,995	0.6
72	Shooker very fine sandy loam	7,855	0.5
147	Spooner silt loam	16,270	1.0
158B	Zimmerman loamy fine sand, 1 to 8 percent slopes	68,620	4.1
167B	Baudette silt loam, 0 to 5 percent slopes	15,965	0.9
202	Meehan loamy sand	10,270	0.6
240B	Warba fine sandy loam, 1 to 8 percent slopes	85,675	5.1
240D	Warba fine sandy loam, 10 to 25 percent slopes	22,185	1.3
243	Stuntz very fine sandy loam	11,305	0.7
268B	Cromwell fine sandy loam, 1 to 10 percent slopes	4,680	0.3
268D	Cromwell fine sandy loam, 10 to 25 percent slopes	3,270	0.2
458E	Menahga loamy sand, 10 to 30 percent slopes	24,890	1.5
533	Loxley peat	7,325	0.4
541	Rifle mucky peat	15,875	0.9
544	Cathro muck	42,130	2.5
549	Greenwood peat	126,365	7.5
550	Dora mucky peat	11,680	0.7
614	Blackhoof muck	1,500	0.1
615	Cowhorn loamy very fine sand	35,700	2.1
616	Effie loam	23,580	1.4
617B	Goodland silt loam, 1 to 10 percent slopes	11,585	0.7
618B	Itasca silt loam, 1 to 10 percent slopes	22,690	1.3
619	Keewatin silt loam	18,170	1.1
620B	Cutaway loamy sand, 0 to 8 percent slopes	76,660	4.6
621	Morph very fine sandy loam	9,640	0.6
622B	Nashwauk fine sandy loam, 1 to 10 percent slopes	126,800	7.5
622E	Nashwauk fine sandy loam, 12 to 35 percent slopes	6,650	0.4
624B	Rosy very fine sandy loam, 0 to 6 percent slopes	19,370	1.1
625	Sandwick loamy fine sand	25,060	1.5
626B	Suomi silt loam, 1 to 8 percent slopes	26,120	1.6
626D	Suomi loam, 10 to 25 percent slopes	10,400	0.6
627	Tawas muck	15,410	0.9
628	Talmoon silt loam	10,200	0.6
629B	Wawina loamy very fine sand, 0 to 10 percent slopes	7,480	0.4
630	Wildwood muck	26,600	1.6
655	Bearville loamy sand	5,900	0.4
656B	Thistledew loamy fine sand, 0 to 6 percent slopes	6,740	0.4
797	Mooselake and Lupton mucky peats	145,300	8.6
798	Sago and Roscommon soils	10,400	0.6
799	Seelyeville-Bowstring association	30,985	1.8
801B	Taylor and Dalbo silt loams, 0 to 6 percent slopes	43,900	2.6
803B	Warba-Menahga complex, 1 to 8 percent slopes	17,500	1.0
803D	Warba-Menahga complex, 10 to 25 percent slopes	11,300	0.7
844F	Mahtomedi and Emmert soils, 12 to 50 percent slopes	3,800	0.2
866B	Menahga-Itasca complex, 1 to 10 percent slopes	6,505	0.4
866E	Menahga-Itasca complex, 10 to 25 percent slopes	2,850	0.2
867B	Menahga and Graycalm soils, 0 to 8 percent slopes	123,400	7.3
868B	Mahtomedi and Graycalm soils, 1 to 10 percent slopes	1,700	0.1
869	Lobo and Waskish peats	2,965	0.2
870C	Itasca-Goodland silt loams, 2 to 12 percent slopes	47,700	2.8
870E	Itasca-Goodland silt loams, 12 to 25 percent slopes	17,800	1.1
871	Indus and Brickton soils	43,900	2.6
872	Pengilly-Winterfield association	24,750	1.5
995	Borosaprists, depressional	27,400	1.6
1031	Histosols, ponded	2,735	0.2
1033	Aquents, sandy	700	*
1041	Pits, mine	3,930	0.2
1042	Dumps, mine	3,720	0.2
1043C	Udorthents, nearly level to rolling	5,980	0.4
1043F	Udorthents, very steep	3,535	0.2
1044	Slickens	6,355	0.4
1826B	Nashwauk-Menahga complex, 1 to 10 percent slopes	18,490	1.1
1826D	Nashwauk-Menahga complex, 10 to 25 percent slopes	27,755	1.6
1883D	Nashwauk-Rock outcrop complex, 6 to 25 percent slopes	3,495	0.2
	Water	11,100	0.7
	Total	1,685,120	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Oats	Grass-legume hay	Bromegrass-alfalfa	Grass-clover	Kentucky bluegrass	Reed canarygrass
	Bu	Tons	AUM*	AUM*	AUM*	Tons
32B---------- Nebish	75	4.0	6.0	5.0	4.0	4.0
32D---------- Nebish	---	---	5.2	4.0	3.5	---
72---------- Shooker	75	4.5	6.5	5.4	4.0	4.5
147---------- Spooner	80	4.5	6.5	5.4	4.0	4.5
158B---------- Zimmerman	50	3.0	4.5	3.3	2.6	---
167B---------- Baudette	85	4.5	6.5	5.4	4.0	4.5
202---------- Meehan	50	2.5	---	---	1.3	---
240B---------- Warba	75	4.0	6.0	5.0	4.0	4.0
240D---------- Warba	---	---	5.2	4.0	3.5	---
243---------- Stuntz	70	4.0	6.0	5.0	4.0	4.5
268B---------- Cromwell	60	---	---	3.0	2.0	---
268D---------- Cromwell	---	---	---	2.5	1.7	---
458E---------- Menahga	---	---	---	---	0.7	---
533---------- Loxley	---	---	---	---	---	---
541---------- Rifle	---	---	---	---	---	---
544---------- Cathro	---	---	---	---	---	---
549---------- Greenwood	---	---	---	---	---	---
550---------- Dora	---	---	---	---	---	---
614---------- Blackhoof	---	---	---	---	---	4.0
615---------- Cowhorn	70	4.0	6.0	5.0	3.8	4.0
616---------- Effie	70	4.0	6.0	5.0	3.8	4.5

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Oats	Grass-legume hay	Bromegrass-alfalfa	Grass-clover	Kentucky bluegrass	Reed canarygrass
	Bu	Tons	AUM*	AUM*	AUM*	Tons
617B---------- Goodland	65	3.8	5.7	4.8	3.5	3.7
618B---------- Itasca	75	4.0	6.0	5.0	3.8	4.0
619---------- Keewatin	60	---	---	4.5	3.2	3.5
620B---------- Cutaway	50	3.0	4.5	4.0	2.5	---
621---------- Morph	75	4.0	6.0	5.0	3.8	4.5
622B---------- Nashwauk	60	---	---	4.2	3.0	---
622E---------- Nashwauk	---	---	---	3.0	2.0	---
624B---------- Rosy	75	4.0	6.0	5.0	4.0	4.0
625---------- Sandwick	55	3.2	4.8	4.2	3.0	3.8
626B---------- Suomi	70	4.0	6.0	5.0	3.8	4.0
626D---------- Suomi	---	---	---	3.8	3.2	---
627---------- Tawas	---	---	---	---	---	---
628---------- Talmoon	---	---	---	---	---	4.0
629B---------- Wawina	60	3.5	5.2	4.2	3.2	---
630---------- Wildwood	---	---	---	---	---	4.5
655---------- Bearville	55	3.5	5.2	4.2	3.0	4.0
656B---------- Thistledew	50	3.0	4.5	3.8	2.5	---
797---------- Mooselake and Lupton	---	---	---	---	---	---
798---------- Sago and Roscommon	---	---	---	---	---	---
799**:						
Seelyeville----------	---	---	---	---	---	---
Bowstring----------	---	---	---	---	---	---
801B---------- Taylor and Dalbo	70	4.0	6.0	5.0	3.8	4.0
803B---------- Warba-Menahga	64	3.4	5.1	3.9	2.9	---

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Oats	Grass-legume hay	Bromegrass-alfalfa	Grass-clover	Kentucky bluegrass	Reed canarygrass
	Bu	Tons	AUM*	AUM*	AUM*	Tons
803D---------- Warba-Menahga	---	---	4.2	3.3	2.7	---
844F---------- Mahtomedi and Emmert	---	---	---	---	---	---
866B---------- Menahga-Itasca	52	3.1	---	---	2.2	---
866E---------- Menahga-Itasca	---	---	---	---	1.8	---
867B---------- Menahga and Graycalm	40	2.5	3.7	---	1.2	---
868B---------- Mahtomedi and Graycalm	35	2.2	---	---	1.0	---
869---------- Lobo and Waskish	---	---	---	---	---	---
870C---------- Itasca-Goodland	70	3.9	5.8	4.8	3.5	3.9
870E---------- Itasca-Goodland	---	---	5.0	4.0	3.0	---
871---------- Indus and Brickton	70	4.0	6.0	5.0	3.5	4.5
872**: Pengilly----------	---	---	---	---	---	---
Winterfield----------	---	---	---	---	---	---
995. Borosaprists						
1031. Histosols						
1033. Aquents						
1041**. Pits						
1042**. Dumps						
1043C, 1043F. Udorthents						
1044**. Slickens						
1826B---------- Nashwauk-Menahga	55	2.8	---	3.5	2.3	---
1826D---------- Nashwauk-Menahga	---	---	---	2.8	1.5	---
1883D---------- Nashwauk-Rock outcrop	---	---	---	---	---	---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
32B---------- Nebish	7A	Slight	Slight	Slight	Slight	Quaking aspen-------	84	99	White spruce, eastern white pine, northern red oak, balsam fir.
						Balsam fir----------	65	129	
						Paper birch---------	65	73	
						American basswood---	70	66	
						Sugar maple---------	60	43	
						Northern red oak----	70	66	
						White spruce--------	60	119	
						Eastern white pine--	55	106	
						Red pine------------	60	101	
						Jack pine-----------	65	94	
32D---------- Nebish	7R	Moderate	Moderate	Slight	Slight	Quaking aspen-------	84	99	White spruce, eastern white pine, northern red oak, balsam fir.
						Balsam fir----------	65	129	
						Paper birch---------	65	73	
						American basswood---	70	66	
						Sugar maple---------	60	43	
						Northern red oak----	70	66	
						White spruce--------	60	119	
						Eastern white pine--	55	106	
						Red pine------------	60	101	
						Jack pine-----------	65	94	
72---------- Shooker	6W	Slight	Severe	Moderate	Moderate	Quaking aspen-------	78	91	White spruce, black spruce, eastern white pine, balsam fir.
						Balsam fir----------	60	118	
						Paper birch---------	65	73	
						American basswood---	65	59	
						Black ash-----------	65	47	
						American elm--------	---	---	
						White spruce--------	60	118	
147---------- Spooner	7W	Slight	Severe	Moderate	Moderate	Quaking aspen-------	80	94	White spruce, black spruce.
						Balsam fir----------	60	118	
						Paper birch---------	65	73	
						Black ash-----------	65	47	
						American elm--------	---	---	
						White spruce--------	60	118	
158B---------- Zimmerman	8S	Slight	Moderate	Moderate	Slight	Red pine------------	65	115	Red pine, eastern white pine, jack pine, balsam fir.
						Eastern white pine--	60	121	
						Jack pine-----------	70	103	
						Paper birch---------	65	73	
						Quaking aspen-------	77	90	
						Balsam fir----------	65	129	
						Northern red oak----	60	51	
						White spruce--------	65	129	
167B---------- Baudette	7A	Slight	Slight	Slight	Slight	Quaking aspen-------	84	99	White spruce, eastern white pine, balsam fir.
						Balsam fir----------	65	129	
						Paper birch---------	65	73	
						Black ash-----------	65	47	
						American elm--------	---	---	
						White spruce--------	60	118	

See footnotes at end of table.

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
202---------- Meehan	6W	Slight	Moderate	Moderate	Moderate	Jack pine---------- Red pine---------- Quaking aspen------- Paper birch--------- Balsam fir---------- Eastern white pine--	60 60 70 60 59 55	85 101 81 65 116 106	Eastern white pine, jack pine, white spruce, balsam fir, red pine, red maple.
240B---------- Warba	7A	Slight	Slight	Slight	Slight	Quaking aspen------- Balsam fir---------- Paper birch--------- American basswood--- Sugar maple--------- Northern red oak---- Eastern white pine-- Red pine---------- White spruce--------	81 61 65 70 60 67 55 60 60	96 121 73 66 43 61 106 101 118	White spruce, balsam fir, eastern white pine, northern red oak.
240D---------- Warba	7R	Moderate	Moderate	Slight	Slight	Quaking aspen------- Balsam fir---------- Paper birch--------- American basswood--- Sugar maple--------- Northern red oak---- Eastern white pine-- Red pine---------- White spruce--------	81 61 65 70 60 67 55 60 60	96 120 73 66 43 61 106 101 118	White spruce, balsam fir, eastern white pine, northern red oak.
243---------- Stuntz	6A	Slight	Slight	Slight	Slight	Quaking aspen------- Balsam fir---------- Paper birch--------- American basswood--- American elm-------- Sugar maple--------- White spruce--------	79 60 65 65 --- 55 60	93 118 73 59 --- 38 118	White spruce, eastern white pine, balsam fir.
268B---------- Cromwell	7S	Slight	Slight	Moderate	Slight	Red pine---------- Balsam fir---------- Quaking aspen------- Paper birch--------- Northern red oak---- Jack pine---------- American basswood--- Eastern white pine--	60 59 70 60 60 65 60 55	101 116 81 65 51 94 51 106	Red pine, jack pine, eastern white pine.
268D---------- Cromwell	7R	Moderate	Moderate	Moderate	Slight	Red pine---------- Balsam fir---------- Quaking aspen------- Paper birch--------- Northern red oak---- Jack pine---------- American basswood--- Eastern white pine--	60 59 70 60 60 65 60 55	101 116 81 65 51 94 51 106	Red pine, jack pine, eastern white pine.

See footnotes at end of table.

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
458E---------- Menahga	7R	Moderate	Moderate	Moderate	Slight	Red pine----------	60	101	Red pine, white spruce, eastern white pine, jack pine.
						Eastern white pine--	55	106	
						Jack pine----------	67	98	
						White spruce--------	60	118	
						Quaking aspen-------	65	73	
						Paper birch---------	60	65	
						Balsam fir----------	58	113	
						Northern red oak----	55	42	
533---------- Loxley	3W	Slight	Severe	Severe	Severe	Black spruce--------	32	46	Black spruce.
						Balsam fir----------	45	83	
						Tamarack----------	49	---	
541---------- Rifle	4W	Slight	Severe	Severe	Severe	Black spruce--------	35	46	Black spruce, tamarack, balsam fir, northern white-cedar.
						Balsam fir----------	45	83	
						Tamarack----------	45	---	
						Northern white-cedar	30	43	
						Black ash----------	50	34	
544---------- Cathro	3W	Slight	Severe	Severe	Severe	Black ash----------	55	38	Black spruce, balsam fir, tamarack, northern white-cedar.
						Balsam fir----------	53	102	
						Black spruce--------	35	50	
						Tamarack----------	50	---	
						Northern white-cedar	30	42	
549---------- Greenwood	3W	Slight	Severe	Severe	Severe	Black spruce--------	30	43	Black spruce, tamarack.
						Tamarack----------	40	---	
550---------- Dora	4W	Slight	Severe	Severe	Severe	Black spruce--------	35	50	Black spruce, tamarack, balsam fir, northern white-cedar.
						Balsam fir----------	50	96	
						Northern white-cedar	30	42	
						Tamarack----------	49	---	
						Black ash----------	50	34	
614---------- Blackhoof	3W	Slight	Severe	Severe	Severe	Black ash----------	60	43	Balsam fir, northern white-cedar, tamarack, black spruce.
						Balsam fir----------	50	96	
						Black spruce--------	40	56	
						Tamarack----------	50	---	
						Northern white-cedar	35	51	
615---------- Cowhorn	6A	Slight	Slight	Slight	Slight	Quaking aspen-------	75	87	White spruce, eastern white pine, jack pine, balsam fir, black spruce.
						Balsam fir----------	63	124	
						Paper birch---------	65	73	
						White spruce--------	65	129	
						Red pine----------	60	101	
						Jack pine----------	65	94	
616---------- Effie	7W	Slight	Moderate	Moderate	Slight	Quaking aspen-------	87	103	White spruce, black spruce, balsam fir, tamarack, northern white-cedar.
						Balsam fir----------	59	116	
						Paper birch---------	65	73	
						Eastern white pine--	55	106	
						White spruce--------	60	118	
						Black ash----------	65	47	
						Balsam poplar-------	90	107	

See footnotes at end of table.

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
617B---------- Goodland	6A	Slight	Slight	Slight	Slight	Quaking aspen-------	77	90	White spruce, eastern white pine, jack pine, northern red oak, balsam fir.
						Eastern white pine--	55	106	
						Paper birch---------	65	73	
						Balsam fir----------	64	127	
						Northern red oak----	62	54	
						Sugar maple---------	55	38	
						American basswood---	60	51	
						White spruce--------	60	118	
						Red pine------------	60	101	
618B---------- Itasca	8A	Slight	Slight	Slight	Slight	Quaking aspen-------	92	110	White spruce, eastern white pine, jack pine, northern red oak, balsam fir.
						Balsam fir----------	64	127	
						Bigtooth aspen------	86	102	
						Paper birch---------	69	80	
						Northern red oak----	64	57	
						Sugar maple---------	60	43	
						American basswood---	65	59	
						White spruce--------	60	118	
						Eastern white pine--	60	121	
						Red pine------------	60	101	
619---------- Keewatin	6W	Slight	Moderate	Slight	Moderate	Quaking aspen-------	75	87	White spruce, balsam fir, black spruce.
						Balsam fir----------	62	122	
						Paper birch---------	65	73	
						Black ash-----------	65	47	
						White spruce--------	60	118	
620B---------- Cutaway	6S	Slight	Moderate	Moderate	Slight	Quaking aspen-------	77	90	White spruce, red pine, eastern white pine, jack pine, balsam fir.
						Paper birch---------	65	73	
						Balsam fir----------	60	118	
						Red pine------------	60	101	
						Northern red oak----	60	51	
						Jack pine-----------	65	94	
						Eastern white pine--	55	106	
						White spruce--------	60	118	
621---------- Morph	7W	Slight	Severe	Moderate	Moderate	Quaking aspen-------	80	94	White spruce, balsam fir, black spruce.
						Balsam fir----------	61	120	
						Paper birch---------	65	73	
						Black ash-----------	65	47	
						White spruce--------	60	118	
622B---------- Nashwauk	6D	Slight	Slight	Slight	Moderate	Quaking aspen-------	76	89	White spruce, eastern white pine, northern red oak, balsam fir.
						Balsam fir----------	64	127	
						Paper birch---------	65	73	
						Northern red oak----	60	51	
						American basswood---	65	59	
						Sugar maple---------	55	38	
						White spruce--------	62	122	
						Eastern white pine--	55	106	
622E---------- Nashwauk	6R	Moderate	Moderate	Slight	Moderate	Quaking aspen-------	76	89	White spruce, eastern white pine, northern red oak, balsam fir.
						Balsam fir----------	64	127	
						Paper birch---------	65	73	
						Northern red oak----	60	51	
						American basswood---	65	59	
						Sugar maple---------	55	38	
						White spruce--------	62	122	
						Eastern white pine--	55	106	

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
624B---------- Rosy	7A	Slight	Slight	Slight	Slight	Quaking aspen-------	85	101	White spruce, eastern white pine, northern red oak, balsam fir.
						Balsam fir----------	60	118	
						Paper birch---------	65	73	
						American basswood---	65	59	
						Sugar maple---------	55	38	
						Northern red oak----	65	59	
						Eastern white pine--	55	106	
						White spruce--------	60	118	
						Red pine------------	60	101	
625---------- Sandwick	7W	Slight	Moderate	Slight	Slight	Quaking aspen-------	90	107	White spruce, eastern white pine, balsam fir.
						Balsam fir----------	60	118	
						Paper birch---------	65	73	
						Eastern white pine--	55	106	
						Black ash-----------	65	47	
626B---------- Suomi	7A	Slight	Slight	Slight	Slight	Quaking aspen-------	90	107	White spruce, eastern white pine, northern red oak, balsam fir, jack pine.
						Balsam fir----------	66	131	
						Paper birch---------	70	81	
						American basswood---	70	66	
						Sugar maple---------	55	35	
						Northern red oak----	65	59	
						Eastern white pine--	55	106	
						White spruce--------	60	118	
626D---------- Suomi	7R	Moderate	Moderate	Slight	Slight	Quaking aspen-------	90	107	White spruce, eastern white pine, northern red oak, balsam fir, jack pine.
						Balsam fir----------	66	131	
						Paper birch---------	70	81	
						American basswood---	70	66	
						Sugar maple---------	55	38	
						Northern red oak----	65	59	
						Eastern white pine--	55	106	
						White spruce--------	60	119	
627---------- Tawas	4W	Slight	Severe	Severe	Severe	Northern white-cedar	35	51	Balsam fir, black spruce, tamarack, northern white-cedar.
						Balsam fir----------	50	96	
						Black ash-----------	55	38	
						Black spruce--------	40	56	
						Tamarack------------	50	---	
628---------- Talmoon	3W	Slight	Severe	Severe	Severe	Black ash-----------	60	43	Balsam fir, black spruce, tamarack, northern white-cedar.
						Balsam fir----------	55	107	
						American elm--------	---	---	
						Black spruce--------	40	56	
						Tamarack------------	50	---	
						Northern white-cedar	35	51	
629B---------- Wawina	6S	Slight	Moderate	Moderate	Slight	Quaking aspen-------	75	87	Red pine, white spruce, eastern white pine, jack pine, balsam fir.
						Balsam fir----------	59	116	
						Paper birch---------	65	73	
						Red pine------------	60	101	
						Eastern white pine--	55	106	
						White spruce--------	65	129	

See footnotes at end of table.

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
630---------- Wildwood	3W	Slight	Severe	Severe	Severe	Black ash----------	60	43	Balsam fir, black spruce, northern white-cedar.
						Balsam fir----------	50	96	
						American elm--------	---	---	
						Black spruce--------	40	56	
						Tamarack----------	50	---	
						Northern white-cedar	35	51	
655---------- Bearville	7W	Slight	Moderate	Moderate	Moderate	Quaking aspen-------	85	101	White spruce, black spruce, eastern white pine.
						Balsam fir----------	59	118	
						Paper birch---------	65	73	
						Black ash----------	65	47	
						White spruce--------	60	118	
656B---------- Thistledew	6S	Slight	Slight	Moderate	Moderate	Quaking aspen-------	76	89	White spruce, eastern white pine, jack pine, red pine.
						Balsam fir----------	60	118	
						Paper birch---------	65	73	
						White spruce--------	65	129	
						Red pine----------	60	101	
						Jack pine----------	65	94	
797**:									
Mooselake---------	3W	Slight	Severe	Severe	Severe	Black ash----------	55	38	Black spruce, balsam fir, northern white-cedar.
						Balsam fir----------	50	96	
						Northern white-cedar	31	44	
						Black spruce--------	40	56	
						Tamarack----------	50	---	
						Paper birch---------	---	---	
Lupton----------	3W	Slight	Severe	Severe	Severe	Black ash----------	55	38	Black spruce, balsam fir, northern white-cedar.
						Balsam fir----------	50	96	
						Northern white-cedar	31	44	
						Black spruce--------	40	56	
						Tamarack----------	50	---	
						Paper birch---------	---	---	
798**:									
Sago----------	4W	Slight	Severe	Severe	Severe	Black spruce--------	40	56	Black spruce, balsam fir, northern white-cedar.
						Balsam fir----------	50	96	
						Tamarack----------	55	---	
						Northern white-cedar	35	51	
						Black ash----------	55	38	
Roscommon---------	4W	Slight	Severe	Severe	Severe	Black spruce--------	35	50	Black spruce, balsam fir, northern white-cedar.
						Balsam fir----------	50	96	
						Tamarack----------	50	---	
						Northern white-cedar	35	51	
						Black ash----------	55	38	
						Quaking aspen-------	60	64	

See footnotes at end of table.

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
799**:									
Seelyeville-------	4W	Slight	Severe	Severe	Severe	Black spruce--------	35	50	Black spruce, tamarack, balsam fir, northern white-cedar.
						Balsam fir----------	45	83	
						Black ash-----------	50	34	
						Tamarack------------	50	---	
						Northern white-cedar	30	42	
Bowstring.									
801B**:									
Taylor------------	6A	Slight	Slight	Slight	Slight	Quaking aspen-------	79	93	White spruce, balsam fir, eastern white pine.
						Balsam fir----------	58	113	
						Paper birch---------	65	73	
						White spruce--------	58	114	
						Eastern white pine--	51	93	
						American basswood---	65	59	
Dalbo-------------	7A	Slight	Slight	Slight	Slight	Quaking aspen-------	85	101	White spruce, eastern white pine, balsam fir.
						Eastern white pine--	52	106	
						White spruce--------	60	118	
						American basswood---	65	59	
						Paper birch---------	65	73	
						Balsam fir----------	60	118	
803B**:									
Warba-------------	7A	Slight	Slight	Slight	Slight	Quaking aspen-------	81	96	White spruce, balsam fir, eastern white pine, northern red oak.
						Balsam fir----------	61	120	
						Paper birch---------	65	73	
						American basswood---	70	66	
						Sugar maple---------	60	43	
						Northern red oak----	67	61	
						Eastern white pine--	55	106	
						Red pine------------	60	101	
						White spruce--------	60	118	
Menahga-----------	7S	Slight	Moderate	Moderate	Slight	Red pine------------	60	101	Red pine, white spruce, eastern white pine, jack pine.
						Eastern white pine--	55	106	
						Jack pine-----------	67	98	
						White spruce--------	60	118	
						Quaking aspen-------	65	73	
						Paper birch---------	60	65	
						Northern red oak----	55	42	
						Balsam fir----------	58	113	
803D**:									
Warba-------------	7R	Moderate	Moderate	Slight	Slight	Quaking aspen-------	81	96	White spruce, balsam fir, eastern white pine, northern red oak.
						Balsam fir----------	61	120	
						Paper birch---------	65	73	
						American basswood---	70	66	
						Sugar maple---------	60	43	
						Northern red oak----	67	61	
						Eastern white pine--	55	106	
						Red pine------------	60	101	
						White spruce--------	60	118	

See footnotes at end of table.

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
803D**:									
Menahga	7R	Moderate	Moderate	Moderate	Slight	Red pine	60	101	Red pine, white spruce, eastern white pine, jack pine.
						Eastern white pine	55	106	
						Jack pine	67	98	
						White spruce	60	118	
						Quaking aspen	65	73	
						Paper birch	60	65	
						Northern red oak	55	42	
						Balsam fir	58	113	
844F**:									
Mahtomedi	6R	Severe	Severe	Moderate	Slight	Red pine	55	88	Red pine, jack pine, eastern white pine, white spruce.
						Eastern white pine	50	90	
						Jack pine	60	85	
						White spruce	55	107	
Emmert	6R	Severe	Severe	Severe	Slight	Red pine	55	88	Red pine, jack pine, eastern white pine, white spruce.
						Eastern white pine	50	90	
						Jack pine	60	85	
						White spruce	55	107	
866B**:									
Menahga	7S	Slight	Moderate	Moderate	Slight	Red pine	60	101	Red pine, white spruce, eastern white pine, jack pine.
						Eastern white pine	55	106	
						Jack pine	67	98	
						White spruce	60	118	
						Quaking aspen	65	73	
						Paper birch	60	65	
						Northern red oak	55	42	
						Balsam fir	58	113	
Itasca	8A	Slight	Slight	Slight	Slight	Quaking aspen	92	110	White spruce, eastern white pine, jack pine, northern red oak, balsam fir.
						Balsam fir	64	127	
						Bigtooth aspen	86	102	
						Paper birch	69	80	
						Northern red oak	64	57	
						Sugar maple	60	43	
						American basswood	65	59	
						White spruce	60	118	
						Eastern white pine	60	121	
						Red pine	60	101	
866E**:									
Menahga	7R	Moderate	Moderate	Moderate	Slight	Red pine	60	101	Red pine, white spruce, eastern white pine, jack pine.
						Eastern white pine	55	106	
						Jack pine	67	98	
						White spruce	60	118	
						Quaking aspen	65	73	
						Paper birch	60	65	
						Northern red oak	55	42	
						Balsam fir	58	113	

See footnotes at end of table.

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
866E**:									
Itasca	8R	Moderate	Moderate	Slight	Slight	Quaking aspen	92	110	White spruce, eastern white pine, jack pine, northern red oak, balsam fir.
						Balsam fir	64	127	
						Bigtooth aspen	86	102	
						Northern red oak	64	57	
						Sugar maple	60	43	
						American basswood	65	59	
						White spruce	60	118	
						Eastern white pine	60	121	
						Red pine	60	101	
						Paper birch	69	80	
867B**:									
Menahga	7S	Slight	Moderate	Moderate	Slight	Red pine	60	101	Red pine, white spruce, eastern white pine, jack pine.
						Eastern white pine	55	106	
						Jack pine	67	98	
						White spruce	60	118	
						Quaking aspen	65	73	
						Paper birch	60	65	
						Northern red oak	55	42	
						Balsam fir	58	113	
Graycalm	7S	Slight	Moderate	Severe	Slight	Red pine	61	104	Red pine, eastern white pine, white spruce, jack pine, balsam fir.
						Balsam fir	58	113	
						Jack pine	67	98	
						Quaking aspen	65	73	
						Eastern white pine	55	106	
						White spruce	60	118	
						Paper birch	60	65	
						Northern red oak	55	42	
868B**:									
Mahtomedi	6S	Slight	Moderate	Moderate	Slight	Red pine	55	88	Red pine, eastern white pine, white spruce, jack pine.
						Eastern white pine	50	90	
						White spruce	55	107	
						Jack pine	60	85	
Graycalm	7S	Slight	Moderate	Severe	Slight	Red pine	61	104	Red pine, eastern white pine, white spruce, jack pine, balsam fir.
						Balsam fir	58	113	
						Jack pine	67	98	
						Quaking aspen	65	73	
						Eastern white pine	55	106	
						White spruce	60	118	
						Paper birch	60	65	
						Northern red oak	55	42	
869**:									
Lobo	3W	Slight	Severe	Severe	Severe	Black spruce	25	37	Black spruce, tamarack.
						Tamarack	30	---	
Waskish	3W	Slight	Severe	Severe	Severe	Black spruce	25	37	Black spruce, tamarack.
						Tamarack	30	---	

See footnotes at end of table.

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
870C**:									
Itasca	8A	Slight	Slight	Slight	Slight	Quaking aspen	92	110	White spruce, eastern white pine, jack pine, northern red oak, balsam fir.
						Balsam fir	64	127	
						Bigtooth aspen	86	102	
						Paper birch	69	80	
						Northern red oak	64	57	
						Sugar maple	60	43	
						American basswood	65	59	
						White spruce	60	118	
						Eastern white pine	60	121	
						Red pine	60	101	
Goodland	6A	Slight	Slight	Slight	Slight	Quaking aspen	77	90	White spruce, eastern white pine, jack pine, northern red oak, balsam fir.
						Eastern white pine	55	106	
						Paper birch	65	73	
						Balsam fir	64	127	
						Northern red oak	62	54	
						Sugar maple	55	35	
						American basswood	60	51	
						White spruce	60	118	
						Red pine	60	101	
870E**:									
Itasca	8R	Moderate	Moderate	Slight	Slight	Quaking aspen	92	110	White spruce, eastern white pine, jack pine, northern red oak, balsam fir.
						Balsam fir	64	127	
						Bigtooth aspen	86	102	
						Paper birch	69	80	
						Northern red oak	64	57	
						Sugar maple	60	43	
						American basswood	65	59	
						White spruce	60	118	
						Eastern white pine	60	121	
						Red pine	60	101	
Goodland	6R	Moderate	Moderate	Slight	Slight	Quaking aspen	77	90	White spruce, eastern white pine, jack pine, northern red oak, balsam fir.
						Balsam fir	64	127	
						Paper birch	65	73	
						Northern red oak	62	54	
						Sugar maple	55	38	
						American basswood	60	51	
						White spruce	60	118	
						Eastern white pine	55	106	
						Red pine	60	101	
871**:									
Indus	7W	Slight	Moderate	Severe	Slight	Quaking aspen	80	94	White spruce, eastern white pine, black spruce, balsam fir, tamarack, northern white-cedar.
						Balsam fir	55	107	
						Paper birch	65	73	
						Black ash	65	47	
						White spruce	55	107	
Brickton	7W	Slight	Moderate	Moderate	Slight	Quaking aspen	87	103	White spruce, eastern white pine, black spruce, balsam fir, tamarack, northern white-cedar.
						Balsam fir	60	118	
						Paper birch	65	73	
						Black ash	65	47	
						White spruce	60	118	

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
872**:									
Pengilly----------	3W	Slight	Severe	Severe	Severe	Black ash----------	60	43	Black spruce, tamarack, red maple.
						Balsam fir----------	55	107	
						American elm--------	---	---	
						Quaking aspen-------	70	81	
						Red maple----------	---	---	
						Paper birch---------	60	65	
Winterfield-------	5S	Slight	Moderate	Moderate	Slight	Quaking aspen-------	65	73	White spruce, eastern white pine, black spruce, northern white-cedar.
						Balsam fir----------	55	107	
						Paper birch---------	55	57	
						Black ash----------	55	38	
						American elm--------	---	---	
						White spruce--------	55	107	
						Eastern white pine--	---	---	
						Bur oak-------------	---	---	
1826B**:									
Nashwauk----------	6D	Slight	Slight	Slight	Moderate	Quaking aspen-------	76	89	White spruce, eastern white pine, northern red oak, balsam fir.
						Balsam fir----------	64	127	
						Paper birch---------	65	73	
						Northern red oak----	60	51	
						American basswood---	65	59	
						Sugar maple---------	55	38	
						White spruce--------	62	122	
						Eastern white pine--	55	106	
Menahga-----------	7S	Slight	Moderate	Moderate	Slight	Red pine-----------	60	101	Red pine, white spruce, eastern white pine, jack pine.
						Eastern white pine--	55	106	
						Jack pine----------	67	98	
						White spruce--------	60	118	
						Quaking aspen-------	65	73	
						Paper birch---------	60	65	
						Northern red oak----	55	42	
						Balsam fir----------	58	113	
1826D**:									
Nashwauk----------	6R	Moderate	Moderate	Slight	Moderate	Quaking aspen-------	76	89	White spruce, eastern white pine, northern red oak, balsam fir.
						Balsam fir----------	64	127	
						Paper birch---------	65	73	
						American basswood---	65	59	
						Sugar maple---------	55	38	
						White spruce--------	62	122	
						Eastern white pine--	55	106	
						Northern red oak----	60	51	
Menahga-----------	7R	Moderate	Moderate	Moderate	Slight	Red pine-----------	60	101	Red pine, white spruce, eastern white pine, jack pine.
						Eastern white pine--	55	106	
						Jack pine----------	67	98	
						White spruce--------	60	118	
						Quaking aspen-------	65	73	
						Paper birch---------	60	65	
						Northern red oak----	55	42	
						Balsam fir----------	58	113	

See footnotes at end of table.

TABLE 6.--FOREST MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
1883D**:									
Nashwauk----------	6R	Moderate	Moderate	Slight	Moderate	Quaking aspen-------	76	89	White spruce, eastern white pine, northern red oak, balsam fir.
						Paper birch---------	65	73	
						Balsam fir----------	64	127	
						American basswood---	65	59	
						Sugar maple---------	55	38	
						White spruce--------	62	122	
						Eastern white pine--	55	106	
						Northern red oak----	60	51	
Rock outcrop.									

* Volume is the yield in cubic feet per acre per year calculated at the age of culmination of mean annual increment for fully stocked, natural stands.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--FORESTRY EQUIPMENT USE

[Only the soils suitable for the production of commercial trees are listed]

Soil name and map symbol	Most limiting season(s)	Ratings for the most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
		Logging areas and skid trails	Log landings	Haul roads		Logging areas and skid trails	Log landings	Haul roads
32B---------- Nebish	Spring----	Moderate: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall.	Slight--------	Moderate: low strength.	Moderate: low strength.
					Winter---	Slight--------	Slight--------	Slight.
32D---------- Nebish	Spring----	Moderate: slope, spring thaw.	Severe: slope, spring thaw.	Severe: spring thaw.	Summer, fall.	Moderate: slope.	Severe: slope.	Moderate: slope.
	Winter*---	Moderate: slope.	Severe: slope.	Moderate: slope.				
72---------- Shooker	Spring----	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer---	Slight--------	Moderate: low strength.	Moderate: low strength.
					Fall-----	Moderate: wetness.	Moderate: wetness, low strength.	Moderate: wetness, low strength.
					Winter**	Slight--------	Slight--------	Slight.
147---------- Spooner	Spring----	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer---	Slight--------	Moderate: low strength.	Moderate: low strength.
					Fall-----	Moderate: wetness.	Moderate: wetness, low strength.	Moderate: wetness, low strength.
					Winter**	Slight--------	Slight--------	Slight.
158B---------- Zimmerman	Spring----	Slight--------	Moderate: slope, spring thaw.	Moderate: spring thaw.	Summer, fall, winter.	Slight--------	Moderate: slope.	Slight.
167B---------- Baudette	Spring----	Moderate: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall.	Slight--------	Moderate: low strength.	Moderate: low strength.
					Winter---	Slight--------	Slight--------	Slight.
202---------- Meehan	Spring----	Slight--------	Moderate: spring thaw.	Moderate: spring thaw.	Summer, fall, winter.	Slight--------	Slight--------	Slight.
240B---------- Warba	Spring----	Severe: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall.	Slight--------	Moderate: low strength.	Moderate: low strength.
					Winter---	Slight--------	Slight--------	Slight.

See footnotes at end of table.

TABLE 7.--FORESTRY EQUIPMENT USE--Continued

Soil name and map symbol	Most limiting season(s)	Ratings for the most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
		Logging areas and skid trails	Log landings	Haul roads		Logging areas and skid trails	Log landings	Haul roads
240D---------- Warba	Spring----	Severe: spring thaw.	Severe: slope, spring thaw.	Severe: spring thaw.	Summer, fall.	Moderate: slope.	Severe: slope.	Moderate: low strength.
	Winter*---	Moderate: slope.	Severe: slope.	Moderate: slope.				
243---------- Stuntz	Spring----	Severe: spring thaw.	Severe: low strength, spring thaw.	Severe: low strength, spring thaw.	Summer, fall.	Slight--------	Severe: low strength.	Severe: low strength.
					Winter---	Slight--------	Slight--------	Slight.
268B---------- Cromwell	Spring----	Slight--------	Moderate: spring thaw.	Moderate: spring thaw.	Summer, fall, winter.	Slight--------	Slight--------	Slight.
268D---------- Cromwell	Winter*---	Moderate: slope.	Severe: slope.	Moderate: slope.	Summer, fall.	Moderate: slope.	Severe: slope.	Moderate: slope.
	Spring----	Moderate: slope.	Severe: slope.	Moderate: slope, spring thaw.				
458E---------- Menahga	Winter*---	Moderate: slope.	Severe: slope.	Moderate: slope, too sandy.	Summer, fall.	Severe: too sandy.	Severe: slope.	Moderate: slope, too sandy.
	Spring----	Severe: too sandy, slope.	Severe: slope.	Moderate: slope, too sandy, spring thaw.				
533---------- Loxley	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight--------	Slight--------	Slight.
541---------- Rifle	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight--------	Slight--------	Slight.
544---------- Cathro	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight--------	Slight--------	Slight.
549---------- Greenwood	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight--------	Slight--------	Slight.

See footnotes at end of table.

TABLE 7.--FORESTRY EQUIPMENT USE--Continued

Soil name and map symbol	Most limiting season(s)	Ratings for the most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
		Logging areas and skid trails	Log landings	Haul roads		Logging areas and skid trails	Log landings	Haul roads
550--Dora	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight	Slight	Slight.
614--Blackhoof	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight	Slight	Slight.
615--Cowhorn	Spring	Moderate: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall, winter.	Slight	Slight	Slight.
616--Effie	Spring	Severe: wetness, spring thaw.	Severe: wetness, low strength, spring thaw.	Severe: wetness, low strength, spring thaw.	Summer	Slight	Severe: low strength.	Severe: low strength.
					Fall	Moderate: wetness.	Severe: low strength.	Severe: low strength.
					Winter**	Slight	Slight	Slight.
617B--Goodland	Spring	Moderate: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall, winter.	Slight	Slight	Slight.
618B--Itasca	Spring	Moderate: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall, winter.	Slight	Slight	Slight.
619--Keewatin	Spring	Severe: wetness, spring thaw.	Severe: wetness, spring thaw.	Severe: wetness, spring thaw.	Summer	Slight	Moderate: low strength.	Moderate: low strength.
					Fall	Moderate: wetness.	Moderate: wetness, low strength.	Moderate: wetness, low strength.
					Winter**	Slight	Slight	Slight.
620B--Cutaway	Spring	Slight	Moderate: spring thaw.	Moderate: spring thaw.	Summer, fall, winter.	Slight	Slight	Slight.
621--Morph	Spring	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer	Slight	Slight	Slight.
					Fall	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
					Winter**	Slight	Slight	Slight.

See footnotes at end of table.

TABLE 7.--FORESTRY EQUIPMENT USE--Continued

Soil name and map symbol	Most limiting season(s)	Ratings for the most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
		Logging areas and skid trails	Log landings	Haul roads		Logging areas and skid trails	Log landings	Haul roads
622B---------- Nashwauk	Spring----	Severe: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall, winter.	Slight--------	Moderate: low strength.	Moderate: low strength.
622E---------- Nashwauk	Spring----	Severe: spring thaw.	Severe: slope, spring thaw.	Severe: spring thaw.	Summer, fall.	Moderate: slope.	Severe: slope.	Moderate: slope, low strength.
	Winter*---	Moderate: slope.	Severe: slope.	Moderate: slope.				
624B---------- Rosy	Spring----	Moderate: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall, winter.	Slight--------	Slight--------	Slight.
625---------- Sandwick	Spring----	Severe: wetness.	Severe: wetness.	Severe: wetness.	Summer, fall.	Slight--------	Moderate: low strength.	Moderate: low strength.
					Winter**	Slight--------	Slight--------	Slight.
626B---------- Suomi	Spring----	Severe: spring thaw.	Severe: low strength, spring thaw.	Severe: low strength, spring thaw.	Summer, fall.	Slight--------	Severe: too clayey, low strength.	Severe: too clayey, low strength.
					Winter---	Slight--------	Slight--------	Slight.
626D---------- Suomi	Spring----	Severe: spring thaw.	Severe: slope, low strength, spring thaw.	Severe: low strength, spring thaw.	Summer, fall.	Moderate: slope.	Severe: too clayey, slope, low strength.	Severe: too clayey, low strength.
	Winter*---	Moderate: slope.	Severe: slope.	Moderate: slope.				
627---------- Tawas	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight--------	Slight--------	Slight.
628---------- Talmoon	Spring, fall.	Severe: wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Summer---	Moderate: wetness.	Severe: low strength.	Severe: low strength.
					Winter**	Slight--------	Slight--------	Slight.
629B---------- Wawina	Spring----	Moderate: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall, winter.	Slight--------	Slight--------	Slight.

See footnotes at end of table.

TABLE 7.--FORESTRY EQUIPMENT USE--Continued

Soil name and map symbol	Most limiting season(s)	Ratings for the most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
		Logging areas and skid trails	Log landings	Haul roads		Logging areas and skid trails	Log landings	Haul roads
630---------- Wildwood	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight--------	Slight--------	Slight.
655---------- Bearville	Spring----	Severe: wetness.	Severe: wetness, low strength.	Severe: wetness, low strength.	Summer---	Slight--------	Severe: low strength.	Severe: low strength.
					Fall-----	Moderate: wetness.	Severe: low strength.	Severe: low strength.
					Winter**	Slight--------	Slight--------	Slight.
656B---------- Thistledew	Spring----	Slight--------	Moderate: spring thaw.	Moderate: spring thaw.	Summer, fall, winter.	Slight--------	Slight--------	Slight.
797***: Mooselake----------	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight--------	Slight--------	Slight.
Lupton----------	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight--------	Slight--------	Slight.
798***: Sago----------	Spring, summer, fall.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Winter**	Slight--------	Slight--------	Slight.
Roscommon----------	Spring, summer, fall.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Winter**	Slight--------	Slight--------	Slight.
799***: Seelyeville--------	Spring, fall.	Severe: low strength, wetness, flooding.	Severe: low strength, wetness, flooding.	Severe: low strength, wetness, flooding.	Winter**	Slight--------	Slight--------	Slight.
	Summer----	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength wetness.				

See footnotes at end of table.

TABLE 7.--FORESTRY EQUIPMENT USE--Continued

Soil name and map symbol	Most limiting season(s)	Ratings for the most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
		Logging areas and skid trails	Log landings	Haul roads		Logging areas and skid trails	Log landings	Haul roads
799***:								
Bowstring----------	Spring, fall.	Severe: low strength, wetness, flooding.	Severe: low strength, wetness, flooding.	Severe: low strength, wetness, flooding.	Winter**	Slight--------	Slight--------	Slight.
	Summer----	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.				
801B***:								
Taylor----------	Spring----	Severe: spring thaw.	Severe: low strength, spring thaw.	Severe: low strength, spring thaw.	Summer, fall.	Slight--------	Severe: low strength.	Severe: low strength.
					Winter---	Slight--------	Slight--------	Slight.
Dalbo----------	Spring----	Severe: spring thaw.	Severe: low strength, spring thaw.	Severe: low strength, spring thaw.	Summer, fall.	Slight--------	Severe: low strength.	Severe: low strength.
					Winter---	Slight--------	Slight--------	Slight.
803B***:								
Warba----------	Spring----	Severe: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall.	Slight--------	Moderate: low strength.	Moderate: low strength.
					Winter---	Slight--------	Slight--------	Slight.
Menahga----------	Spring----	Slight--------	Moderate: too sandy, spring thaw.	Moderate: too sandy, spring thaw.	Summer, fall, winter.	Slight--------	Moderate: too sandy.	Moderate: too sandy.
803D***:								
Warba----------	Spring----	Severe: spring thaw.	Severe: slope, spring thaw.	Severe: spring thaw.	Summer, fall.	Moderate: slope.	Severe: slope.	Moderate: low strength.
	Winter*---	Moderate: slope.	Severe: slope.	Severe: slope.				
Menahga----------	Winter*---	Moderate: slope.	Severe: slope.	Moderate: slope, too sandy.	Summer, fall.	Moderate: slope.	Severe: slope.	Moderate: slope, too sandy.
	Spring----	Severe: too sandy, slope.	Severe: slope.	Moderate: slope, too sandy, spring thaw.				

See footnotes at end of table.

TABLE 7.--FORESTRY EQUIPMENT USE--Continued

Soil name and map symbol	Most limiting season(s)	Ratings for the most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
		Logging areas and skid trails	Log landings	Haul roads		Logging areas and skid trails	Log landings	Haul roads
844F***:								
Mahtomedi	Winter*	Severe: slope.	Severe: slope.	Severe: slope.	Spring, summer, fall.	Severe: slope.	Severe: slope.	Severe: slope.
Emmert	Winter*	Severe: slope.	Severe: slope.	Severe: slope.	Spring, summer, fall.	Severe: slope.	Severe: slope.	Severe: slope.
866B***:								
Menahga	Spring	Slight	Moderate: too sandy, spring thaw.	Moderate: too sandy, spring thaw.	Summer, fall, winter.	Slight	Moderate: too sandy.	Moderate: too sandy.
Itasca	Spring	Moderate: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall, winter.	Slight	Slight	Slight.
866E***:								
Menahga	Winter*	Moderate: slope.	Severe: slope.	Moderate: slope, too sandy.	Summer, fall.	Severe: too sandy.	Severe: slope.	Moderate: slope, too sandy.
	Spring	Severe: too sandy, slope.	Severe: slope.	Moderate: slope, too sandy, spring thaw.				
Itasca	Winter*	Moderate: slope.	Severe: slope.	Moderate: slope.	Fall, summer.	Moderate: slope.	Severe: slope.	Moderate: slope.
	Spring	Moderate: slope, spring thaw.	Severe: slope, spring thaw.	Severe: spring thaw.				
867B***:								
Menahga	Spring	Slight	Moderate: too sandy, spring thaw.	Moderate: too sandy, spring thaw.	Summer, fall, winter.	Slight	Moderate: too sandy.	Moderate: too sandy.
Graycalm	Spring	Slight	Moderate: too sandy, spring thaw.	Moderate: too sandy, spring thaw.	Summer, fall, winter.	Slight	Moderate: too sandy.	Moderate: too sandy.

See footnotes at end of table.

TABLE 7.--FORESTRY EQUIPMENT USE--Continued

Soil name and map symbol	Most limiting season(s)	Ratings for the most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
		Logging areas and skid trails	Log landings	Haul roads		Logging areas and skid trails	Log landings	Haul roads
868B***:								
Mahtomedi	Spring	Slight	Moderate: spring thaw.	Moderate: spring thaw.	Summer, fall, winter.	Slight	Slight	Slight.
Graycalm	Spring	Slight	Moderate: too sandy, spring thaw.	Moderate: too sandy, spring thaw.	Summer, fall, winter.	Slight	Moderate: too sandy.	Moderate: too sandy.
869***:								
Lobo	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight	Slight	Slight.
Waskish	Spring, summer, fall.	Severe: low strength, wetness.	Severe: low strength, wetness.	Severe: low strength, wetness.	Winter**	Slight	Slight	Slight.
870C***:								
Itasca	Spring	Moderate: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall, winter.	Slight	Moderate: slope.	Slight.
Goodland	Spring	Moderate: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall, winter.	Slight	Moderate: slope.	Slight.
870E***:								
Itasca	Winter*	Moderate: slope.	Severe: slope.	Moderate: slope.	Summer, fall.	Moderate: slope.	Severe: slope.	Moderate: slope.
	Spring	Moderate: slope, spring thaw.	Severe: slope, spring thaw.	Severe: spring thaw.				
Goodland	Winter*	Moderate: slope.	Severe: slope.	Moderate: slope.	Summer, fall.	Moderate: slope.	Severe: slope.	Moderate: slope.
	Spring	Moderate: slope, spring thaw.	Severe: slope, spring thaw.	Severe: spring thaw.				

See footnotes at end of table.

TABLE 7.--FORESTRY EQUIPMENT USE--Continued

Soil name and map symbol	Most limiting season(s)	Ratings for the most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
		Logging areas and skid trails	Log landings	Haul roads		Logging areas and skid trails	Log landings	Haul roads
871***:								
Indus	Spring	Severe: wetness.	Severe: wetness, too clayey, low strength.	Severe: wetness, too clayey, low strength.	Summer	Slight	Severe: too clayey, low strength.	Severe: too clayey, low strength.
					Fall	Moderate: wetness.	Severe: too clayey, low strength.	Severe: too clayey, low strength.
					Winter**	Slight	Slight	Slight.
Brickton	Spring	Severe: wetness.	Severe: wetness, too clayey, low strength.	Severe: wetness, too clayey, low strength.	Summer	Slight	Severe: low strength.	Severe: low strength.
					Fall	Moderate: wetness.	Severe: low strength.	Severe: low strength.
					Winter**	Slight	Slight	Slight.
872***:								
Pengilly	Spring, summer, fall.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Winter**	Slight	Slight	Slight.
Winterfield	Spring	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Winter**, summer.	Slight	Slight	Slight.
	Fall	Moderate: wetness.	Severe: flooding.	Severe: flooding.				
1826B***:								
Nashwauk	Spring	Severe: spring thaw.	Severe: spring thaw.	Severe: spring thaw.	Summer, fall.	Slight	Moderate: low strength.	Moderate: low strength.
					Winter	Slight	Slight	Slight.
Menahga	Spring	Slight	Moderate: too sandy, spring thaw.	Moderate: too sandy, spring thaw.	Summer, fall, winter.	Slight	Moderate: too sandy.	Moderate: too sandy.
1826D***:								
Nashwauk	Spring	Severe: spring thaw.	Severe: slope, spring thaw.	Severe: spring thaw.	Summer, fall.	Moderate: slope.	Severe: slope.	Moderate: slope, low strength.
	Winter*	Moderate: slope.	Severe: slope.	Moderate: slope.				

See footnotes at end of table.

TABLE 7.--FORESTRY EQUIPMENT USE--Continued

Soil name and map symbol	Most limiting season(s)	Ratings for the most limiting season(s)			Preferred operating season(s)	Ratings for preferred operating season(s)		
		Logging areas and skid trails	Log landings	Haul roads		Logging areas and skid trails	Log landings	Haul roads
1826D***: Menahga	Winter	Moderate: slope.	Severe: slope.	Moderate: slope, too sandy.	Summer, fall.	Severe: too sandy.	Severe: slope.	Moderate: slope, too sandy.
	Spring	Severe: slope, too sandy.	Severe: slope.	Moderate: slope, too sandy, spring thaw.				
1883D***: Nashwauk	Spring, summer, fall, winter.	Severe: rock outcrop.	Severe: rock outcrop.	Severe: rock outcrop.				

* Traction is a problem when the soil is frozen or snow covered. Tracked equipment may be needed.
** The rating is severe if the soil cannot support the equipment because the ground is not adequately frozen.
*** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
32B, 32D---------- Nebish	---	Amur maple, redosier dogwood, Siberian peashrub, lilac.	Northern white-cedar, white spruce, eastern redcedar, Manchurian crabapple, blue spruce.	Eastern white pine, green ash, red pine.	---
72---------- Shooker	---	Common ninebark, lilac, Siberian peashrub, American cranberrybush, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple.
147---------- Spooner	---	Common ninebark, lilac, Siberian peashrub, American cranberrybush, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple.
158B---------- Zimmerman	---	Eastern redcedar, lilac, Tatarian honeysuckle, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Jack pine, red pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
167B---------- Baudette	---	Redosier dogwood, lilac, American cranberrybush.	White spruce, eastern redcedar, blue spruce.	Norway spruce, eastern white pine, green ash, red pine, green ash, jack pine.	---
202---------- Meehan	---	Siberian peashrub, redosier dogwood, lilac, American cranberrybush.	Eastern redcedar, blue spruce, white spruce.	Eastern white pine, red pine, jack pine, green ash, Norway spruce.	---
240B, 240D-------- Warba	---	Siberian peashrub, Amur maple, redosier dogwood, lilac.	Northern white-cedar, Manchurian crabapple, eastern redcedar, white spruce, blue spruce.	Green ash, eastern white pine, red pine.	---
243---------- Stuntz	---	Siberian peashrub, American cranberrybush, lilac, redosier dogwood.	Eastern redcedar, white spruce, blue spruce.	Norway spruce, red pine, jack pine, eastern white pine, green ash.	---
268B, 268D-------- Cromwell	---	Eastern redcedar, Siberian peashrub, lilac, Tatarian honeysuckle, Manchurian crabapple, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
458E---------- Menahga	---	Eastern redcedar, lilac, Tatarian honeysuckle, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
533. Loxley					
541. Rifle					
544. Cathro					
549. Greenwood					
550. Dora					
614. Blackhoof					
615---------- Cowhorn	---	Siberian peashrub, lilac, redosier dogwood, American cranberrybush.	White spruce, eastern redcedar, blue spruce.	Eastern white pine, jack pine, Norway spruce, green ash, red pine.	---
616---------- Effie	---	Northern white-cedar, Siberian peashrub, lilac.	White spruce, Manchurian crabapple, blue spruce, bur oak, Russian-olive, eastern redcedar.	Green ash, golden willow.	Eastern cottonwood.
617B---------- Goodland	Lilac, silver buffaloberry, Siberian peashrub.	Siberian crabapple, eastern redcedar, Tatarian honeysuckle, Manchurian crabapple.	Eastern white pine, green ash, jack pine, red pine, Russian-olive.	---	---
618B---------- Itasca	---	Amur maple, redosier dogwood, Siberian peashrub, lilac.	Northern white-cedar, white spruce, blue spruce, Manchurian crabapple, eastern redcedar.	Red pine, green ash, eastern white pine.	---
619---------- Keewatin	---	Northern white-cedar, Amur maple, Tatarian honeysuckle, American cranberrybush, Siberian peashrub, lilac.	Manchurian crabapple, eastern redcedar, white spruce.	Green ash, eastern white pine, jack pine.	---
620B---------- Cutaway	---	Siberian peashrub, American cranberrybush, lilac, Amur maple.	White spruce, blue spruce, red pine, eastern redcedar.	Eastern white pine, Norway spruce, green ash, jack pine.	---

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
621---------- Morph	---	Common ninebark, lilac, Siberian peashrub, American cranberrybush, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple.
622B, 622E-------- Nashwauk	---	Amur maple, Tatarian honeysuckle, lilac, American cranberrybush, Siberian peashrub, northern white-cedar.	White spruce, Manchurian crabapple, eastern redcedar.	Jack pine, green ash, eastern white pine.	---
624B---------- Rosy	---	Redosier dogwood, American cranberrybush, lilac, Siberian peashrub.	White spruce, eastern redcedar, blue spruce.	Norway spruce, eastern white pine, green ash, red pine, jack pine.	---
625---------- Sandwick	---	Siberian peashrub, American cranberrybush, lilac, redosier dogwood.	Eastern redcedar, white spruce, blue spruce.	Norway spruce, red pine, jack pine, eastern white pine, green ash.	---
626B, 626D-------- Suomi	---	Amur maple, American cranberrybush, Siberian peashrub, lilac, Tatarian honeysuckle, northern white-cedar.	White spruce, Manchurian crabapple, eastern redcedar.	Jack pine, green ash, eastern white pine.	---
627. Tawas					
628. Talmoon					
629B---------- Wawina	---	Siberian peashrub, lilac, American cranberrybush, Amur maple.	White spruce, red pine, blue spruce, eastern redcedar.	Green ash, eastern white pine, Norway spruce, jack pine.	---
630. Wildwood					
655---------- Bearville	---	Common ninebark, lilac, Siberian peashrub, American cranberrybush, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple.
656B---------- Thistledew	---	Siberian peashrub, lilac, American cranberrybush, redosier dogwood.	White spruce, eastern redcedar, blue spruce.	Red pine, Norway spruce, green ash, jack pine, eastern white pine.	---
797*: Mooselake.					
Lupton.					

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
798*: Sago.					
Roscommon.					
799*: Seelyeville.					
Bowstring.					
801B*: Taylor	---	Amur maple, Tatarian honeysuckle, lilac, American cranberrybush, Siberian peashrub, northern white-cedar.	White spruce, eastern redcedar, Manchurian crabapple.	Eastern white pine, green ash, jack pine.	---
Dalbo	---	Northern white-cedar, Amur maple, lilac, American cranberrybush, Siberian peashrub, Tatarian honeysuckle.	White spruce, Manchurian crabapple, eastern redcedar.	Green ash, jack pine, eastern white pine.	---
803B*, 803D*: Warba	---	Siberian peashrub, Amur maple, redosier dogwood, lilac.	Northern white-cedar, Manchurian crabapple, eastern redcedar, white spruce, blue spruce.	Green ash, eastern white pine, red pine.	---
Menahga	---	Eastern redcedar, lilac, Tatarian honeysuckle, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
844F*: Mahtomedi	---	Eastern redcedar, Tatarian honeysuckle, lilac, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
Emmert	Lilac, Tatarian honeysuckle, Siberian peashrub, silver buffaloberry.	Eastern redcedar, Siberian crabapple, Manchurian crabapple.	Russian-olive, red pine, jack pine, eastern white pine, green ash.	---	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
866B*, 866E*: Menahga	---	Eastern redcedar, lilac, Tatarian honeysuckle, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
Itasca	---	Amur maple, redosier dogwood, Siberian peashrub, lilac.	Northern white-cedar, white spruce, blue spruce, Manchurian crabapple, eastern redcedar.	Red pine, green ash, eastern white pine.	---
867B*: Menahga	---	Eastern redcedar, lilac, Tatarian honeysuckle, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
Graycalm	---	Lilac, eastern redcedar, Manchurian crabapple, Siberian peashrub, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
868B*: Mahtomedi	---	Eastern redcedar, Tatarian honeysuckle, lilac, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
Graycalm	---	Lilac, eastern redcedar, Manchurian crabapple, Siberian peashrub, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
869*: Lobo.					
Waskish.					

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
870C*, 870E*: Itasca	---	Amur maple, redosier dogwood, Siberian peashrub, lilac.	Northern white-cedar, white spruce, blue spruce, Manchurian crabapple, eastern redcedar.	Red pine, green ash, eastern white pine.	---
Goodland	Lilac, silver buffaloberry, Siberian peashrub.	Siberian crabapple, eastern redcedar, Tatarian honeysuckle, Manchurian crabapple.	Eastern white pine, green ash, jack pine, red pine, Russian-olive.	---	---
871*: Indus	---	Northern white-cedar, lilac, Siberian peashrub.	White spruce, eastern redcedar, Russian-olive, bur oak, Manchurian crabapple, blue spruce.	Green ash, golden willow.	Eastern cottonwood.
Brickton	---	Common ninebark, lilac, Siberian peashrub, American cranberrybush, redosier dogwood.	White spruce, northern white-cedar, blue spruce, Norway spruce.	Eastern white pine, green ash.	Silver maple.
872*: Pengilly.					
Winterfield	---	White spruce, Amur privet, silky dogwood, Amur honeysuckle, blue spruce.	Black spruce, northern white-cedar.	Eastern white pine	Red maple, Carolina poplar, green ash.
995. Borosaprists					
1031. Histosols					
1033. Aquents					
1041*. Pits					
1042*. Dumps					
1043C, 1043F. Udorthents					
1044*. Slickens					
1826B*, 1826D*: Nashwauk	---	Amur maple, Tatarian honeysuckle, lilac, American cranberrybush, Siberian peashrub, northern white-cedar.	White spruce, Manchurian crabapple, eastern redcedar.	Jack pine, green ash, eastern white pine.	---

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
1826B*, 1826D*: Menahga	---	Eastern redcedar, lilac, Tatarian honeysuckle, Siberian peashrub, Manchurian crabapple, Siberian crabapple.	Red pine, jack pine, green ash, Russian-olive.	Eastern white pine, Siberian elm.	---
1883D*: Nashwauk	---	Amur maple, Tatarian honeysuckle, lilac, American cranberrybush, Siberian peashrub, northern white-cedar.	White spruce, Manchurian crabapple, eastern redcedar.	Jack pine, green ash, eastern white pine.	---
Rock outcrop.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
32B Nebish	Slight	Slight	Moderate: slope.	Slight.
32D Nebish	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
72 Shooker	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
147 Spooner	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
158B Zimmerman	Slight	Slight	Moderate: slope.	Slight.
167B Baudette	Slight	Slight	Moderate: slope.	Severe: erodes easily.
202 Meehan	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
240B Warba	Slight	Slight	Moderate: slope.	Slight.
240D Warba	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
243 Stuntz	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.
268B Cromwell	Slight	Slight	Moderate: slope.	Slight.
268D Cromwell	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
458E Menahga	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope, too sandy.
533 Loxley	Severe: ponding, excess humus, too acid.	Severe: ponding, excess humus, too acid.	Severe: excess humus, ponding, too acid.	Severe: ponding, excess humus.
541 Rifle	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
544 Cathro	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
549 Greenwood	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
550 Dora	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
614 Blackhoof	Severe: ponding, percs slowly, excess humus.	Severe: ponding, excess humus, percs slowly.	Severe: excess humus, ponding, percs slowly.	Severe: ponding, excess humus.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
615--Cowhorn	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
616--Effie	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
617B--Goodland	Slight	Slight	Moderate: slope.	Slight.
618B--Itasca	Slight	Slight	Moderate: slope.	Slight.
619--Keewatin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
620B--Cutaway	Slight	Slight	Moderate: slope, small stones.	Slight.
621--Morph	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
622B--Nashwauk	Slight	Slight	Moderate: slope, small stones.	Slight.
622E--Nashwauk	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
624B--Rosy	Slight	Slight	Moderate: slope.	Slight.
625--Sandwick	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
626B--Suomi	Slight	Slight	Moderate: slope.	Slight.
626D--Suomi	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.
627--Tawas	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
628--Talmoon	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
629B--Wawina	Slight	Slight	Moderate: slope.	Slight.
630--Wildwood	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
655--Bearville	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
656B--Thistledew	Slight	Slight	Moderate: slope.	Slight.
797*: Mooselake	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
797*:				
Lupton	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
798*:				
Sago	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
Roscommon	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
799*:				
Seelyeville	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.
Bowstring	Severe: flooding, wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness, flooding.	Severe: wetness, excess humus.
801B*:				
Taylor	Slight	Slight	Moderate: slope.	Slight.
Dalbo	Slight	Slight	Moderate: slope.	Slight.
803B*:				
Warba	Slight	Slight	Moderate: slope.	Slight.
Menahga	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
803D*:				
Warba	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Menahga	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope, too sandy.
844F*:				
Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Slight.
Emmert	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.
866B*:				
Menahga	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Itasca	Slight	Slight	Moderate: slope.	Slight.
866E*:				
Menahga	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope, too sandy.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
866E*:				
Itasca	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.
867B*:				
Menahga	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Graycalm	Slight	Slight	Moderate: slope, small stones.	Slight.
868B*:				
Mahtomedi	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Moderate: too sandy.
Graycalm	Slight	Slight	Moderate: slope, small stones.	Slight.
869*:				
Lobo	Severe: wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness.	Severe: wetness, excess humus.
Waskish	Severe: wetness, excess humus, too acid.	Severe: wetness, excess humus, too acid.	Severe: excess humus, wetness, too acid.	Severe: wetness, excess humus.
870C*:				
Itasca	Slight	Slight	Severe: slope.	Slight.
Goodland	Slight	Slight	Severe: slope.	Slight.
870E*:				
Itasca	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.
Goodland	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.
871*:				
Indus	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Brickton	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.
872*:				
Pengilly	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding, flooding.	Severe: ponding.
Winterfield	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.
995. Borosaprists				
1031. Histosols				

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1033. Aquents				
1041*. Pits				
1042*. Dumps				
1043C, 1043F. Udorthents				
1044*. Slickens				
1826B*:				
Nashwauk	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Menahga	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
1826D*:				
Nashwauk	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Menahga	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope, too sandy.
1883D*:				
Nashwauk	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Rock outcrop.				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
32B---------- Nebish	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
32D---------- Nebish	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
72---------- Shooker	Poor	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
147---------- Spooner	Poor	Fair	Good	Fair	Fair	Good	Good	Fair	Fair	Good.
158B---------- Zimmerman	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
167B---------- Raudette	Good	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
202---------- Meehan	Poor	Fair	Good	Fair	Good	Fair	Poor	Poor	Fair	Poor.
240B---------- Warba	Poor	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
240D---------- Warba	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
243---------- Stuntz	Fair	Good	Good	Good	Fair	Fair	Fair	Fair	Good	Fair.
268B---------- Cromwell	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
268D---------- Cromwell	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
458E---------- Menahga	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
533---------- Loxley	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
541---------- Rifle	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
544---------- Cathro	Poor	Fair	Fair	Fair	Fair	Good	Good	Poor	Poor	Good.
549---------- Greenwood	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
550---------- Dora	Very poor.	Very poor.	Very poor.	Poor	Poor	Good	Good	Very poor.	Poor	Good.
614---------- Blackhoof	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
615---------- Cowhorn	Fair	Good	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
616---------- Effie	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
617B---------- Goodland	Good	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
618B---------- Itasca	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
619---------- Keewatin	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
620B---------- Cutaway	Fair	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
621---------- Morph	Fair	Fair	Good	Fair	Fair	Good	Fair	Fair	Fair	Fair.
622B---------- Nashwauk	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
622E---------- Nashwauk	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
624B---------- Rosy	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
625---------- Sandwick	Fair	Fair	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
626B---------- Suomi	Good	Good	Fair	Good	Good	Poor	Very poor.	Fair	Good	Poor.
626D---------- Suomi	Poor	Fair	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
627---------- Tawas	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
628---------- Talmoon	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
629B---------- Wawina	Good	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
630---------- Wildwood	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
655---------- Bearville	Poor	Fair	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
656B---------- Thistledew	Fair	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
797*:										
Mooselake---------	Very poor.	Poor	Poor	Poor	Fair	Good	Good	Poor	Poor	Good.
Lupton----------	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
798*:										
Sago----------	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Roscommon---------	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
799*:										
Seelyeville-------	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Fair	Good.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
799*:										
Bowstring	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
801B*:										
Taylor	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Dalbo	Fair	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
803B*:										
Warba	Good	Good	Good	Good	Poor	Very poor.	Very poor.	Good	Good	Very poor.
Menahga	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
803D*:										
Warba	Fair	Good	Good	Good	Poor	Very poor.	Very poor.	Good	Good	Very poor.
Menahga	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
844F*:										
Mahtomedi	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Emmert	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
866B*:										
Menahga	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Itasca	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
866E*:										
Menahga	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Itasca	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
867B*:										
Menahga	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Graycalm	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
868B*:										
Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
Graycalm	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
869*:										
Lobo	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Fair.
Waskish	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
870C*:										
Itasca	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Goodland	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
870E*:										
Itasca	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
Goodland	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
871*:										
Indus	Fair	Fair	Fair	Good	Good	Fair	Good	Fair	Good	Good.
Brickton	Poor	Fair	Fair	Good	Fair	Good	Good	Fair	Fair	Good.
872*:										
Pengilly	Poor	Poor	Fair	Fair	Fair	Fair	Good	Poor	Poor	Good.
Winterfield	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
995. Borosaprists										
1031. Histosols										
1033. Aquents										
1041*. Pits										
1042*. Dumps										
1043C, 1043F. Udorthents										
1044*. Slickens										
1826B*:										
Nashwauk	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Menahga	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
1826D*:										
Nashwauk	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Menahga	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
1883D*:										
Nashwauk	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Rock outcrop.										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
32B---------- Nebish	Slight---------	Moderate: shrink-swell.	Slight---------	Moderate: shrink-swell, slope.	Moderate: frost action, shrink-swell.	Slight.
32D---------- Nebish	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
72---------- Shooker	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
147---------- Spooner	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
158B---------- Zimmerman	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
167B---------- Baudette	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
202---------- Meehan	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
240B---------- Warba	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
240D---------- Warba	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
243---------- Stuntz	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.
268B---------- Cromwell	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
268D---------- Cromwell	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
458E---------- Menahga	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
533---------- Loxley	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: too acid, ponding, excess humus.
541---------- Rifle	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
544---------- Cathro	Severe: excess humus, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding, excess humus.
549---------- Greenwood	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
550---------- Dora	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, shrink-swell.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
614---------- Blackhoof	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding, excess humus.
615---------- Cowhorn	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Moderate: wetness.
616---------- Effie	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
617B---------- Goodland	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
618B---------- Itasca	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
619---------- Keewatin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
620B---------- Cutaway	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
621---------- Morph	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
622B---------- Nashwauk	Moderate: dense layer.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: droughty.
622E---------- Nashwauk	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
624B---------- Rosy	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Moderate: frost action.	Slight.
625---------- Sandwick	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength.	Moderate: wetness.
626B---------- Suomi	Moderate: too clayey.	Severe: shrink-swell.	Moderate: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
626D---------- Suomi	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.	Severe: slope.
627---------- Tawas	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
628---------- Talmoon	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action, low strength.	Severe: ponding.
629B---------- Wawina	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
630---------- Wildwood	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding.	Severe: ponding, excess humus.
655---------- Bearville	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
656B---------- Thistledew	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Slight---------	Slight.
797*:						
Mooselake--------	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
Lupton----------	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
798*:						
Sago----------	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding, excess humus.
Roscommon--------	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
799*:						
Seelyeville------	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: ponding, flooding, frost action.	Severe: ponding, flooding, excess humus.
Bowstring--------	Severe: cutbanks cave, excess humus, wetness.	Severe: flooding, wetness, low strength.	Severe: flooding, wetness, low strength.	Severe: flooding, wetness, low strength.	Severe: wetness, flooding, frost action.	Severe: wetness, flooding, excess humus.
801B*:						
Taylor----------	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
Dalbo----------	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
803B*:						
Warba----------	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
Menahga----------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: too sandy.
803D*:						
Warba----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Menahga----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
844F*:						
Mahtomedi--------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Emmert----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
866B*:						
Menahga	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: too sandy.
Itasca	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
866E*:						
Menahga	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Itasca	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
867B*:						
Menahga	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: too sandy.
Graycalm	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
868B*:						
Mahtomedi	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Graycalm	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
869*:						
Lobo	Severe: excess humus, wetness.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, frost action.	Severe: wetness, excess humus.
Waskish	Severe: excess humus, wetness.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, frost action, shrink-swell.	Severe: too acid, wetness, excess humus.
870C*:						
Itasca	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Goodland	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
870E*:						
Itasca	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Goodland	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
871*:						
Indus	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness, too clayey.
Brickton	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
872*:						
Pengilly	Severe: cutbanks cave, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: ponding, flooding, frost action.	Severe: ponding, flooding.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
872*: Winterfield	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding.
995. Borosaprists						
1031. Histosols						
1033. Aquents						
1041*. Pits						
1042*. Dumps						
1043C, 1043F. Udorthents						
1044*. Slickens						
1826B*: Nashwauk	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope, droughty.
Menahga	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: too sandy.
1826D*: Nashwauk	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Menahga	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1883D*: Nashwauk	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop.						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
32B Nebish	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
32D Nebish	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
72 Shooker	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
147 Spooner	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
158B Zimmerman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
167B Baudette	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
202 Meehan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
240B Warba	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
240D Warba	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
243 Stuntz	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey, wetness.
268B Cromwell	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
268D Cromwell	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
458E Menahga	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
533 Loxley	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus, too acid.
541 Rifle	Severe: ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
544---------- Cathro	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
549---------- Greenwood	Severe: ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
550---------- Dora	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding, too clayey.	Severe: seepage, ponding.	Poor: too clayey, hard to pack, ponding.
614---------- Blackhoof	Severe: ponding, percs slowly.	Severe: excess humus, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
615---------- Cowhorn	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Fair: too sandy, wetness.
616---------- Effie	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
617B---------- Goodland	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
618B---------- Itasca	Moderate: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
619---------- Keewatin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
620B---------- Cutaway	Severe: percs slowly, poor filter.	Severe: seepage.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy.
621---------- Morph	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
622B---------- Nashwauk	Severe: percs slowly.	Moderate: slope.	Slight----------	Slight----------	Good.
622E---------- Nashwauk	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
624B---------- Rosy	Severe: wetness.	Severe: wetness.	Severe: wetness, too sandy.	Severe: wetness.	Poor: too sandy.
625---------- Sandwick	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
626B---------- Suomi	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight----------	Poor: too clayey, hard to pack.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
626D---------- Suomi	Severe: percs slowly, slope.	Severe: slope.	Severe: slope, too clayey.	Severe: slope.	Poor: too clayey, hard to pack, slope.
627---------- Tawas	Severe: ponding, percs slowly, poor filter.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
628---------- Talmoon	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
629B---------- Wawina	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Fair: too sandy.
630---------- Wildwood	Severe: ponding, percs slowly.	Severe: excess humus, ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
655---------- Bearville	Severe: wetness, percs slowly.	Slight----------	Severe: wetness, too clayey.	Severe: seepage, wetness.	Poor: too clayey, hard to pack, wetness.
656B---------- Thistledew	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Moderate: wetness, too sandy.	Severe: seepage.	Poor: seepage.
797*:					
Mooselake----------	Severe: ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
Lupton----------	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
798*:					
Sago----------	Severe: ponding.	Severe: excess humus, ponding.	Severe: ponding, too sandy.	Severe: ponding.	Poor: too sandy, ponding.
Roscommon----------	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
799*:					
Seelyeville--------	Severe: flooding, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: ponding, excess humus.
Bowstring----------	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: wetness, excess humus.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
801B*:					
Taylor	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Dalbo	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
803B*:					
Warba	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Menahga	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
803D*:					
Warba	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Menahga	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
844F*:					
Mahtomedi	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Emmert	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
866B*:					
Menahga	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Itasca	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
866E*:					
Menahga	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Itasca	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
867B*:					
Menahga	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Graycalm	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
868B*:					
Mahtomedi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Graycalm	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
869*:					
Lobo	Severe: wetness, poor filter.	Severe: seepage, excess humus, wetness.	Severe: seepage, wetness, excess humus.	Severe: seepage, wetness.	Poor: wetness, excess humus.
Waskish	Severe: wetness, poor filter.	Severe: seepage, excess humus, wetness.	Severe: wetness, excess humus, too acid.	Severe: seepage, wetness.	Poor: wetness, excess humus, too acid.
870C*:					
Itasca	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
Goodland	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
870E*:					
Itasca	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Goodland	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
871*:					
Indus	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Brickton	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
872*:					
Pengilly	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Poor: ponding.
Winterfield	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.
995. Borosaprists					
1031. Histosols					
1033. Aquents					

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1041*. Pits					
1042*. Dumps					
1043C, 1043F. Udorthents					
1044*. Slickens					
1826B*: Nashwauk	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Menahga	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
1826D*: Nashwauk	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Menahga	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
1883D*: Nashwauk	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Rock outcrop.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
32B---------- Nebish	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
32D---------- Nebish	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
72---------- Shooker	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
147---------- Spooner	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
158B---------- Zimmerman	Good----------	Probable----------	Improbable: too sandy.	Fair: too sandy.
167B---------- Baudette	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
202---------- Meehan	Fair: wetness.	Probable----------	Improbable: too sandy.	Fair: too sandy, small stones.
240B---------- Warba	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
240D---------- Warba	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
243---------- Stuntz	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
268B---------- Cromwell	Good----------	Probable----------	Improbable: too sandy.	Poor: small stones.
268D---------- Cromwell	Fair: slope.	Probable----------	Improbable: too sandy.	Poor: small stones, slope.
458E---------- Menahga	Fair: slope.	Probable----------	Improbable: too sandy.	Poor: slope, too sandy.
533---------- Loxley	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness, too acid.
541---------- Rifle	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
544---------- Cathro	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
549---------- Greenwood	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
550---------- Dora	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
614--Blackhoof	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, excess humus, wetness.
615--Cowhorn	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
616--Effie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
617B--Goodland	Good	Probable	Improbable: too sandy.	Fair: area reclaim, small stones.
618B--Itasca	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
619--Keewatin	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, wetness.
620B--Cutaway	Fair: thin layer.	Improbable: thin layer.	Improbable: too sandy.	Poor: thin layer.
621--Morph	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
622B--Nashwauk	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
622E--Nashwauk	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
624B--Rosy	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
625--Sandwick	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, too sandy, small stones.
626B--Suomi	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
626D--Suomi	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
627--Tawas	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
628--Talmoon	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
629B--Wawina	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy.
630--Wildwood	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
655--Bearville	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy, small stones.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
656B---------- Thistledew	Fair: thin layer.	Improbable: thin layer.	Improbable: too sandy.	Fair: too sandy, small stones.
797*:				
Mooselake----------	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
Lupton----------	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
798*:				
Sago----------	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
Roscommon----------	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: wetness.
799*:				
Seelyeville----------	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
Bowstring----------	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
801B*:				
Taylor----------	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Dalbo----------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
803B*:				
Warba----------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Menahga----------	Good----------	Probable----------	Improbable: too sandy.	Poor: too sandy.
803D*:				
Warba----------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Menahga----------	Fair: slope.	Probable----------	Improbable: too sandy.	Poor: slope, too sandy.
844F*:				
Mahtomedi----------	Poor: slope.	Probable----------	Improbable: too sandy.	Poor: too sandy, small stones, area reclaim.
Emmert----------	Poor: slope.	Probable----------	Probable----------	Poor: small stones, area reclaim, slope.
866B*:				
Menahga----------	Good----------	Probable----------	Improbable: too sandy.	Poor: too sandy.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
866B*:				
Itasca	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
866E*:				
Menahga	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope, too sandy.
Itasca	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
867B*:				
Menahga	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Graycalm	Good	Probable	Improbable: too sandy.	Fair: too sandy, small stones.
868B*:				
Mahtomedi	Good	Probable	Improbable: too sandy.	Poor: too sandy, small stones, area reclaim.
Graycalm	Good	Probable	Improbable: too sandy.	Fair: too sandy, small stones.
869*:				
Lobo	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
Waskish	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness, too acid.
870C*:				
Itasca	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Goodland	Good	Probable	Improbable: too sandy.	Fair: area reclaim, small stones.
870E*:				
Itasca	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Goodland	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope.
871*:				
Indus	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Brickton	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
872*:				
Pengilly	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
872*: Winterfield	Fair: wetness.	Probable	Improbable: too sandy.	Fair: too sandy, small stones.
995. Borosaprists				
1031. Histosols				
1033. Aquents				
1041*. Pits				
1042*. Dumps				
1043C, 1043F. Udorthents				
1044*. Slickens				
1826B*: Nashwauk	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Menahga	Good	Probable	Improbable: too sandy.	Poor: too sandy.
1826D*: Nashwauk	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
Menahga	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope, too sandy.
1883D*: Nashwauk	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
Rock outcrop.				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
32B---------- Nebish	Moderate: seepage, slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Soil blowing---	Favorable.
32D---------- Nebish	Severe: slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
72---------- Shooker	Moderate: seepage.	Severe: wetness, piping.	Frost action---	Wetness, soil blowing.	Wetness, soil blowing.	Wetness.
147---------- Spooner	Moderate: seepage.	Severe: piping, wetness.	Frost action---	Wetness, erodes easily.	Erodes easily, wetness.	Wetness, erodes easily.
158B---------- Zimmerman	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
167B---------- Baudette	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
202---------- Meehan	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
240B---------- Warba	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Soil blowing, slope.	Soil blowing---	Favorable.
240D---------- Warba	Severe: slope.	Moderate: piping.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
243---------- Stuntz	Moderate: seepage.	Moderate: wetness.	Frost action---	Wetness, soil blowing.	Wetness, soil blowing.	Favorable.
268B---------- Cromwell	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
268D---------- Cromwell	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
458E---------- Menahga	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
533---------- Loxley	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides, frost action.		Not needed-----	Not needed.
541---------- Rifle	Severe: seepage.	Severe: excess humus, ponding.	Ponding, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
544---------- Cathro	Severe: seepage.	Severe: piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
549---------- Greenwood	Severe: seepage.	Severe: excess humus, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
550---------- Dora	Severe: seepage.	Severe: ponding.	Ponding, percs slowly, subsides.	Ponding, soil blowing, percs slowly.	Ponding, soil blowing, percs slowly.	Wetness, percs slowly.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
614---------- Blackhoof	Slight---------	Severe: piping, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly, rooting depth.	Ponding--------	Wetness, rooting depth, percs slowly.
615---------- Cowhorn	Severe: seepage.	Severe: piping, wetness.	Frost action, cutbanks cave.	Wetness, fast intake, soil blowing.	Wetness, soil blowing.	Favorable.
616---------- Effie	Slight---------	Moderate: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily, percs slowly.
617B---------- Goodland	Severe: seepage.	Severe: seepage, piping.	Deep to water	Rooting depth, slope.	Erodes easily, too sandy.	Erodes easily, rooting depth.
618B---------- Itasca	Moderate: seepage, slope.	Severe: piping.	Deep to water	Rooting depth, slope.	Erodes easily	Erodes easily, rooting depth.
619---------- Keewatin	Slight---------	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily, rooting depth.
620B---------- Cutaway	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Erodes easily, too sandy.	Erodes easily, droughty.
621---------- Morph	Moderate: seepage.	Severe: piping, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
622B---------- Nashwauk	Moderate: slope.	Moderate: piping.	Deep to water	Droughty, soil blowing, percs slowly.	Erodes easily, soil blowing.	Erodes easily, droughty.
622E---------- Nashwauk	Severe: slope.	Moderate: piping.	Deep to water	Droughty, soil blowing, percs slowly.	Slope, erodes easily, soil blowing.	Slope, erodes easily, droughty.
624B---------- Rosy	Moderate: seepage, slope.	Severe: piping.	Deep to water	Soil blowing, slope.	Too sandy, soil blowing.	Favorable.
625---------- Sandwick	Severe: seepage.	Severe: wetness.	Favorable------	Wetness, fast intake, soil blowing.	Erodes easily, wetness, soil blowing.	Wetness, erodes easily, rooting depth.
626B---------- Suomi	Moderate: slope.	Moderate: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
626D---------- Suomi	Severe: slope.	Moderate: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
627---------- Tawas	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
628---------- Talmoon	Slight---------	Severe: piping, ponding.	Ponding, frost action.	Ponding--------	Erodes easily, ponding.	Wetness, erodes easily.
629B---------- Wawina	Severe: seepage.	Severe: piping.	Deep to water	Fast intake, soil blowing, slope.	Soil blowing---	Favorable.
630---------- Wildwood	Slight---------	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly, soil blowing.	Ponding, percs slowly, soil blowing.	Wetness, percs slowly.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
655---------- Bearville	Slight---------	Moderate: hard to pack, wetness.	Percs slowly, frost action.	Wetness, fast intake, soil blowing.	Wetness, soil blowing, percs slowly.	Wetness, rooting depth, percs slowly.
656B---------- Thistledew	Severe: seepage.	Severe: seepage, piping.	Deep to water	Fast intake, soil blowing, percs slowly.	Too sandy, soil blowing.	Favorable.
797*: Mooselake--------	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides, frost action.	Ponding--------	Ponding--------	Wetness.
Lupton----------	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
798*: Sago----------	Moderate: seepage.	Severe: seepage, piping, ponding.	Ponding, subsides, frost action.	Ponding--------	Ponding, too sandy.	Wetness.
Roscommon--------	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Ponding, too sandy, soil blowing.	Wetness, droughty.
799*: Seelyeville------	Severe: seepage.	Severe: excess humus, ponding.	Ponding, flooding, subsides.	Ponding, soil blowing, flooding.	Ponding, soil blowing.	Wetness.
Bowstring--------	Severe: seepage.	Severe: excess humus, wetness.	Flooding, subsides, frost action.	Wetness, flooding.	Wetness--------	Wetness.
801B*: Taylor----------	Moderate: slope.	Severe: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Dalbo----------	Moderate: seepage, slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
803B*: Warba----------	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Soil blowing, slope.	Soil blowing---	Favorable.
Menahga----------	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
803D*: Warba----------	Severe: slope.	Moderate: piping.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
Menahga----------	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
844F*: Mahtomedi--------	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty, rooting depth.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
844F*:						
Emmert	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, fast intake, slope.	Slope, too sandy.	Slope, droughty.
866B*:						
Menahga	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Itasca	Moderate: seepage, slope.	Severe: piping.	Deep to water	Rooting depth, slope.	Erodes easily	Erodes easily, rooting depth.
866E*:						
Menahga	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
Itasca	Severe: slope.	Severe: piping.	Deep to water	Rooting depth, slope.	Slope, erodes easily.	Slope, erodes easily, rooting depth.
867B*:						
Menahga	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Graycalm	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
868B*:						
Mahtomedi	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, fast intake.	Too sandy, soil blowing.	Droughty, rooting depth.
Graycalm	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
869*:						
Lobo	Severe: seepage.	Severe: excess humus, wetness.	Subsides, frost action.	Wetness	Wetness	Wetness.
Waskish	Severe: seepage.	Severe: excess humus, wetness.	Frost action, too acid.	Wetness, too acid.	Wetness	Wetness.
870C*:						
Itasca	Moderate: seepage, slope.	Severe: piping.	Deep to water	Rooting depth, slope.	Erodes easily	Erodes easily, rooting depth.
Goodland	Severe: seepage.	Severe: seepage, piping.	Deep to water	Rooting depth, slope.	Erodes easily, too sandy.	Erodes easily, rooting depth.
870E*:						
Itasca	Severe: slope.	Severe: piping.	Deep to water	Rooting depth, slope.	Slope, erodes easily.	Slope, erodes easily, rooting depth.
Goodland	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Rooting depth, slope.	Slope, erodes easily, too sandy.	Slope, erodes easily, rooting depth.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
871*:						
Indus	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Brickton	Slight	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly, erodes easily.	Wetness, erodes easily, percs slowly.
872*:						
Pengilly	Moderate: seepage.	Severe: piping, ponding.	Ponding, flooding, frost action.	Ponding, flooding.	Ponding, soil blowing.	Wetness.
Winterfield	Severe: seepage.	Severe: seepage, piping, wetness.	Flooding, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
995. Borosaprists						
1031. Histosols						
1033. Aquents						
1041*. Pits						
1042*. Dumps						
1043C, 1043F. Udorthents						
1044*. Slickens						
1826B*:						
Nashwauk	Severe: slope.	Moderate: piping.	Deep to water	Droughty, soil blowing, percs slowly.	Slope, erodes easily, soil blowing.	Slope, erodes easily, droughty.
Menahga	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
1826D*:						
Nashwauk	Severe: slope.	Moderate: piping.	Deep to water	Droughty, soil blowing, percs slowly.	Slope, erodes easily, soil blowing.	Slope, erodes easily, droughty.
Menahga	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
1883D*:						
Nashwauk	Severe: slope.	Moderate: piping.	Deep to water	Droughty, soil blowing, percs slowly.	Slope, erodes easily, soil blowing.	Slope, erodes easily, droughty.
Rock outcrop.						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
32B---------- Nebish	0-8	Very fine sandy loam.	SM	A-4	0-3	95-100	90-100	75-85	35-50	20-35	NP-7
	8-39	Clay loam, loam	CL, ML	A-7, A-6, A-4	0-3	95-100	90-100	70-95	50-75	20-50	5-20
	39-60	Loam, sandy loam	SC, CL, ML, SM	A-4, A-6	0-3	95-100	90-100	70-95	35-70	20-40	3-20
32D---------- Nebish	0-9	Fine sandy loam	SM	A-4	0-3	95-100	90-100	75-85	35-50	20-35	NP-7
	9-29	Sandy clay loam, clay loam, loam.	ML, CL	A-4, A-7, A-6	0-3	95-100	90-100	70-95	50-75	20-50	5-20
	29-60	Loam, sandy loam	SC, CL, ML, SM	A-4, A-6	0-3	95-100	90-100	70-95	35-70	20-40	3-20
72---------- Shooker	0-9	Very fine sandy loam.	SM, ML, SM-SC, CL-ML	A-4	0-3	95-100	90-98	80-95	35-60	< 28	1-7
	9-27	Loam, clay loam, sandy clay loam.	ML, CL, CL-ML	A-6, A-4	0-3	95-100	90-98	70-95	50-70	20-40	3-20
	27-60	Loam, fine sandy loam, sandy loam.	ML, CL, SC, SM	A-4, A-6	0-3	95-100	90-98	70-95	40-65	20-40	2-20
147---------- Spooner	0-4	Silt loam--------	ML	A-4, A-6	0	100	100	90-100	50-80	25-40	1-14
	4-9	Silt loam, very fine sandy loam, loam.	SM, SC, CL, ML	A-4, A-6	0	100	100	90-100	60-85	10-40	1-15
	9-20	Loam, silt loam, clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0	100	100	70-90	40-85	20-40	5-15
	20-60	Very fine sandy loam, silt loam, sandy loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	50-95	20-40	5-15
158B---------- Zimmerman	0-3	Loamy fine sand	SM	A-2	0	100	100	95-100	15-30	< 20	NP
	3-60	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	95-100	5-20	< 20	NP
167B---------- Baudette	0-9	Silt loam--------	ML	A-4	0	100	100	95-100	60-90	20-40	1-10
	9-33	Clay loam, silt loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	80-98	20-50	5-20
	33-60	Silt loam, very fine sandy loam, loamy very fine sand.	ML	A-4	0	100	100	95-100	70-98	20-40	1-10
202---------- Meehan	0-5	Loamy sand-------	SM	A-2, A-1	0	90-100	75-100	40-90	15-30	---	NP
	5-35	Sand, loamy sand, loamy coarse sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	90-100	75-100	40-90	3-30	---	NP
	35-60	Sand, coarse sand	SP, SP-SM	A-1, A-3, A-2	0	90-100	75-100	40-90	0-5	---	NP
240B, 240D------- Warba	0-12	Fine sandy loam	ML	A-4	0-1	98-100	95-100	85-95	55-80	20-40	NP-10
	12-48	Clay loam, loam, sandy clay loam.	CL	A-7, A-6	0-3	95-100	85-98	75-85	50-75	30-45	10-25
	48-60	Loam, sandy clay loam, clay loam.	CL	A-6, A-7	0-3	90-100	85-98	70-80	55-75	30-50	10-25
243---------- Stuntz	0-13	Very fine sandy loam.	ML, SM, CL-ML, SM-SC	A-4	0-3	98-100	95-100	85-95	45-75	< 25	NP-6
	13-43	Sandy clay loam, clay loam, loam.	CL	A-7, A-6	0-3	95-100	85-97	70-85	50-80	30-50	15-25
	43-60	Loam, sandy clay loam, clay loam.	CL, ML	A-6, A-7	0-5	90-100	85-97	65-85	50-75	30-50	10-20

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
268B, 268D------- Cromwell	0-16	Fine sandy loam, sandy loam.	SM	A-4, A-2	0	95-100	90-100	55-85	20-45	< 20	NP-4
	16-60	Loamy sand, coarse sand.	SM, SP, SP-SM	A-1, A-3, A-2	0	95-100	60-100	35-70	0-15	< 20	NP
458E------------- Menahga	0-3	Loamy coarse sand	SM, SP-SM	A-2	0	100	85-100	60-80	10-30	---	NP
	3-28	Coarse sand, sand	SP, SP-SM	A-3, A-2	0	100	80-100	50-75	0-10	---	NP
	28-60	Coarse sand, sand	SP, SP-SM	A-3, A-2	0	100	80-100	50-75	0-10	---	NP
533-------------- Loxley	0-12	Fibric material	PT	A-8	0	---	---	---	---	---	---
	12-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
541-------------- Rifle	0-4	Hemic material---	PT	A-8	0	---	---	---	---	---	---
	4-60	Hemic material---	PT	A-8	0	---	---	---	---	---	---
544-------------- Cathro	0-14	Sapric and hemic material.	PT	A-8	0	---	---	---	---	---	---
	14-39	Sapric material	PT	A-8	0	---	---	---	---	---	---
	39-60	Sandy loam, loam, silt loam.	SM, ML, SC, CL	A-4	0-5	80-100	65-100	60-100	35-90	< 25	3-10
549-------------- Greenwood	0-15	Fibric material	PT	A-8	0	---	---	---	---	---	---
	15-60	Hemic material---	PT	A-8	0	---	---	---	---	---	---
550-------------- Dora	0-12	Hemic material---	PT	A-8	0	---	---	---	---	---	---
	12-32	Sapric material	PT	A-8	0	---	---	---	---	---	---
	32-60	Silty clay loam, silty clay, clay.	CH, CL	A-7	0	100	100	90-100	90-100	45-70	25-40
614-------------- Blackhoof	0-8	Sapric material	PT	---	0	---	---	---	---	---	---
	8-11	Loam, clay loam	CL, ML, CL-ML, SM-SC	A-4, A-6	0-2	95-100	90-100	80-90	50-80	20-40	2-15
	11-60	Loam, clay loam	CL, ML	A-4, A-6	0-2	95-100	85-100	80-90	50-80	20-40	2-15
615-------------- Cowhorn	0-8	Loamy very fine sand.	ML, SM	A-4	0	100	100	75-100	35-60	< 25	NP-4
	8-51	Loamy very fine sand, very fine sand.	SM, ML	A-4	0	100	100	75-100	35-60	< 25	NP-4
	51-60	Very fine sand, loamy very fine sand.	SM, ML	A-4	0	100	100	75-100	35-60	< 25	NP-4
616-------------- Effie	0-5	Loam-------------	CL, ML, CL-ML	A-4, A-6	0-2	95-100	90-100	85-100	60-90	20-40	3-15
	5-19	Clay loam, clay, silty clay loam.	CH, CL	A-7	0-2	95-100	95-100	85-100	70-90	45-70	25-45
	19-60	Clay loam, clay, silty clay loam.	CH, CL	A-7, A-6	0-2	95-100	95-100	85-100	65-90	35-60	20-40
617B------------- Goodland	0-12	Silt loam--------	ML, CL-ML	A-4	0	95-100	95-100	85-100	50-90	< 25	2-5
	12-28	Fine sandy loam, sandy loam, loam.	SM, SC, CL, ML	A-4	0-3	95-100	85-95	45-75	35-60	20-30	2-10
	28-34	Gravelly loamy coarse sand, loamy coarse sand, loamy sand.	SM, SP-SM, SM-SC	A-2, A-1	0-10	70-100	65-100	35-50	5-30	< 20	NP-5
	34-60	Sand, gravelly coarse sand, gravelly sand.	SP, SW, SP-SM	A-1	0-10	80-100	75-100	35-50	2-10	---	NP

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
618B---------- Itasca	0-9	Silt loam--------	ML, CL-ML	A-4	0	100	100	90-100	70-95	15-25	NP-5
	9-19	Silt loam, very fine sandy loam, loamy very fine sand.	ML, CL-ML, SM, SM-SC	A-4	0	95-100	95-100	80-100	45-90	15-25	NP-5
	19-43	Fine sandy loam, sandy loam, loam.	SM, SC, CL, ML	A-4, A-2	0-5	90-100	85-100	55-85	25-70	20-30	3-10
	43-60	Fine sandy loam, sandy loam, loam.	SM, SC, CL, ML	A-4, A-2	0-5	90-100	85-100	55-85	25-70	20-30	3-10
619---------- Keewatin	0-6	Silt loam--------	ML, CL, CL-ML	A-4	0-4	90-100	85-96	75-85	50-70	20-30	2-8
	6-16	Fine sandy loam, silt loam, sandy loam.	SM, ML	A-2, A-4	0-4	90-100	85-96	55-85	25-65	<20	NP-4
	16-60	Loam, fine sandy loam, clay loam.	CL	A-6	0-4	90-100	85-95	75-90	50-80	30-40	10-20
	60-65	Loam, fine sandy loam, clay loam.	CL, SC	A-6	0-4	90-100	85-96	70-90	40-80	30-40	10-20
620B---------- Cutaway	0-4	Loamy sand-------	SM, SP-SM	A-2	0-3	100	85-100	55-90	10-25	---	NP
	4-35	Loamy sand, sand, coarse sand.	SM, SP-SM	A-2, A-3	0-3	100	85-100	50-80	5-20	---	NP
	35-51	Clay loam, loam, sandy loam.	CL, ML	A-7, A-6	0-4	95-100	85-100	75-85	60-80	30-45	10-20
	51-60	Loam, clay loam, sandy loam.	CL, ML	A-6	0-4	90-100	85-100	70-80	55-70	30-40	10-20
621---------- Morph	0-13	Very fine sandy loam.	ML, CL-ML, SM, SM-SC	A-4, A-2	0	100	95-100	60-95	30-70	<25	NP-5
	13-33	Loam, fine sandy loam, very fine sandy loam.	ML, CL, SM, SC	A-4	0	100	95-100	60-100	35-90	20-30	3-9
	33-60	Stratified loamy sand to silty clay loam.	SM, SC, CL, ML	A-4, A-2	0	100	95-100	60-100	30-90	<25	2-8
622B, 622E------- Nashwauk	0-7	Fine sandy loam	SM, ML	A-4, A-2	0-4	90-100	85-100	55-85	25-55	<25	NP-4
	7-16	Loam, sandy loam, fine sandy loam.	ML, SM, CL, SC	A-4	0-4	90-100	85-100	60-85	35-70	<30	4-10
	16-58	Loam, clay loam, sandy clay loam.	CL, SC	A-6, A-4	0-4	90-100	85-100	75-90	35-80	30-40	8-15
	58-72	Loam, clay loam, sandy loam.	CL	A-6	0-4	90-100	85-100	70-90	50-85	25-40	10-20
624B---------- Rosy	0-9	Very fine sandy loam, fine sandy loam.	ML, SM, CL-ML, SM-SC	A-4	0	100	95-100	70-95	40-65	15-25	NP-6
	9-20	Loam, very fine sandy loam, fine sandy loam.	ML, SM, SC, CL	A-4, A-6	0	100	95-100	70-95	40-75	20-40	3-15
	20-60	Stratified sand to silty clay loam.	SM, SC, ML, CL	A-4, A-2-4	0	95-100	95-100	60-95	30-75	<30	2-8
625---------- Sandwick	0-4	Loamy fine sand	SM	A-2	0	95-100	85-100	65-90	15-30	---	NP
	4-22	Loamy fine sand, loamy sand, sand.	SM, SP-SM	A-2	0	95-100	85-100	60-90	10-30	---	NP
	22-38	Loam, clay loam, sandy loam.	CL, ML	A-6, A-7	0-5	90-100	85-100	70-90	55-80	30-45	10-20
	38-60	Loam, clay loam, sandy loam.	CL, ML	A-6	0-5	90-100	85-100	70-90	50-80	30-40	10-20

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
626B---------- Suomi	0-12	Silt loam--------	CL, ML, CL-ML	A-6, A-4	0-3	95-100	90-100	85-100	60-90	20-40	3-15
	12-30	Silty clay, clay, silty clay loam.	CH, CL	A-7	0-3	95-100	90-100	85-100	70-95	45-70	25-45
	30-60	Silty clay, silty clay loam, clay.	CH, CL	A-7, A-6	0-3	95-100	90-100	80-100	65-95	35-60	15-30
626D---------- Suomi	0-12	Loam----------	CL, ML, CL-ML	A-6, A-4	0-3	95-100	90-100	85-100	60-90	20-40	3-15
	12-30	Silty clay, clay, clay loam.	CH, CL	A-7	0-3	95-100	90-100	85-100	70-95	45-70	25-45
	30-60	Silty clay, silty clay loam, loam.	CH, CL	A-7, A-6	0-3	95-100	90-100	80-100	65-95	35-60	15-30
627---------- Tawas	0-31	Sapric material	PT	A-8	0	---	---	---	---	---	---
	31-60	Coarse sand, loamy sand.	SP, SM, SP-SM	A-3, A-2-4	0	80-100	60-100	50-75	0-20	---	NP
628---------- Talmoon	0-6	Silt loam--------	ML, CL, CL-ML	A-4	0	95-100	85-100	70-100	60-90	20-32	3-10
	6-16	Very fine sandy loam, sandy loam, silt loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	95-100	85-100	60-95	35-75	23-35	6-15
	16-42	Clay loam, sandy clay loam, loam.	CL, ML	A-6, A-7, A-4	0	95-100	85-100	70-100	50-95	30-50	9-20
	42-60	Loam, sandy clay loam, clay loam.	CL, CL-ML, SC, SM-SC	A-6, A-4, A-7	0	95-100	85-100	75-100	45-80	25-45	6-18
629B---------- Wawina	0-3	Loamy very fine sand.	SM, ML	A-4, A-2	0	100	100	95-100	30-60	---	NP
	3-60	Very fine sand, loamy very fine sand.	SM, ML	A-4, A-2	0	100	100	75-100	20-60	---	NP
630---------- Wildwood	0-12	Sapric material	PT	A-8	---	---	---	---	---	---	---
	12-24	Clay, silty clay	CH	A-7	0	100	100	95-100	85-98	50-80	35-60
	24-60	Clay, silty clay	CH	A-7	0	100	85-100	85-100	80-98	50-80	35-60
655---------- Bearville	0-16	Loamy sand-------	SM, SP-SM	A-2	0-2	95-100	95-100	50-70	10-30	---	NP
	16-25	Sandy clay loam, loam, sandy loam.	SC, CL	A-6	0-2	95-100	95-100	55-85	35-60	20-40	10-25
	25-35	Clay, silty clay	CH, MH	A-7	0	100	95-100	80-100	75-100	50-75	25-45
	35-60	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	100	95-100	80-95	60-95	45-70	20-40
656B---------- Thistledew	0-2	Loamy fine sand	SM	A-2	0-2	95-100	95-100	50-80	15-35	---	NP
	2-23	Loamy sand, sand, loamy coarse sand.	SM, SP-SM	A-2	0-2	95-100	95-100	50-70	10-30	---	NP
	23-38	Sandy clay loam, loam, sandy loam.	SC, CL	A-6	0-2	95-100	95-100	55-85	35-60	20-40	10-20
	38-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	80-95	70-95	50-75	25-45
797*:											
Mooselake-------	0-60	Hemic material---	PT	A-8	0	---	---	---	---	---	---
Lupton----------	0-8	Hemic material---	PT	A-8	---	---	---	---	---	---	---
	8-65	Sapric material	PT	A-8	---	---	---	---	---	---	---
798*:											
Sago----------	0-13	Sapric material	PT	---	0	---	---	---	---	---	---
	13-60	Stratified fine sand to silt loam.	SM, ML, CL, SC	A-4, A-2	0	98-100	95-100	70-95	15-85	15-30	2-9
Roscommon-------	0-6	Mucky loamy sand	SM, SP-SM	A-2, A-3	0	100	95-100	50-70	5-25	---	NP
	6-60	Sand, loamy sand, loamy coarse sand.	SP, SP-SM, SM	A-1, A-2, A-3	0	95-100	85-100	40-70	0-15	---	NP

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					*Pct	
799*:											
Seelyeville-----	0-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
Bowstring-------	0-38	Sapric material	PT	A-8	0	---	---	---	---	---	---
	38-43	Mucky sand-------	SP-SM, SM	A-2	0	100	100	50-85	10-35	<20	NP-5
	43-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
801B*:											
Taylor----------	0-6	Silt loam--------	CL	A-6	0	100	100	90-100	70-90	30-40	10-15
	6-21	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	60-80	35-50
	21-60	Silty clay, clay	CH	A-7	0	100	100	95-100	90-100	50-80	30-50
Dalbo-----------	0-6	Silt loam--------	CL, ML, CL-ML	A-4	0	100	100	95-100	60-100	20-35	2-10
	6-35	Clay, silty clay, silty clay loam.	CL, CH	A-7	0	100	95-100	95-100	85-100	40-65	20-40
	35-60	Silty clay loam, silty clay, clay.	CL, CH	A-6, A-7	0	100	95-100	95-100	85-100	30-60	10-35
803B*, 803D*:											
Warba-----------	0-15	Fine sandy loam	ML	A-4	0-1	98-100	95-100	85-95	55-80	20-40	NP-10
	15-37	Clay loam, loam, sandy clay loam.	CL	A-7, A-6	0-3	95-100	85-98	75-85	60-80	30-50	15-25
	37-60	Loam, sandy clay loam, clay loam.	CL	A-6, A-7	0-3	90-100	85-98	70-80	55-75	30-50	10-25
Menahga---------	0-3	Loamy coarse sand	SM, SP-SM	A-2	0	100	85-100	60-80	10-30	---	NP
	3-38	Coarse sand, sand	SP, SP-SM	A-3, A-2	0	100	80-100	50-75	0-10	---	NP
	38-60	Coarse sand, sand	SP, SP-SM	A-3, A-2	0	100	80-100	50-75	0-10	---	NP
844F*:											
Mahtomedi-------	0-3	Loamy sand-------	SM, SM-SC	A-2, A-1	0-1	95-100	60-90	40-70	15-30	<20	NP-4
	3-33	Loamy coarse sand, gravelly loamy coarse sand, gravelly coarse sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-70	5-15	<20	NP
	33-60	Sand, coarse sand, gravelly coarse sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-5	75-95	50-90	30-70	2-15	<20	NP
Emmert----------	0-9	Gravelly loamy coarse sand.	SM, SP-SM	A-1	0-10	80-90	65-75	30-50	10-20	<25	NP
	9-60	Very gravelly coarse sand, very gravelly sand.	GW, GP, SP, SW	A-1	0-30	20-60	10-45	5-25	0-5	---	NP
866B*, 866E*:											
Menahga---------	0-3	Loamy sand-------	SM, SP-SM	A-2	0	100	85-100	60-80	10-30	---	NP
	3-60	Coarse sand, sand	SP, SP-SM	A-3, A-2	0	100	80-100	50-75	0-10	---	NP
Itasca----------	0-19	Silt loam--------	ML, CL-ML	A-4	0	100	100	90-100	70-95	15-25	NP-5
	19-43	Silt loam, very fine sandy loam, loamy very fine sand.	ML, CL-ML, SM, SM-SC	A-4	0	95-100	95-100	80-100	45-90	15-25	NP-5
	43-60	Fine sandy loam, sandy loam, loam.	SM, SC, CL, ML	A-4, A-2	0-5	90-100	85-100	55-85	25-70	20-30	3-10
867B*:											
Menahga---------	0-3	Loamy coarse sand	SM, SP-SM	A-2	0	100	85-100	60-80	10-30	---	NP
	3-60	Coarse sand, sand	SP, SP-SM	A-3, A-2	0	100	80-100	50-75	0-10	---	NP

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
867B*:											
Graycalm--------	0-3	Loamy sand-------	SP-SM, SM	A-2, A-1	0	95-100	75-100	40-75	10-20	---	NP
	3-17	Sand, loamy sand	SP-SM, SM	A-3, A-2, A-1	0	95-100	75-100	40-75	5-20	---	NP
	17-58	Sand, loamy sand, loamy coarse sand.	SM, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-75	5-20	---	NP
	58-72	Sand, coarse sand	SP, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-75	0-15	---	NP
868B*:											
Mahtomedi-------	0-4	Loamy coarse sand	SM, SM-SC	A-2, A-1	0-1	95-100	60-90	40-70	15-30	<20	NP-4
	4-34	Sand, loamy coarse sand, gravelly coarse sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-70	5-15	<20	NP
	34-60	Sand, coarse sand, gravelly coarse sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-5	75-95	50-90	30-70	2-15	<20	NP
Graycalm--------	0-3	Loamy sand-------	SP-SM, SM	A-2, A-1	0	95-100	75-100	40-75	10-20	---	NP
	3-17	Sand, loamy sand	SP-SM, SM	A-3, A-2, A-1	0	95-100	75-100	40-75	5-20	---	NP
	17-60	Sand, loamy sand, loamy coarse sand.	SM, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-75	5-20	---	NP
	60-70	Sand, coarse sand	SP, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-75	0-15	---	NP
869*:											
Lobo------------	0-44	Fibric material	PT	A-8	0	---	---	---	---	---	---
	44-60	Hemic material---	PT	A-8	0	---	---	---	---	---	---
Waskish---------	0-60	Fibric material	PT	A-8	0	---	---	---	---	---	---
870C*, 870E*:											
Itasca----------	0-9	Silt loam--------	ML, CL-ML	A-4	0	100	100	90-100	70-95	15-25	NP-5
	9-19	Silt loam, very fine sandy loam, loamy very fine sand.	ML, CL-ML, SM, SM-SC	A-4	0	95-100	95-100	80-100	45-90	15-25	NP-5
	19-43	Fine sandy loam, sandy loam, loam.	SM, SC, CL, ML	A-4, A-2	0-5	90-100	85-100	55-85	25-70	20-30	3-10
	43-60	Fine sandy loam, sandy loam, loam.	SM, SC, CL, ML	A-4, A-2	0-5	90-100	85-100	55-85	25-70	20-30	3-10
Goodland--------	0-12	Silt loam--------	ML, CL-ML	A-4	0	95-100	95-100	85-100	50-90	<25	2-5
	12-28	Fine sandy loam, sandy loam, loam.	SM, SC, CL, ML	A-4	0-3	95-100	85-95	45-75	35-60	20-30	2-10
	28-34	Gravelly loamy coarse sand, loamy coarse sand, loamy sand.	SM, SP-SM, SM-SC	A-2, A-1	0-10	70-100	65-100	35-50	5-30	<20	NP-5
	34-60	Sand, gravelly coarse sand, gravelly sand.	SP, SW, SP-SM	A-1	0-10	80-100	75-100	35-50	2-10	---	NP
871*:											
Indus-----------	0-6	Clay, loam-------	CH, CL	A-7	0	100	98-100	90-100	80-98	45-65	20-35
	6-29	Clay-------------	CH	A-7	0	100	95-100	90-100	85-100	60-80	35-50
	29-60	Clay, silty clay	CH	A-7	0	98-100	95-100	90-100	85-100	60-80	35-50

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
871*:											
Brickton--------	0-10	Silt loam--------	CL-ML, ML	A-4	0	100	100	90-100	60-100	25-35	4-10
	10-25	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	95-100	90-100	85-100	40-65	20-40
	25-60	Silty clay, clay, silty clay loam.	CH, CL, ML, MH	A-6, A-7	0	100	95-100	90-100	85-100	35-60	10-35
872*:											
Pengilly--------	0-4	Very fine sandy loam.	ML, CL-ML, SM, SM-SC	A-4, A-2	0	95-100	90-100	60-95	30-65	<26	2-7
	4-60	Stratified loamy very fine sand to silt loam.	ML, CL-ML, SM, SM-SC	A-4, A-2	0	95-100	90-100	60-95	30-75	<20	NP-7
Winterfield-----	0-3	Loamy fine sand	SM	A-2-4, A-4	0	100	95-100	50-90	15-45	---	NP
	3-14	Sand, loamy sand, loamy fine sand.	SM, SP-SM	A-2-4, A-3, A-4	0	100	95-100	50-90	5-45	---	NP
	14-60	Sand, gravelly sand, fine sand.	SP-SM, SP	A-3, A-1, A-2	0	90-100	80-100	45-80	0-35	---	NP
995. Borosaprists											
1031. Histosols											
1033. Aquents											
1041*. Pits											
1042*. Dumps											
1043C, 1043F. Udorthents											
1044*. Slickens											
1826B*, 1826D*:											
Nashwauk--------	0-7	Fine sandy loam	SM, ML	A-4, A-2	0-4	90-100	85-100	55-85	25-55	<25	NP-4
	7-16	Loam, sandy loam, fine sandy loam.	ML, SM, CL, SC	A-4	0-4	90-100	85-100	60-85	35-70	<30	4-10
	16-58	Loam, clay loam, sandy clay loam.	CL, SC	A-6, A-4	0-4	90-100	85-100	75-90	35-80	30-40	8-15
	58-72	Loam, clay loam, sandy loam.	CL, SC	A-6, A-4	0-4	90-100	85-100	70-90	35-85	25-40	8-15
Menahga---------	0-3	Loamy coarse sand	SM, SP-SM	A-2	0	100	85-100	60-80	10-30	---	NP
	3-60	Coarse sand, sand	SP, SP-SM	A-3, A-2	0	100	80-100	50-75	0-10	---	NP
1883D*:											
Nashwauk--------	0-7	Fine sandy loam	SM, ML	A-4, A-2	0-4	90-100	85-100	55-85	25-55	<25	NP-4
	7-16	Loam, sandy loam, fine sandy loam.	ML, SM, CL, SC	A-4	0-4	90-100	85-100	60-85	35-70	<30	4-10
	16-58	Loam, clay loam, sandy clay loam.	CL, SC	A-6, A-4	0-4	90-100	85-100	75-90	35-80	30-40	8-15
	58-72	Loam, clay loam, sandy loam.	CL, SC	A-6, A-4	0-4	90-100	85-100	70-90	35-85	25-40	8-15
Rock outcrop.											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cm³	In/hr	In/in	pH					Pct
32B----------	0-8	5-18	1.35-1.50	2.0-6.0	0.13-0.18	6.1-7.3	Low----------	0.24	5	3	1-2
Nebish	8-39	18-35	1.50-1.65	0.6-2.0	0.15-0.19	6.1-7.8	Moderate-----	0.32			
	39-60	10-27	1.50-1.70	0.6-2.0	0.11-0.19	7.4-8.4	Low----------	0.32			
32D----------	0-9	5-18	1.35-1.50	2.0-6.0	0.13-0.18	6.1-7.3	Low----------	0.24	5	3	1-2
Nebish	9-29	18-35	1.50-1.65	0.6-2.0	0.15-0.19	6.1-7.8	Moderate-----	0.32			
	29-60	10-27	1.50-1.70	0.6-2.0	0.11-0.19	7.4-8.4	Low----------	0.32			
72----------	0-9	5-20	1.25-1.45	2.0-6.0	0.13-0.15	5.6-7.3	Low----------	0.32	5	3	2-4
Shooker	9-27	18-35	1.40-1.60	0.6-2.0	0.15-0.19	5.6-7.8	Moderate-----	0.32			
	27-60	12-27	1.40-1.65	0.6-2.0	0.11-0.19	7.4-8.4	Low----------	0.32			
147----------	0-4	10-24	1.25-1.40	0.6-2.0	0.20-0.24	5.6-7.8	Low----------	0.37	5	5	1-4
Spooner	4-9	3-18	1.35-1.55	0.6-6.0	0.17-0.19	5.6-7.8	Low----------	0.37			
	9-20	18-35	1.30-1.50	0.6-2.0	0.17-0.22	6.1-7.8	Low----------	0.37			
	20-60	5-32	1.40-1.60	0.6-2.0	0.17-0.22	7.4-8.4	Low----------	0.37			
158B----------	0-3	2-10	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2	.5-1
Zimmerman	3-60	2-10	1.50-1.70	6.0-20	0.06-0.10	6.1-7.3	Low----------	0.17			
167B----------	0-9	10-27	1.20-1.40	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.37	5	6	1-4
Baudette	9-33	18-35	1.25-1.45	0.6-2.0	0.17-0.24	5.6-7.8	Moderate-----	0.37			
	33-60	5-27	1.30-1.60	0.6-2.0	0.17-0.22	7.4-8.4	Low----------	0.37			
202----------	0-5	4-10	1.35-1.65	6.0-20	0.10-0.12	5.1-7.3	Low----------	0.17	5	2	.5-3
Meehan	5-35	4-9	1.35-1.65	6.0-20	0.06-0.11	5.1-7.3	Low----------	0.17			
	35-60	1-4	1.50-1.65	6.0-20	0.02-0.07	5.1-7.8	Low----------	0.17			
240B, 240D-------	0-12	5-15	1.10-1.40	0.6-2.0	0.18-0.23	5.1-6.5	Low----------	0.32	5	3	1-3
Warba	12-48	23-35	1.50-1.70	0.2-0.6	0.16-0.19	5.1-7.3	Moderate-----	0.32			
	48-60	20-32	1.50-1.70	0.6-2.0	0.16-0.19	6.6-8.4	Moderate-----	0.32			
243----------	0-13	5-15	1.10-1.40	2.0-6.0	0.18-0.23	4.5-6.5	Low----------	0.28	5	3	1-3
Stuntz	13-43	20-35	1.50-1.70	0.2-0.6	0.16-0.19	5.1-7.8	Moderate-----	0.28			
	43-60	20-32	1.50-1.70	0.2-0.6	0.16-0.19	6.6-8.4	Low----------	0.28			
268B, 268D-------	0-16	5-18	1.20-1.40	0.6-2.0	0.16-0.18	4.5-6.0	Low----------	0.20	3	3	.5-2
Cromwell	16-60	0-8	1.35-1.60	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.15			
458E----------	0-3	2-10	1.20-1.50	6.0-20	0.10-0.12	4.5-6.0	Low----------	0.15	5	2	.5-2
Menahga	3-28	0-5	1.50-1.65	6.0-20	0.05-0.07	4.5-6.0	Low----------	0.15			
	28-60	0-5	1.50-1.65	6.0-20	0.05-0.07	5.6-7.3	Low----------	0.15			
533----------	0-12	---	0.30-0.40	0.6-6.0	0.45-0.55	<4.5	----------	----	2	5	70-90
Loxley	12-60	---	0.10-0.35	0.2-6.0	0.35-0.45	<4.5	----------	----			
541----------	0-4	---	0.20-0.35	>0.2	0.45-0.65	5.6-7.3	----------	----	2	5	70-90
Rifle	4-60	---	0.08-0.20	0.6-6.0	0.45-0.55	5.6-7.3	----------	----			
544----------	0-14	---	0.28-0.45	0.2-6.0	0.45-0.55	5.6-7.8	----------	----	2	2	60-85
Cathro	14-39	---	0.15-0.30	0.2-6.0	0.35-0.45	5.6-7.8	----------	----			
	39-60	10-25	1.50-1.70	0.2-2.0	0.11-0.22	6.6-8.4	Low----------	----			
549----------	0-15	---	0.30-0.40	>6.0	0.55-0.65	3.6-4.4	----------	----	2	5	55-75
Greenwood	15-60	---	0.10-0.25	0.6-6.0	0.45-0.55	3.6-4.4	----------	----			
550----------	0-12	---	0.13-0.42	0.6-6.0	0.35-0.55	4.5-7.8	----------	----	2	3	>21
Dora	12-32	---	0.13-0.42	0.6-6.0	0.35-0.55	4.5-7.8	----------	----			
	32-60	35-60	1.40-1.65	<0.06	0.10-0.20	6.1-8.4	High----------	----			
614----------	0-8	---	0.07-0.30	0.6-6.0	0.55-0.65	5.1-6.5	----------	----	2	8	25-50
Blackhoof	8-11	18-35	1.80-2.00	<0.2	0.07-0.09	5.1-6.5	Moderate-----	----			
	11-60	18-35	1.60-1.80	0.2-0.6	0.07-0.13	5.1-7.8	Moderate-----	----			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cm³	In/hr	In/in	pH					Pct
615----------	0-8	2-10	1.20-1.40	0.6-2.0	0.16-0.20	5.1-6.5	Low----------	0.37	5	2	1-2
Cowhorn	8-51	2-10	1.40-1.60	2.0-6.0	0.12-0.19	5.1-6.5	Low----------	0.24			
	51-60	2-10	1.40-1.60	2.0-6.0	0.12-0.19	6.1-8.4	Low----------	0.24			
616----------	0-5	8-27	1.35-1.55	0.6-2.0	0.20-0.24	5.6-7.3	Low----------	0.37	3	5	1-3
Effie	5-19	35-60	1.50-1.70	0.06-0.2	0.12-0.19	5.6-7.8	High---------	0.37			
	19-60	25-55	1.50-1.70	0.06-0.2	0.12-0.19	7.9-8.4	Moderate-----	0.37			
617B----------	0-12	4-10	1.35-1.55	0.6-2.0	0.20-0.24	5.1-6.5	Low----------	0.37	5	5	.5-2
Goodland	12-28	8-18	1.60-1.75	0.6-2.0	0.12-0.19	5.1-6.5	Low----------	0.24			
	28-34	2-10	1.65-1.85	2.0-6.0	0.06-0.10	5.1-6.5	Low----------	0.15			
	34-60	0-5	1.65-1.85	6.0-20	0.02-0.07	5.6-7.8	Low----------	0.15			
618B----------	0-9	3-10	1.35-1.55	0.6-2.0	0.22-0.24	5.1-6.5	Low----------	0.37	5	5	.5-2
Itasca	9-19	3-10	1.60-1.75	0.6-2.0	0.17-0.22	5.1-6.0	Low----------	0.37			
	19-43	8-18	1.60-1.80	0.6-2.0	0.11-0.19	5.6-7.3	Low----------	0.24			
	43-60	8-18	1.60-1.80	0.6-2.0	0.11-0.19	6.6-8.4	Low----------	0.24			
619----------	0-6	6-15	1.45-1.65	0.6-2.0	0.20-0.22	4.5-6.5	Low----------	0.37	3	5	1-6
Keewatin	6-16	4-15	1.50-1.70	0.2-2.0	0.13-0.20	4.5-6.5	Low----------	0.28			
	16-60	18-35	1.70-1.95	0.06-0.2	0.12-0.15	5.1-6.5	Moderate-----	0.37			
	60-65	15-35	1.60-1.80	0.06-0.2	0.12-0.15	6.1-8.4	Moderate-----	0.37			
620B----------	0-4	0-8	1.45-1.55	6.0-20	0.10-0.12	5.1-6.0	Low----------	0.17	5	2	.5-2
Cutaway	4-35	0-8	1.50-1.60	6.0-20	0.06-0.11	5.1-6.0	Low----------	0.17			
	35-51	20-35	1.60-1.85	0.06-0.6	0.12-0.19	5.1-6.5	Moderate-----	0.37			
	51-60	18-30	1.60-1.85	0.06-2.0	0.12-0.19	6.1-8.4	Low----------	0.37			
621----------	0-13	4-12	1.40-1.55	2.0-6.0	0.13-0.22	5.1-6.5	Low----------	0.24	5	3	1-3
Morph	13-33	18-27	1.55-1.70	0.6-2.0	0.11-0.19	6.1-8.4	Low----------	0.24			
	33-60	8-20	1.55-1.70	0.6-2.0	0.11-0.19	6.1-8.4	Low----------	0.24			
622B, 622E-------	0-7	4-10	1.40-1.60	0.6-2.0	0.13-0.22	5.1-6.5	Low----------	0.28	3	3	1-2
Nashwauk	7-16	10-24	1.60-1.80	0.2-0.6	0.07-0.19	4.5-6.0	Low----------	0.28			
	16-58	18-32	1.70-1.95	0.06-0.2	0.07-0.10	5.1-7.3	Low----------	0.37			
	58-72	15-32	1.60-1.85	0.06-0.2	0.10-0.12	5.6-8.4	Low----------	0.37			
624B----------	0-9	3-12	1.40-1.55	0.6-2.0	0.14-1.19	5.1-7.3	Low----------	0.24	5	3	.5-2
Rosy	9-20	8-18	1.50-1.65	0.6-2.0	0.14-0.19	5.1-7.3	Low----------	0.28			
	20-60	6-18	1.55-1.70	0.6-2.0	0.11-0.17	5.6-8.4	Low----------	0.28			
625----------	0-4	0-8	1.45-1.55	6.0-20	0.08-0.10	5.1-6.5	Low----------	0.17	5	2	.5-2
Sandwick	4-22	0-8	1.50-1.60	6.0-20	0.06-0.09	5.1-6.5	Low----------	0.15			
	22-38	18-35	1.65-2.00	0.2-0.6	0.10-0.16	5.1-7.3	Moderate-----	0.37			
	38-60	18-30	1.65-2.00	0.2-0.6	0.02-0.10	6.1-8.4	Low----------	0.37			
626B, 626D-------	0-12	8-27	1.35-1.55	0.6-2.0	0.20-0.24	5.1-7.3	Low----------	0.43	3	5	1-3
Suomi	12-30	35-60	1.50-1.70	0.06-0.2	0.10-0.19	5.1-7.3	High---------	0.32			
	30-60	27-45	1.50-1.70	0.06-0.2	0.11-0.17	7.4-8.4	Moderate-----	0.32			
627----------	0-31	---	0.30-0.55	0.2-6.0	0.35-0.45	4.5-7.8	----------	----	2	2	40-60
Tawas	31-60	0-10	1.40-1.65	6.0-20	0.03-0.10	5.6-8.4	Low----------	----			
628----------	0-6	8-20	1.10-1.35	0.6-2.0	0.20-0.22	5.1-7.3	Low----------	0.37	5	5	3-10
Talmoon	6-16	15-27	1.20-1.40	0.6-2.0	0.13-0.22	5.1-7.3	Moderate-----	0.28			
	16-42	18-35	1.40-1.60	0.2-0.6	0.16-0.19	5.6-7.3	Moderate-----	0.37			
	42-60	15-35	1.40-1.60	0.2-0.6	0.15-0.19	7.4-8.4	Moderate-----	0.37			
629B----------	0-3	2-10	1.40-1.55	2.0-6.0	0.16-0.18	5.1-6.5	Low----------	0.24	5	2	.5-2
Wawina	3-60	2-10	1.55-1.70	2.0-6.0	0.14-0.16	5.1-7.3	Low----------	0.24			
630----------	0-12	---	0.10-0.25	---	---	5.1-6.5	----------	----	---	2	>25
Wildwood	12-24	60-75	1.50-1.60	0.06-0.2	0.10-0.14	5.6-7.3	High---------	0.28			
	24-60	50-75	1.40-1.60	0.06-0.2	0.09-0.13	7.4-8.4	High---------	0.28			
655----------	0-16	2-7	1.40-1.55	6.0-20	0.06-0.10	5.1-6.5	Low----------	0.15	4	2	1-3
Bearville	16-25	18-35	1.50-1.75	0.2-0.6	0.13-0.18	5.6-7.3	Moderate-----	0.32			
	25-35	45-75	1.35-1.60	0.06-0.2	0.13-0.19	6.6-7.8	High---------	0.32			
	35-60	35-60	1.30-1.50	0.06-0.2	0.12-0.16	6.6-8.4	High---------	0.32			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cm³	In/hr	In/in	pH					Pct
656B----------	0-2	2-10	1.40-1.55	6.0-20	0.08-0.10	5.1-6.5	Low----------	0.15	4	2	1-2
Thistledew	2-23	2-7	1.40-1.55	6.0-20	0.06-0.09	5.1-6.5	Low----------	0.15			
	23-38	18-35	1.40-1.65	0.2-0.6	0.10-0.16	5.6-7.8	Moderate-----	0.32			
	38-60	45-75	1.30-1.50	0.06-0.2	0.07-0.14	6.1-8.4	High---------	0.32			
797*:											
Mooselake-------	0-3	---	0.05-0.30	2.0-6.0	0.35-0.55	4.5-7.3	----------	----	---	5	>25
	3-60	---	0.10-0.20	2.0-6.0	0.40-0.50	4.5-7.3	----------	----			
Lupton----------	0-8	---	0.10-0.35	0.2-6.0	0.35-0.45	5.6-7.8	----------	----	2	2	70-90
	8-65	---	0.10-0.35	0.2-6.0	0.35-0.45	5.6-7.8	----------	----			
798*:											
Sago----------	0-13	---	0.15-0.25	0.6-6.0	0.35-0.55	4.5-6.5	High---------	----	2	3	50-95
	13-60	6-18	1.50-1.70	0.6-2.0	0.14-0.20	5.6-8.4	Low----------	0.24			
Roscommon-------	0-6	0-12	0.90-1.60	6.0-20	0.07-0.20	5.6-7.8	Low----------	0.17	5	2	4-15
	6-60	0-10	1.45-1.75	6.0-20	0.05-0.07	5.6-8.4	Low----------	0.17			
799*:											
Seelyeville-----	0-60	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-7.3	----------	----	---	3	>25
Bowstring-------	0-38	0-5	0.15-0.30	0.2-6.0	0.35-0.45	5.6-8.4	----------	----	---	8	40-90
	38-43	1-12	1.40-1.60	0.6-20	0.08-0.14	5.6-8.4	Low----------	----			
	43-60	0-5	0.15-0.30	0.2-6.0	0.35-0.45	5.6-8.4	----------	----			
801B*:											
Taylor----------	0-6	20-27	1.50-1.60	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.43	3	6	1-2
	6-21	60-85	1.40-1.60	0.06-0.2	0.10-0.14	5.1-7.8	High---------	0.32			
	21-60	50-80	1.35-1.60	0.06-0.2	0.09-0.13	7.4-8.4	High---------	0.32			
Dalbo----------	0-6	20-27	1.25-1.45	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.43	3	6	2-4
	6-35	35-60	1.25-1.45	0.06-0.6	0.10-0.18	5.1-7.3	High---------	0.32			
	35-60	27-60	1.30-1.60	0.2-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.32			
803B*, 803D*:											
Warba----------	0-15	5-15	1.10-1.40	0.6-2.0	0.18-0.23	5.1-6.5	Low----------	0.32	5	3	1-3
	15-37	23-35	1.50-1.70	0.2-0.6	0.16-0.19	5.1-7.3	Moderate-----	0.32			
	37-60	20-32	1.50-1.70	0.6-2.0	0.16-0.19	6.6-8.4	Moderate-----	0.32			
Menahga---------	0-3	2-10	1.20-1.50	6.0-20	0.10-0.12	4.5-6.0	Low----------	0.15	5	2	.5-2
	3-38	0-5	1.50-1.65	6.0-20	0.05-0.07	4.5-6.0	Low----------	0.15			
	38-60	0-5	1.50-1.65	6.0-20	0.05-0.07	5.6-7.3	Low----------	0.15			
844F*:											
Mahtomedi-------	0-3	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
	3-33	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.10			
	33-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
Emmert----------	0-9	1-5	1.45-1.60	>20	0.06-0.10	5.1-6.5	Low----------	0.15	2	8	.5-1
	9-60	1-3	1.55-1.65	>20	0.02-0.04	5.1-7.3	Low----------	0.15			
866B*, 866E*:											
Menahga---------	0-3	2-10	1.20-1.50	6.0-20	0.10-0.12	4.5-6.0	Low----------	0.15	5	2	.5-2
	3-60	0-5	1.50-1.65	6.0-20	0.05-0.07	4.5-7.3	Low----------	0.15			
Itasca----------	0-19	3-10	1.35-1.55	0.6-2.0	0.22-0.24	5.1-6.5	Low----------	0.37	5	5	.5-2
	19-43	8-18	1.60-1.80	0.6-2.0	0.11-0.19	5.6-7.5	Low----------	0.24			
	43-60	8-18	1.60-1.80	0.6-2.0	0.11-0.19	6.6-8.4	Low----------	0.24			
867B*:											
Menahga---------	0-3	2-10	1.20-1.50	6.0-20	0.10-0.12	4.5-6.0	Low----------	0.15	5	2	.5-2
	3-60	0-5	1.50-1.65	6.0-20	0.05-0.07	4.5-7.3	Low----------	0.15			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cm³	In/hr	In/in	pH					Pct
867B*:											
Graycalm--------	0-3	0-10	1.30-1.55	6.0-20	0.06-0.12	4.5-6.5	Low----------	0.15	5	2	.5-2
	3-17	0-15	1.25-1.60	6.0-20	0.05-0.10	4.5-6.5	Low----------	0.15			
	17-58	0-10	1.50-1.65	6.0-20	0.04-0.09	4.5-6.5	Low----------	0.15			
	58-72	0-10	1.50-1.65	6.0-20	0.04-0.06	5.1-8.4	Low----------	0.15			
868B*:											
Mahtomedi-------	0-4	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
	4-34	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.10			
	34-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
Graycalm--------	0-3	0-10	1.30-1.55	6.0-20	0.06-0.12	4.5-6.5	Low----------	0.15	5	2	.5-2
	3-17	0-15	1.25-1.60	6.0-20	0.05-0.10	4.5-6.5	Low----------	0.15			
	17-60	0-10	1.50-1.65	6.0-20	0.04-0.09	4.5-6.5	Low----------	0.15			
	60-70	0-10	1.50-1.65	6.0-20	0.04-0.06	5.1-8.4	Low----------	0.15			
869*:											
Lobo------------	0-44	---	0.02-0.10	>6.0	0.55-0.65	3.6-4.4	----------	----	---	8	>25
	44-60	---	0.07-0.20	0.6-6.0	0.45-0.55	3.6-5.0	----------	----			
Waskish---------	0-60	---	0.02-0.10	>6.0	0.55-0.65	<4.5	----------	----	---	8	>90
870C*, 870E*:											
Itasca----------	0-9	3-10	1.35-1.55	0.6-2.0	0.22-0.24	5.1-6.5	Low----------	0.37	5	5	.5-2
	9-19	3-10	1.60-1.75	0.6-2.0	0.17-0.22	5.1-6.0	Low----------	0.37			
	19-43	8-18	1.60-1.80	0.6-2.0	0.11-0.19	5.6-7.3	Low----------	0.24			
	43-60	8-18	1.60-1.80	0.6-2.0	0.11-0.19	6.6-8.4	Low----------	0.24			
Goodland--------	0-12	4-10	1.35-1.55	0.6-2.0	0.20-0.24	5.1-6.5	Low----------	0.37	5	5	.5-2
	12-28	8-18	1.60-1.75	0.6-2.0	0.12-0.19	5.1-6.5	Low----------	0.24			
	28-34	2-10	1.65-1.85	2.0-6.0	0.06-0.10	5.1-6.5	Low----------	0.15			
	34-60	0-5	1.65-1.85	6.0-20	0.02-0.07	5.6-7.8	Low----------	0.15			
871*:											
Indus-----------	0-6	41-55	1.20-1.40	0.06-0.6	0.13-0.17	5.1-7.3	High---------	0.28	5	4	1-2
	6-29	60-85	1.30-1.50	0.06-0.2	0.12-0.16	5.6-8.4	High---------	0.28			
	29-60	50-85	1.30-1.50	0.06-0.2	0.10-0.14	7.4-8.4	High---------	0.28			
Brickton--------	0-10	15-27	1.20-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.43	3	6	2-4
	10-25	35-60	1.25-1.40	0.06-0.6	0.16-0.19	5.1-7.8	High---------	0.32			
	25-60	35-60	1.30-1.45	0.06-0.6	0.16-0.22	7.4-8.4	High---------	0.32			
872*:											
Pengilly--------	0-4	8-15	1.25-1.40	2.0-6.0	0.13-0.22	5.6-7.8	Low----------	0.24	5	3	2-4
	4-60	6-18	1.40-1.60	0.6-2.0	0.12-0.20	6.1-8.4	Low----------	0.24			
Winterfield-----	0-3	0-15	0.90-1.50	2.0-6.0	0.10-0.12	5.6-7.8	Low----------	0.17	5	2	---
	3-14	0-15	1.45-1.60	6.0-20	0.06-0.11	5.6-7.8	Low----------	0.17			
	14-60	0-10	1.55-1.65	6.0-20	0.04-0.10	5.6-8.4	Low----------	0.17			
995. Borosaprists											
1031. Histosols											
1033. Aquents											
1041*. Pits											
1042*. Dumps											
1043C, 1043F. Udorthents											

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cm³	In/hr	In/in	pH					Pct
1044*.											
Slickens											
1826B*, 1826D*:											
Nashwauk--------	0-7	4-10	1.40-1.60	0.6-2.0	0.13-0.22	5.1-6.5	Low----------	0.28	3	3	1-2
	7-16	10-24	1.60-1.80	0.2-0.6	0.07-0.19	4.5-6.0	Low----------	0.28			
	16-58	18-32	1.70-1.95	0.06-0.2	0.07-0.10	5.1-7.3	Low----------	0.37			
	58-72	15-32	1.60-1.85	0.06-0.2	0.10-0.12	5.6-8.4	Low----------	0.37			
Menahga---------	0-3	2-10	1.20-1.50	6.0-20	0.10-0.12	4.5-6.0	Low----------	0.15	5	2	.5-2
	3-60	0-5	1.50-1.65	6.0-20	0.05-0.07	4.5-7.3	Low----------	0.15			
1883D*:											
Nashwauk--------	0-7	4-10	1.40-1.60	0.6-2.0	0.13-0.22	5.1-6.5	Low----------	0.28	3	3	1-2
	7-16	10-24	1.60-1.80	0.2-0.6	0.07-0.19	4.5-6.0	Low----------	0.28			
	16-58	18-32	1.70-1.95	0.06-0.2	0.07-0.10	5.1-7.3	Low----------	0.37			
	58-72	15-32	1.60-1.85	0.06-0.2	0.10-0.12	5.6-8.4	Low----------	0.37			
Rock outcrop.											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock depth	Subsidence		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Initial	Total		Uncoated steel	Concrete
					Ft			In	In	In			
32B, 32D--------- Nebish	B	None---------	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Low.
72---------- Shooker	C	None---------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	---	High-----	High-----	Low.
147---------- Spooner	C/D	None---------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	---	High-----	High-----	Low.
158B---------- Zimmerman	A	None---------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	High.
167B---------- Baudette	B	None---------	---	---	3.0-6.0	Apparent	May-Jul	>60	---	---	High-----	Moderate	Low.
202---------- Meehan	B	None---------	---	---	1.5-3.0	Apparent	Oct-May	>60	---	---	Moderate	Low------	Moderate
240B, 240D------- Warba	B	None---------	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Moderate
243---------- Stuntz	C	None---------	---	---	1.5-3.0	Perched	Mar-Jun	>60	---	---	High-----	High-----	Moderate
268B, 268D------- Cromwell	A	None---------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Moderate
458E---------- Menahga	A	None---------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Moderate
533---------- Loxley	A/D	None---------	---	---	+1-1.0	Apparent	Nov-May	>60	---	50-55	High-----	High-----	High.
541---------- Rifle	A/D	None---------	---	---	+1-1.0	Apparent	Nov-Jun	>60	---	---	High-----	High-----	Low.
544---------- Cathro	A/D	None---------	---	---	+1-1.0	Apparent	Nov-Jun	>60	---	19-22	High-----	High-----	Low.
549---------- Greenwood	A/D	None---------	---	---	+1-1.0	Apparent	Sep-Jun	>60	---	---	High-----	High-----	High.
550---------- Dora	B/D	None---------	---	---	+2-1.0	Perched	Nov-May	>60	4-12	25-30	High-----	High-----	Moderate
614---------- Blackhoof	D	None---------	---	---	+2-1.0	Apparent	Jan-Dec	>60	---	---	High-----	High-----	Moderate
615---------- Cowhorn	B	None---------	---	---	1.5-3.0	Apparent	Apr-Jun	>60	---	---	High-----	Moderate	Moderate

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock depth	Subsidence		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Initial	Total		Uncoated steel	Concrete
					Ft			In	In	In			
616--- Effie	C	None	---	---	1.0-2.5	Perched	Mar-Jun	>60	---	---	High	High	Moderate
617B--- Goodland	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Moderate
618B--- Itasca	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Moderate
619--- Keewatin	C	None	---	---	0.5-1.5	Perched	Apr-Jun	>60	---	---	High	Moderate	Low.
620B--- Cutaway	B	None	---	---	>6.0	---	---	>60	---	---	Low	Moderate	Moderate
621--- Morph	B/D	None	---	---	1.0-3.0	Apparent	Oct-Jun	>60	---	---	High	Moderate	Low.
622B, 622E--- Nashwauk	C	None	---	---	>6.0	---	---	>60	---	---	Moderate	High	Moderate
624B--- Rosy	B	None	---	---	3.0-5.0	Apparent	Mar-Jun	>60	---	---	Moderate	Moderate	Moderate
625--- Sandwick	B	None	---	---	1.0-2.0	Apparent	Apr-Jun	>60	---	---	Moderate	High	Moderate
626B, 626D--- Suomi	C	None	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Moderate
627--- Tawas	A/D	None	---	---	+1-1.0	Apparent	Nov-May	>60	---	25-30	High	High	Moderate
628--- Talmoon	D	None	---	---	+1-1.5	Apparent	Nov-Jun	>60	---	---	High	High	Moderate
629B--- Wawina	A	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Moderate
630--- Wildwood	D	None	---	---	+1-1.0	Perched	Sep-Jun	>60	---	---	High	High	Low.
655--- Bearville	C	None	---	---	1.0-3.0	Perched	Oct-Jun	>60	---	---	High	High	Moderate
656B--- Thistledew	B	None	---	---	3.0-4.0	Perched	Apr-May	>60	---	---	Low	Low	Moderate
797*:													
Mooselake---	A/D	None	---	---	+1-1.0	Apparent	Jan-Dec	>60	0-12	>12	High	High	High.
Lupton---	A/D	None	---	---	+1-1.0	Apparent	Sep-May	>60	---	50-55	High	High	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock depth	Subsidence		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Initial	Total		Uncoated steel	Concrete
					Ft			In	In	In			
798*:													
Sago	D	None	---	---	+1-1.0	Apparent	Oct-Jul	>60	---	5-10	High	High	Moderate
Roscommon	A/D	None	---	---	+1-1.0	Apparent	Sep-Jun	>60	---	---	Moderate	High	Low.
799*:													
Seelyeville	A/D	Frequent	Long	Nov-May	+2-2.0	Apparent	Jan-Dec	>60	---	50-55	High	High	Moderate
Bowstring	A/D	Frequent	Long	Mar-Jun	0-2.0	Apparent	Oct-Jun	>60	---	20-30	High	High	Low.
801B*:													
Taylor	C	None	---	---	3.0-6.0	Perched	Apr-Jul	>60	---	---	Moderate	High	Low.
Dalbo	B	None	---	---	2.5-5.0	Apparent	Nov-May	>60	---	---	High	High	Moderate
803B*, 803D*:													
Warba	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Moderate
Menahga	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	Moderate
844F*:													
Mahtomedi	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	High.
Emmert	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	Moderate
866B*, 866E*:													
Menahga	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	Moderate
Itasca	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Moderate
867B*:													
Menahga	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	Moderate
Graycalm	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	Moderate
868B*:													
Mahtomedi	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	High.
Graycalm	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	Moderate
869*:													
Lobo	D	None	---	---	0-2.0	Apparent	Jan-Dec	>60	---	55-50	High	High	High.
Waskish	D	None	---	---	0-2.0	Apparent	Nov-Jul	>60	---	---	High	High	High.
870C*, 870E*:													
Itasca	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Moderate
Goodland	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Moderate
871*:													
Indus	D	None	---	---	0.5-3.0	Perched	Apr-Jul	>60	---	---	Moderate	High	Moderate
Brickton	C	None	---	---	1.0-3.0	Apparent	Oct-Jun	>60	---	---	High	High	Moderate

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock depth	Subsidence		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Initial	Total		Uncoated steel	Concrete
					Ft			In	In	In			
872*:													
Pengilly--------	B/D	Frequent----	Brief-----	May-Oct	+.5-2.0	Apparent	Jan-Dec	>60	---	---	High-----	High-----	Moderate
Winterfield-----	A/D	Frequent----	Brief-----	Nov-May	1.0-2.0	Apparent	Nov-May	>60	---	---	Moderate	Low------	Low.
995. Borosaprists													
1031. Histosols													
1033. Aquents													
1041*. Pits													
1042*. Dumps													
1043C, 1043F. Udorthents													
1044*. Slickens													
1826B*, 1826D*:													
Nashwauk--------	C	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	High-----	Moderate
Menahga---------	A	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Moderate
1883D*:													
Nashwauk--------	C	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	High-----	Moderate
Rock outcrop.													

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aquents	Mixed, frigid Psammaquents
Baudette	Fine-silty, mixed Aquic Eutroboralfs
Bearville	Fine-loamy over clayey, mixed, frigid Typic Ochraqualfs
Blackhoof	Fine-loamy, mixed, nonacid, frigid Histic Humaquepts
Borosaprists	Euic Borosaprists
Bowstring	Euic Fluvaquentic Borosaprists
Brickton	Fine, mixed, frigid Typic Ochraqualfs
Cathro	Loamy, mixed, euic Terric Borosaprists
Cowhorn	Coarse-loamy, mixed, nonacid, frigid Aeric Haplaquepts
Cromwell	Sandy, mixed, frigid Typic Dystrochrepts
Cutaway	Loamy, mixed Arenic Eutroboralfs
Dalbo	Fine, mixed Aquic Eutroboralfs
Dora	Clayey, montmorillonitic, euic Terric Borosaprists
Effie	Fine, mixed, frigid Typic Ochraqualfs
Emmert	Sandy-skeletal, mixed, frigid Typic Udorthents
Goodland	Coarse-loamy, mixed Glossic Eutroboralfs
Graycalm	Mixed, frigid Alfic Udipsamments
Greenwood	Dysic Typic Borohemists
Histosols	Mixed, euic Terric Borosaprists
Indus	Very-fine, montmorillonitic, frigid Typic Ochraqualfs
Itasca	Coarse-loamy, mixed Glossic Eutroboralfs
Keewatin	Fine-loamy, mixed, frigid Aeric Glossaqualfs
Lobo	Dysic, frigid Hemic Sphagnofibrists
Loxley	Dysic Typic Borosaprists
Lupton	Euic Typic Borosaprists
Mahtomedi	Mixed, frigid Typic Udipsamments
Meehan	Mixed, frigid Aquic Udipsamments
Menahga	Mixed, frigid Typic Udipsamments
Mooselake	Euic Typic Borohemists
Morph	Fine-loamy, mixed, frigid Typic Glossaqualfs
Nashwauk	Fine-loamy, mixed Typic Glossoboralfs
Nebish	Fine-loamy, mixed Typic Eutroboralfs
Pengilly	Coarse-loamy, mixed, nonacid, frigid Typic Fluvaquents
Rifle	Euic Typic Borohemists
Roscommon	Mixed, frigid Mollic Psammaquents
Rosy	Coarse-loamy, mixed Aquic Eutroboralfs
Sago	Coarse-loamy, mixed, nonacid, frigid Histic Humaquepts
Sandwick	Loamy, mixed, frigid Arenic Glossaqualfs
Seelyeville	Euic Typic Borosaprists
Shooker	Fine-loamy, mixed, frigid Typic Ochraqualfs
Spooner	Fine-silty, mixed, frigid Typic Ochraqualfs
Stuntz	Fine-loamy, mixed, frigid Aeric Glossaqualfs
Suomi	Fine, mixed Aquic Eutroboralfs
Talmoon	Fine-loamy, mixed, frigid Mollic Ochraqualfs
Tawas	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
Taylor	Very-fine, montmorillonitic Aquic Eutroboralfs
Thistledew	Fine-loamy over clayey, mixed Aquic Eutroboralfs
Udorthents	Mixed, frigid Udorthents
Warba	Fine-loamy, mixed Glossic Eutroboralfs
Waskish	Dysic, frigid Typic Sphagnofibrists
Wawina	Coarse-loamy, mixed, frigid Typic Dystrochrepts
Wildwood	Very-fine, montmorillonitic, nonacid, frigid Histic Humaquepts
Winterfield	Mixed, frigid Aquic Udipsamments
Zimmerman	Mixed, frigid Alfic Udipsamments

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