United States
Department of
Agriculture

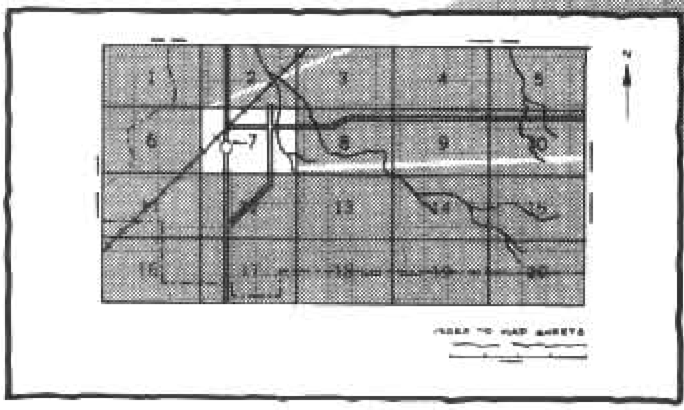
Soil
Conservation
Service

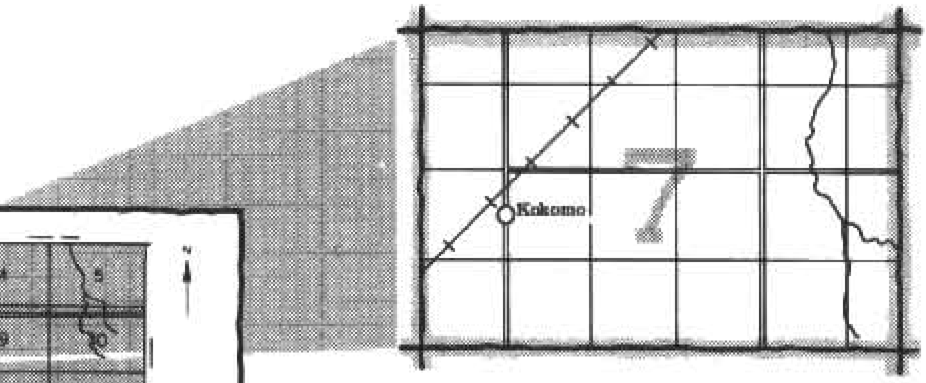
In cooperation with
Ohio Department of Natural
Resources, Division of Soil
and Water Conservation, and
Ohio Agricultural Research
and Development Center

Soil Survey of Sandusky County, Ohio

HOW TO USE

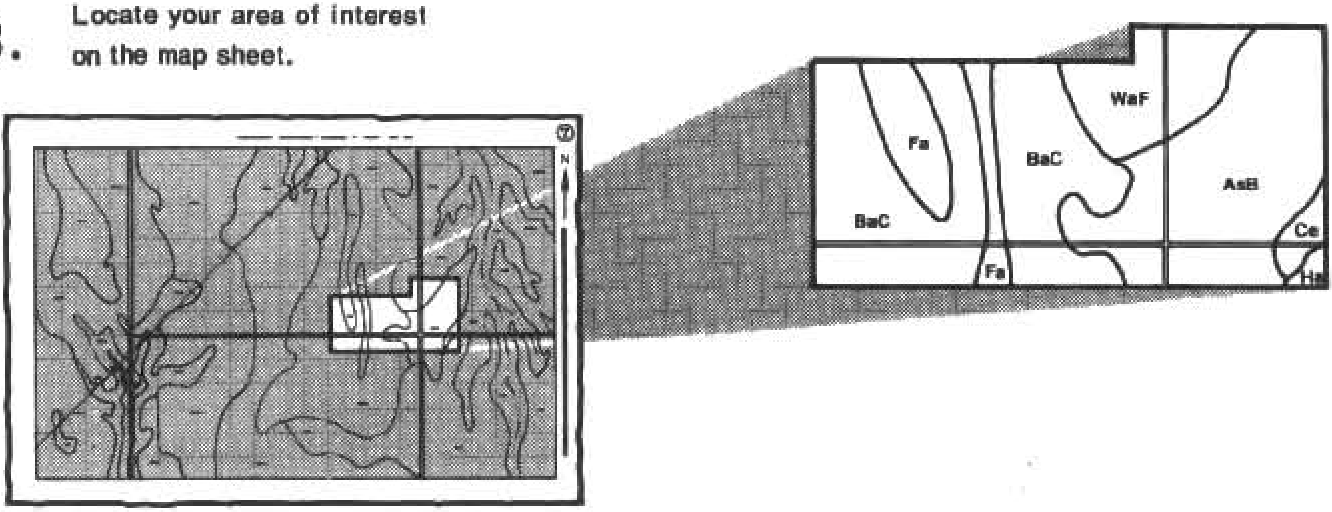
1. Locate your area of interest on the "Index to Map Sheets"



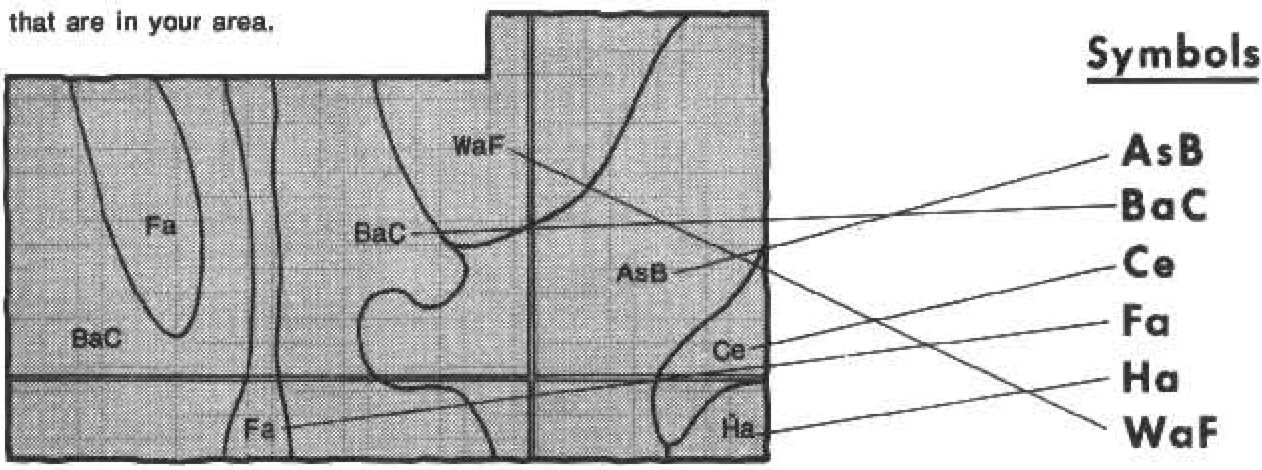


2. Note the number of the map sheet and turn to that sheet.

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

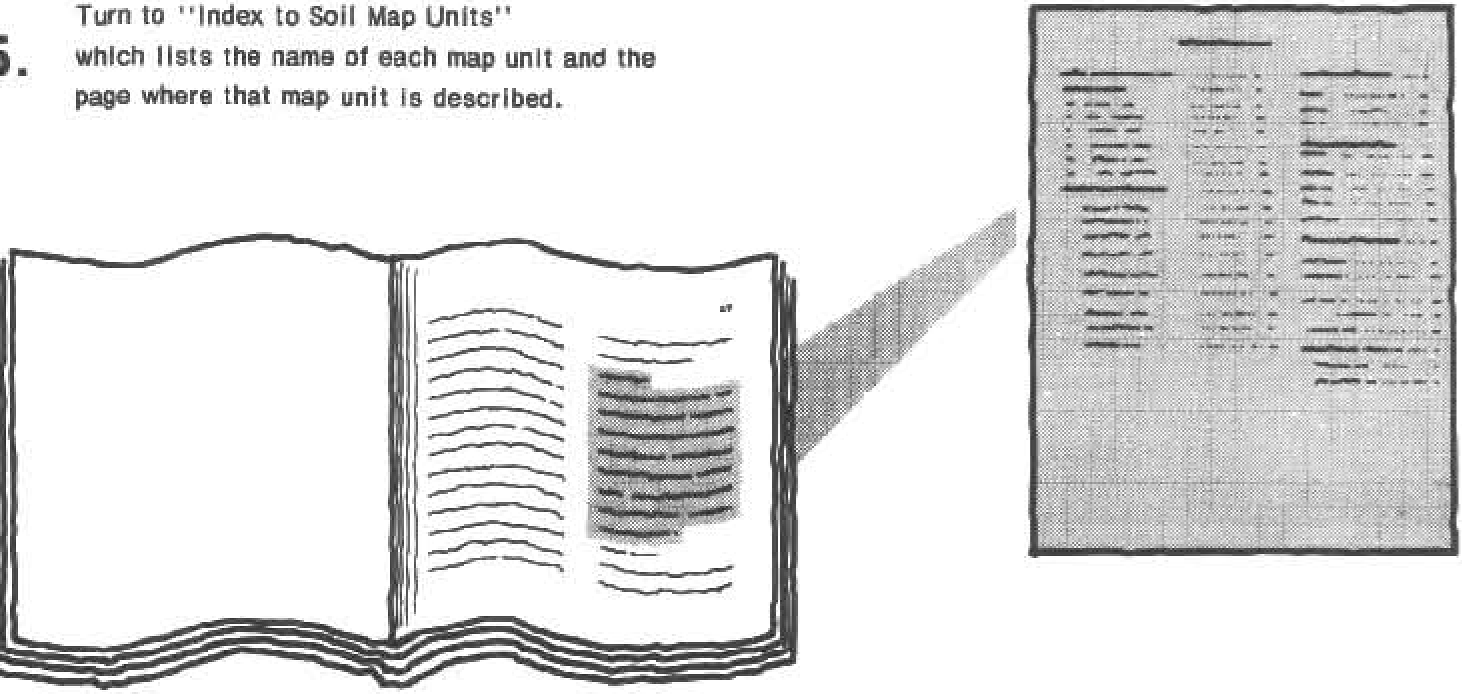


4. List the map unit symbols that are in your area.

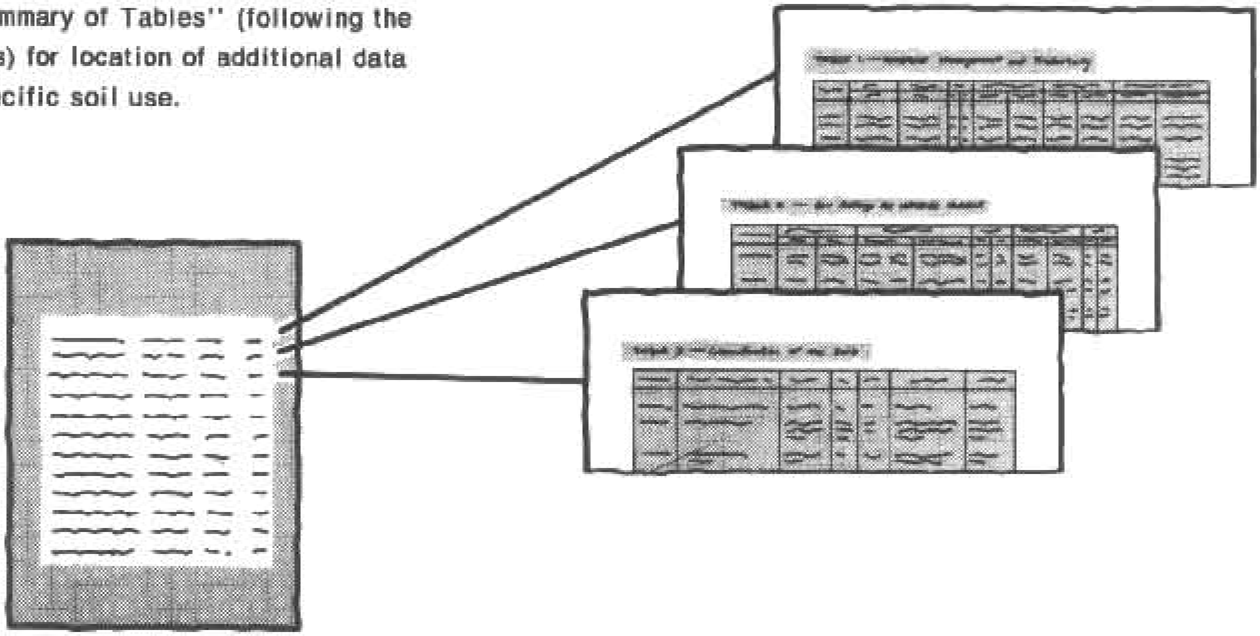


HIS SOIL SURVEY

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



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



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

This 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 1982. Soil names and descriptions were approved in 1983. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1983. This survey was made cooperatively by the Soil Conservation Service; the Ohio Department of Natural Resources, Division of Soil and Water Conservation; and the Ohio Agricultural Research and Development Center. It is part of the technical assistance furnished to the Sandusky County Soil and Water Conservation District. Financial assistance was provided by the Sandusky County Commissioners.

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

Cover: An area of Dixboro and Kibble soils. These soils are well suited to cropland.

Contents

Soil Series

Issued July 1987

Index to Map Units

Summary of Tables

Foreword

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

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 water table at the surface 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.

Harry W. Oneth
State Conservationist
Soil Conservation Service

Soil Survey of Sandusky County, Ohio

By J.E. Ernst and R.L. Hunter, Ohio Department of Natural Resources,
Division of Soil and Water Conservation

United States Department of Agriculture, Soil Conservation Service,
in cooperation with the Ohio Department of Natural Resources,
Division of Soil and Water Conservation, and the
Ohio Agricultural Research and Development Center

General Nature of the County

Sandusky County is in north-central Ohio (fig. 1). The total area is 261,888 acres, or about 409 square miles. Fremont, the county seat, is near the center of the county. In 1980, the county had a population of 63,267.

Most areas are used for agricultural purposes, dominantly cash-grain and processed specialty crops. Corn, soybeans, wheat, oats, and hay are grown on many farms. Tomatoes, sugar beets, cabbage, and cucumbers are the principal specialty crops. A few areas of woodland are on the very steep slopes along the Sandusky River and its larger tributaries and in undrained areas or areas where the soil is moderately deep to bedrock.

Poor natural drainage is the major management concern in the flatter areas of the county. Erosion is a hazard in gently sloping to very steep areas. If drainage systems are installed and if erosion control and other management practices are applied, most of the soils are highly productive.

Although the county is used dominantly for agricultural purposes, nonfarm development is taking place. It is not so extensive as that in the large metropolitan areas, but many of the same soil-related limitations and hazards are common.

This survey updates the soil survey of Sandusky County published in 1920 (*2*). It provides additional information and larger maps, which show the soils in greater detail.

Climate

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

Sandusky County is cold and snowy in winter and warm in summer. Precipitation is well distributed during the year and generally is adequate for most crops. From late fall through winter, snow squalls are frequent.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Fremont, Ohio, in the period 1951 to 1980. 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 27 degrees F, and the average daily minimum temperature is 19 degrees. The lowest temperature on record, which occurred at Fremont on January 17, 1972, is -17 degrees. In summer the average temperature is 71 degrees, and the average daily maximum temperature is 82 degrees. The highest recorded temperature, which occurred on September 2, 1953, is 105 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.

Crop growth early in the growing season is retarded by frequent cool winds off of Lake Erie. Fruit crops are especially affected.

Figure 1. Location of Sandusky County in Ohio.

The total annual precipitation is about 33 inches. Of this, about 20 inches, or nearly 60 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 7.95 inches at Fremont on July 5, 1969. Thunderstorms occur on about 39 days each year.

The average seasonal snowfall is 17.4 inches. The greatest snow depth at any one time during the period of record was 13 inches. On the average, 11 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 40 percent in winter. The prevailing wind is from the southwest. Average windspeed is highest, 11 miles per hour, in winter.

Agriculture

Glenn E. Maddy, county agent, Cooperative Extension Service, helped write this section.

The acreage of farmland in the county increased from 213,719 acres in 1974 to 217,732 acres in 1978 (*20*). During the same period, the number of farms decreased from 1,130 to 1,075. The average size of the farms increased from 189 to 203 acres. More than 83 percent of the county is used as farmland.

The number of part-time farmers increased from 381 in 1974 to 446 in 1978. During the same period, the number of full-time farmers decreased from 733 to 629.

The acreage of cropland is increasing because woodlots are being cleared and soils that were too wet for cultivation are being drained for use as cropland. Woodland, pasture, pastured woodland, and cropland used only for pasture decreased from 33,553 acres in 1974 to 16,962 acres in 1978. During the same period, harvested cropland increased from 175,174 acres to 182,536 acres.

The number of livestock, such as dairy and beef cattle, sheep, and swine, is declining because of the decrease in the acreage of hayland and pasture and the increase in the acreage of cash-grain and specialty crops. The grain is exported from Toledo.

Soybeans are the leading crop in acreage and income in the county. In 1981, they were grown on about 69,400 acres (*6, 7*). The second leading source of farm income alternates between corn used for grain and specialty crops used in food processing. In 1981, about 56,200 acres was used for corn, 2,900 acres for tomatoes, 2,250 acres for cucumbers, and 600 acres for cabbage. The total acreage of specialty crops was only about 5,750 acres, but these crops produced a very high income per acre.

Sandusky County is a leading county in Ohio in the production of sugar beets, tomatoes, cucumbers, and cabbage, mainly because of the suitability of the soils for these crops and the processing facilities located in the county or in nearby counties.

Physiography, Relief, and Drainage

Sandusky County is mainly in the broad lake plain section of the Central Lowlands Province. A strip along the Seneca County line, in the southeastern part of the county, however, is in the till plain section (*8*). The county was covered by several glaciers. The last glacier was the Late Wisconsin glacier, approximately 10,000 to 15,000 years ago. The glacial drift varies in thickness throughout the county. Most of the glacial drift was later covered by water. The soils formed mainly in glacial till or lacustrine sediments. They commonly have a clayey subsoil.

When the Late Wisconsin glacier melted and receded northward, large glacial lakes formed in front of the ice sheet. These lakes essentially covered the county. During this period, lacustrine sediments were deposited. Glacial Lake Maumee had several stages and occurred at the highest elevation (*9*). The other glacial lakes that covered parts of the county were, in order of decreasing elevation, Whittlesey, Arkona, Warren, Wayne, and

Lundy. Prominent sandy or gravelly beach ridges were left at the margins of these glacial lakes.

The surface slopes generally from south to north. The highest elevation is in the southeast corner of the county, and the lowest is next to Sandusky Bay, in the northern part. The elevation ranges from 575 to 810 feet above sea level.

Exceptions to the nearly flat topography dominant throughout the county are the beach ridges in the southeastern and southwestern parts of the county; the areas next to the Sandusky River; and the bedrock highs, mainly in the western and southeastern parts. Bedrock is exposed in places along the Sandusky and Portage Rivers and their tributaries.

The southeastern and southwestern parts of the county have a series of sandy beach ridges. These remnants of ancient beaches formed along shores through the action of waves. The ridges indicate the various stages of the Lake Erie Basin since the retreat of the glacier. Three major beach ridges can be located with smaller interstages. In some areas these ridges are not continuous and are difficult to trace. They have been sources of sand over the years.

The bedrock in Sandusky County is primarily of the Silurian-aged Lockport Dolomite and Salina Group. A small amount of Devonian-aged Columbus Limestone underlies the extreme eastern portion of the county (*11*). There are more dolomite and limestone quarries in the county than in any other county in the state. The largest concentration of quarries is located in a line extending from Gibsonburg to Woodville, where the Lockport is quarried. The Lockport is used for crushed rock, burned lime, agricultural lime, and chemical production. One quarry is located in the area underlain by the Columbus Limestone, which is used for crushed rock.

Sandusky County is drained by the Sandusky and Portage Rivers. Numerous smaller streams flow north into Sandusky Bay and Lake Erie.

History and Economic Development

Prior to 1800, the area that is now called Sandusky county was inhabited by the Wyandot Indians. After "Mad Anthony" Wayne defeated the Indians at Fallen Timbers in 1794, settlers began to move into the area. After the War of 1812, large numbers of German settlers began moving into the area to claim the rich farmland. Early settlements and the main travel routes were generally on the better drained sandy soils on the beach ridges.

Sandusky County was established in February 1820 by an act of the Ohio General Assembly. Industry then began to develop in Fremont. Shipbuilding and fishing were the major industries.

Farming developed slowly because of the need for suitable drainage measures in the extensive areas of nearly level, wet soils. The county was part of the Black Swamp in northwestern Ohio. After the installation of open ditches and subsurface drains and the construction of railroads, farming developed rapidly. The railroad transported agricultural products west to the Maumee River.

Ground Water Resources

Generally, water can be obtained from the glacial drift or bedrock in the county. The quality, quantity, and depth to water vary from area to area (*15*).

In the western half of the county, wells may yield as much as 100 gallons per minute at a depth of less than 200 feet. This area is characterized by a thin deposit of glacial drift. Bedrock generally is within a depth of 30 feet.

In a narrow north-south strip that runs through the central part of the county, the wells may yield 100 to 500 gallons per minute at a depth of less than 300 feet. This area is characterized by a thin deposit of glacial till. Bedrock generally is at a depth of 30 to 70 feet.

From the east side of Fremont to the eastern county line, the wells may yield 500 to 1,000 gallons per minute. The wells in the eastern third of the county are commonly drilled into dolomite. The water in this area has a high degree of hardness and a high content of hydrogen sulfide and sulfate, which may prohibit its use. A narrow strip along Green Creek is characterized by a thick deposit of clayey glacial till interbedded with lenses of sand and gravel. This is a partially filled remnant of an old channel. The wells in this area are generally less than 200 feet deep.

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.

The names, descriptions, and delineations of soils in this survey do not necessarily agree or join fully with those in surveys of adjoining counties. Some differences result from a better knowledge of soils or from modifications and refinements in the concepts of soil series. Other differences result from the predominance of different soils in map units consisting of soils of two or more series and from variations in the range in slope allowed within the map units in different surveys. In addition, the correlation of a recognized soil is based on the acreage of that soil and the extent to which it differs from adjacent soils within the survey area. In mapping, it is often more feasible to include soils that are minor in extent with similar soils that require similar management than to map these minor soils separately.

Survey Procedures

The general procedures followed in making this survey are described in the National Soil Handbook of the Soil Conservation Service. The survey of the county published in 1920 (*2*), a geologic map of Ohio (*5*), and a circular about the beach ridges of northern Ohio (*9*) were among the references used.

Before the actual fieldwork began, aerial photographs taken in 1977 at a scale of 1:38,000 and enlarged to a scale of 1:15,840 were studied. U.S. Geologic Survey topographic maps, at a scale of 1:24,000, also helped the soil scientists to relate land and image features.

A reconnaissance was made by automobile and pickup truck before the soil scientists traversed the surface on foot, examining the soil at about one-quarter mile intervals. Traverses at closer intervals were made in areas of high variability. Some of these areas are in the Kibbie-Dixboro and Spinks-Rimer-Kibbie associations.

Soil examinations along the traverses were made at points 100 to 800 yards apart, depending on the landscape and soil pattern (*14*). Observations of such items as landforms, blown-down trees, vegetation, roadbanks, and animal burrows were made without regard to spacing. Soil boundaries were determined on the bases of soil examinations, observations, and photo interpretation. The soil material was examined with the aid of a hand auger or a spade to a depth of about 6 feet or to bedrock within a depth of 6 feet. It also was examined in cores taken from the ground with the aid of a probe truck. The pedons described as typical were observed and studied in pits that were dug with shovels, mattocks, and digging bars.

Delineations of each map unit were selected to represent the map unit. Transects were made to determine the composition of the map unit. The point-intercept method of transecting was used (*13*).

Samples for chemical and physical analyses and for analyses of engineering properties were taken from representative sites of several of the soils in the survey area. The physical and chemical analyses were made by the Soil Characterization Laboratory, Department of Agronomy, Ohio State University, Columbus, Ohio. The results of the analyses are stored in a computerized data file at the laboratory. The analyses of engineering properties were made by the Ohio Department of Transportation, Division of Highways, Bureau of Testing, Soils and Foundation Section, Columbus, Ohio. The laboratory procedures can be obtained on request from the two laboratories. The results of the studies can be obtained from the Department of Agronomy, Ohio State University; the Ohio Department of Natural Resources, Division of Soil and Water Conservation; and the Soil Conservation Service, State Office, Columbus, Ohio.

After completion of the soil mapping on aerial photographs, map unit delineations were transferred by hand to another set of the same photographs. Surface drainage was mapped in the field. Cultural features were recorded from observations of the maps and the landscape.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association 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 association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

Deep Soils on Lake Plains, Till Plains, and Terraces

These soils make up about 63 percent of the county. They are nearly level and gently sloping and are very poorly drained to moderately well drained. They formed in glacial till, lacustrine sediment, glacial outwash, tufa, or marl. The landscape is characterized by broad flats, slight rises, and low slope breaks on lake plains, till plains, and terraces. These soils are used mainly as cropland. Some undrained areas are used as woodland. Seasonal wetness, ponding, the hazard of erosion, a high shrink-swell potential, soil blowing, unavailability of applied plant nutrients, and moderately slow to very slow permeability are management concerns.

1. Hoytville-Nappanee Association

Nearly level, very poorly drained and somewhat poorly drained, moderately fine textured and medium textured soils that formed in glacial till

This association is in broad, uniform lake basins that have slight rises. Low slope breaks are along drainageways. Slope ranges from 0 to 3 percent.

This association makes up about 32 percent of the county. It is about 60 percent Hoytville soils, 10 percent Nappanee soils, and 30 percent soils of minor extent (fig. 2).

Hoytville soils are very poorly drained and moderately fine textured. They are on broad flats. Permeability is slow. The content of organic matter is high. The available water capacity is moderate. Runoff is very slow or ponded.

Nappanee soils are somewhat poorly drained and medium textured. They are on slight rises and low slope breaks along drainageways. Permeability is slow. The content of organic matter and the available water capacity are moderate. Runoff is slow.

Of minor extent in this association are Glynwood, Haskins, Kibbie, Millsdale, Rimer, and Shoals soils. Glynwood soils are moderately well drained and are on knolls, ridges, and side slopes at the head of drainageways. Haskins, Kibbie, and Rimer soils have less clay and more sand in the subsoil than the major soils. They are on slight rises. Millsdale soils are on flats and in depressions. They are 20 to 40 inches deep over limestone or dolomite bedrock. Shoals soils formed in alluvium on flood plains.

This association is used mainly for row crops and specialty crops. Undrained areas are used as woodland. Cash-grain farming is the main enterprise. The soils are well suited to corn, soybeans, small grain, hay and pasture, and specialty crops. The main specialty crops are tomatoes and sugar beets. The soils are poorly suited to buildings and poorly suited or generally unsuited to septic tank absorption fields. Seasonal wetness and slow permeability in both of the major soils and ponding and a high shrink-swell potential in areas of the Hoytville soils are the main limitations. Tilling only within a limited range of moisture content is important because the soils become compacted and cloddy if worked when wet and sticky. It is especially important on the Hoytville soils.

2. Lenawee-Del Rey Association

Nearly level, very poorly drained and somewhat poorly drained, moderately fine textured and medium textured soils that formed in lacustrine sediment

This association is on broad lake plains. Some low slope breaks are along drainageways. Slope is 0 to 2 percent.

This association makes up about 14 percent of the county. It is about 35 percent Lenawee soils, 30 percent Del Rey soils, and 35 percent soils of minor extent.

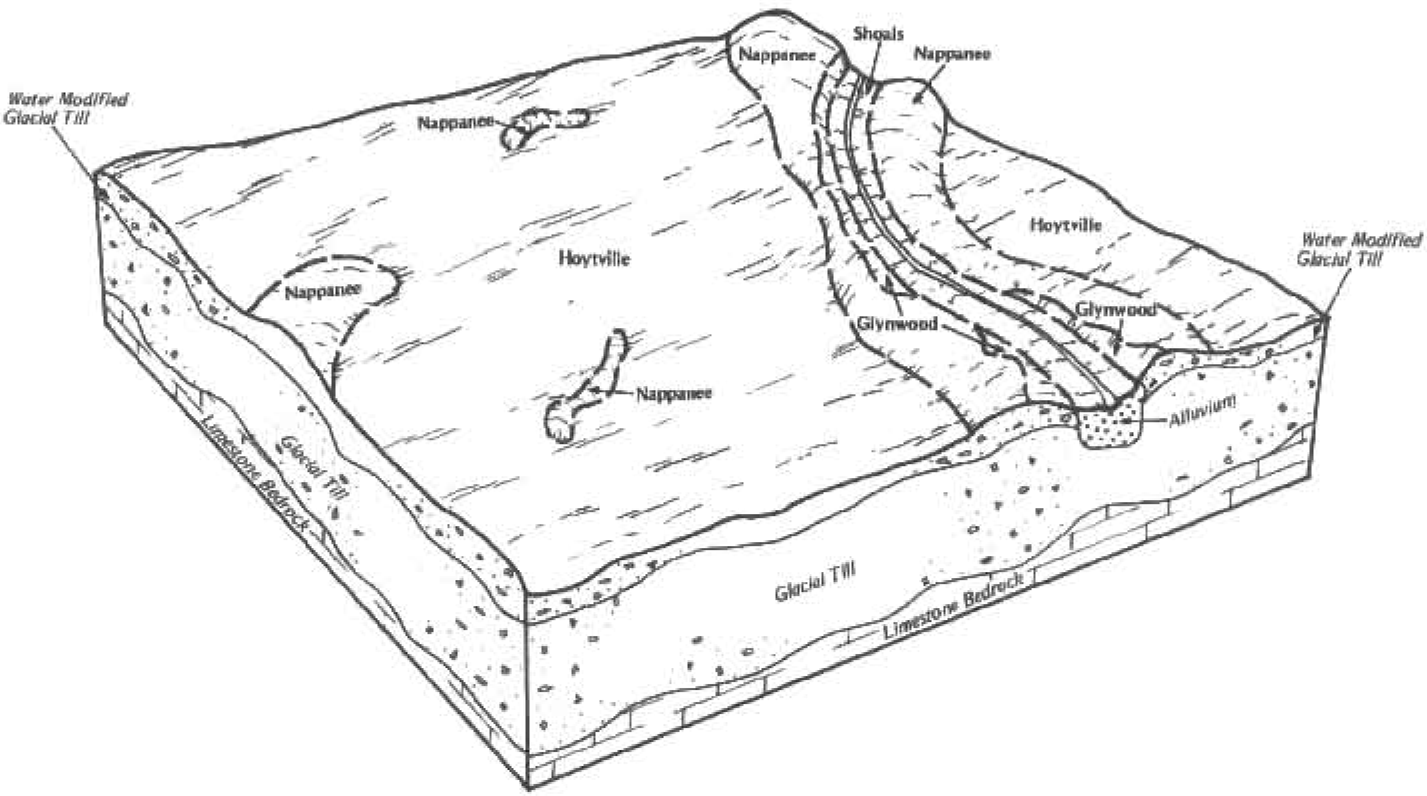


Figure 2.—Typical pattern of soils and parent material in the Hoytville-Nappanee association.

Lenawee soils are very poorly drained and moderately fine textured. They are on broad flats and in depressional areas. Permeability is moderately slow. The content of organic matter and the available water capacity are high. Runoff is very slow or ponded.

Del Rey soils are somewhat poorly drained and medium textured. They are on slight rises. Permeability is slow. The content of organic matter is moderate. The available water capacity is moderate or high. Runoff is slow.

Of minor extent in this association are Colwood, Fulton, Glenford, Haskins, Kibbie, Mentor, Rimer, Saylesville, Shoals, and Toledo soils. Colwood, Glenford, Haskins, Kibbie, Mentor, and Rimer soils typically have less clay in the subsoil than the major soils. Fulton and Toledo soils typically have more clay in the subsoil and substratum than the major soils. Colwood and Toledo soils are along drainageways. Fulton, Haskins, Kibbie, and Rimer soils are on slight rises and on slopes along drainageways. Glenford and Saylesville soils are moderately well drained. Glenford, Mentor, and Saylesville soils are on side slopes along drainageways. Shoals soils formed in alluvium in shallow depressions on flood plains.

This association is used mainly for row crops and specialty crops. Some undrained areas are used as woodland. If drained, the soils are well suited to cropland. The main crops are corn, soybeans, wheat, sugar beets, cucumbers, and tomatoes. The soils are poorly suited or moderately well suited to buildings and poorly suited or generally unsuited to septic tank absorption fields. Seasonal wetness, moderately slow or slow permeability, and ponding are the major management concerns. Wetness delays planting and limits the choice of crops. Tilling only within a limited range of moisture content is important because the soils become compacted and cloddy if worked when wet and sticky. It is especially important on the Lenawee soils.

3. Toledo-Fulton Association

Nearly level, very poorly drained and somewhat poorly drained, fine textured and moderately fine textured soils that formed in lacustrine sediment

This association is on broad, uniform lake plains that have slight rises. Some areas of the more sloping soils are on side slopes along drainageways. Slope ranges from 0 to 3 percent.

This association makes up about 12 percent of the county. It is about 60 percent Toledo soils, 20 percent Fulton soils, and 20 percent soils of minor extent (fig. 3).

Toledo soils are very poorly drained and fine textured. They are on broad flats and in long, narrow concave areas. Permeability is slow. The content of organic matter is high. The available water capacity is moderate. Runoff is very slow or ponded.

Fulton soils are somewhat poorly drained and moderately fine textured. They are on slight rises and on slopes along drainageways. Permeability is slow or very slow. The content of organic matter and the available water capacity are moderate. Runoff is slow.

Of minor extent in this association are Bono, Del Rey, Haskins, Lenawee, Lucas, Mentor, and Shoals soils. Bono soils have a dark surface layer that is thicker than that of the Toledo soils. They are in depressions. Del Rey, Haskins, Lenawee, and Mentor soils have less clay in the subsoil than the major soils. Del Rey and Haskins soils are on slight rises and low ridges. Lenawee soils are on broad flats and in depressional areas. Lucas soils are moderately well drained. Lucas and Mentor soils are on slope breaks along drainageways. Shoals soils formed in alluvium on flood plains.

This association is used mainly as cropland. Some undrained areas are used as woodland. These soils are moderately well suited to corn, soybeans, and wheat. They are poorly suited to buildings and poorly suited or generally unsuited to septic tank absorption fields. They are better suited to buildings without basements than to buildings with basements. Slow or very slow permeability, seasonal wetness, ponding, a high shrink-swell potential, and a moderately fine textured or fine textured surface layer are the major management concerns. Tilling only within a limited range of moisture content is important because the soils become compacted and cloddy if worked when wet and sticky.

4. Toledo Association

Nearly level, very poorly drained, moderately fine textured soils that formed in lacustrine sediment

This association is in broad low areas adjacent to bays and streams. The soils are ponded for long periods. Slope is 0 to 2 percent.

This association makes up about 2 percent of the county. It is about 55 percent Toledo soils and 45 percent soils of minor extent.

Toledo soils are below the normal water level of the adjacent bays and streams. Permeability is slow. The content of organic matter is high. The available water capacity is moderate. Runoff is very slow or ponded.

Of minor extent in this association are Colwood, Fulton, Kibbie, Lenawee, Mentor, and Shoals soils. Colwood and Lenawee soils are in landscape positions similar to those of the Toledo soils. They have less clay in the subsoil than the Toledo soils. Fulton and Kibbie soils are somewhat poorly drained. They are on slight rises. Mentor soils are well drained. They are on slope breaks along drainageways. Shoals soils formed in alluvium on flood plains.

Most of this association has a controlled water level and is used as wildlife refuges or hunting preserves. A few areas are drained by pumps and are used as cropland. Unless drained, the Toledo soils are generally unsuited to crops. They also are generally unsuited to woodland, buildings, and septic tank absorption fields. Ponding, a high shrink-swell potential, and slow permeability are the major limitations.

5. Blount-Glynwood-Pewamo Association

Nearly level and gently sloping, somewhat poorly drained, moderately well drained, and very poorly drained, medium textured and moderately fine textured soils that formed in glacial till

This association is on undulating till plains. Areas of these soils are interspersed with drainageways. Slope ranges from 0 to 6 percent.

This association makes up about 1 percent of the county. It is about 45 percent Blount soils, 20 percent Glynwood soils, 15 percent Pewamo soils, and 20 percent soils of minor extent.

Blount soils are somewhat poorly drained, medium textured, and nearly level. They are on flats and slight rises. Permeability is slow or moderately slow. The content of organic matter and the available water capacity are moderate. Runoff is slow.

Glynwood soils are moderately well drained, medium textured, and gently sloping. They are on knolls, ridges, and side slopes at the head of drainageways. Permeability is slow. The content of organic matter and the available water capacity are moderate. Runoff is medium.

Pewamo soils are very poorly drained, moderately fine textured, and nearly level. They are in shallow depressions and drainageways. Permeability is moderately slow. The content of organic matter and the available water capacity are high. Runoff is very slow or ponded.

Of minor extent in this association are Belmore, Dunbridge, Haskins, Mermill, and Seward soils. Belmore soils are well drained and are on stream and outwash terraces. Dunbridge soils are on the sides of ridges. They are 20 to 40 inches deep over limestone or dolomite bedrock. Haskins, Mermill, and Seward soils have less clay in the upper part than the major soils. Haskins soils are on flats and slight rises on till plains and stream terraces. Mermill soils are on flats and in depressions on outwash plains, terraces, and till plains. Seward soils are on outwash plains.

This association is used for general farming. The main crops are corn, soybeans, small grain, and hay. A few areas along drainageways are used as woodland. The soils are well suited to row crops, hay and pasture, and

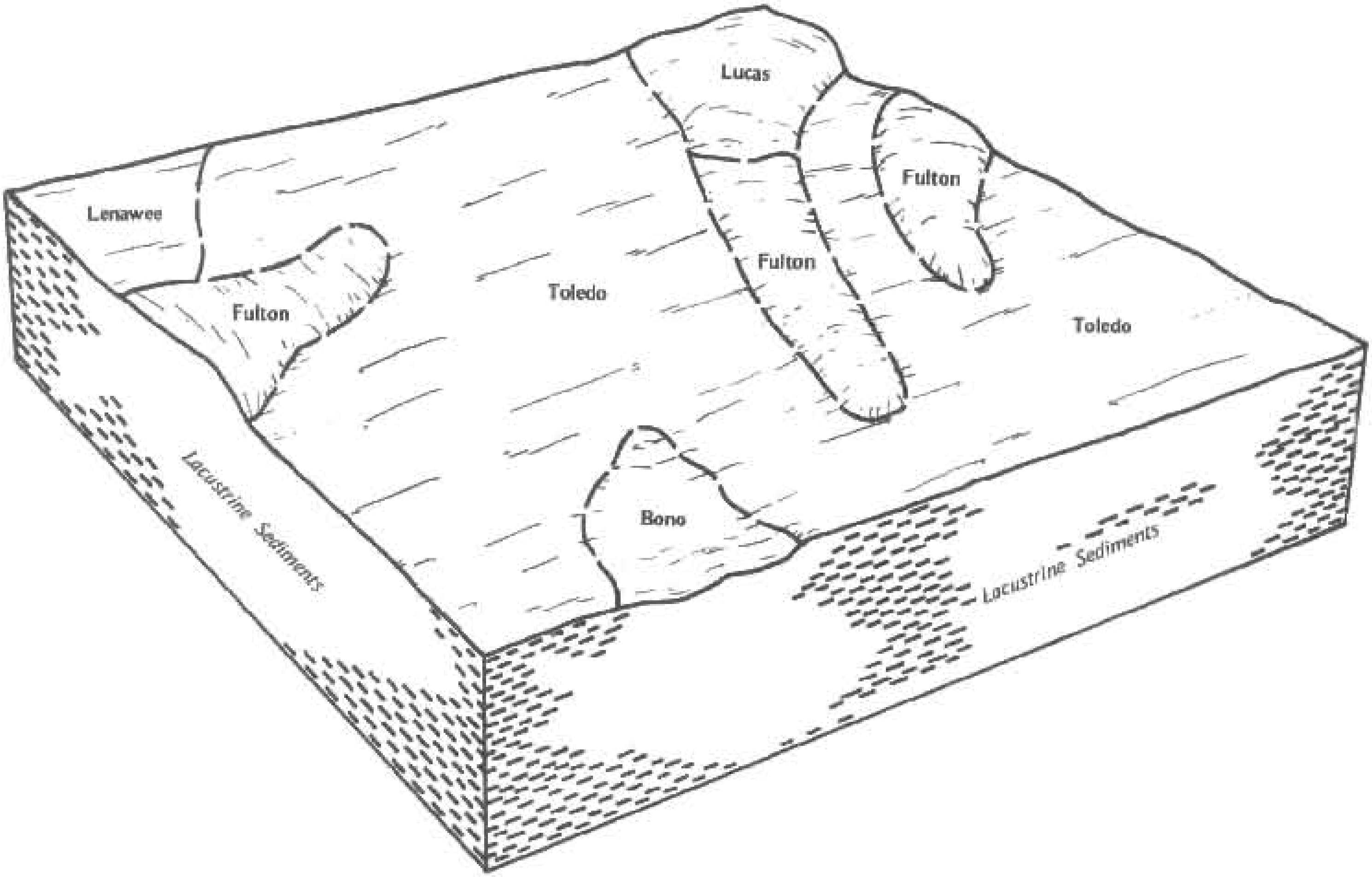


Figure 3.—Typical pattern of soils and parent material in the Toledo-Fulton association.

woodland. They are moderately well suited or poorly suited to buildings and poorly suited or generally unsuited to septic tank absorption fields. The Glynwood soils are better sites for buildings than the Blount and Pewamo soils. Seasonal wetness, the hazard of erosion, the shrink-swell potential, ponding, and slow or moderately slow permeability are management concerns.

6. Bennington-Glenford-Haskins Association

Nearly level and gently sloping, somewhat poorly drained and moderately well drained, medium textured and moderately coarse textured soils that formed in glacial till, lacustrine sediment, and glacial outwash

This association is on flat and undulating parts of lake plains and terraces. Some steeper areas are on side slopes along drainageways. Slope ranges from 0 to 6 percent.

This association makes up about 1 percent of the county. It is about 30 percent Bennington soils, 20 percent Glenford soils, 15 percent Haskins soils, and 35 percent soils of minor extent.

Bennington soils are somewhat poorly drained, medium textured, and nearly level. They are on broad flats on lake plains. Permeability is slow. The content of organic matter and the available water capacity are moderate. Runoff is slow.

Glenford soils are moderately well drained, medium textured, and gently sloping. They are on side slopes and the crests of slight rises on lake plains and terraces along streams. Permeability is moderately slow. The content of organic matter is moderate. The available water capacity is moderate or high. Runoff is medium.

Haskins soils are somewhat poorly drained, moderately coarse textured, and nearly level and gently sloping. They are on slight rises and flats on lake plains and stream terraces. Permeability is moderate in the subsoil and slow or very slow in the substratum. The content of organic matter is moderately low. The available water capacity is moderate. Runoff is slow.

Of minor extent in this association are Belmore, Castalia, Colwood, Dunbridge, Kibbie, Mermill, and Spinks soils. Belmore and Spinks soils are well drained. They are on beach ridges. Belmore soils also are on stream and outwash terraces. Castalia and Dunbridge soils are moderately deep to bedrock. They are on knolls, ridges, and slight rises. Colwood and Mermill soils are very poorly drained and are on flats and in depressions. Kibbie soils have a surface layer that is darker than that of the major soils. They are on flats and slight rises.

This association is used mainly for row crops. A few areas are used as woodland. Cash-grain farming is the main enterprise. These soils are well suited to row crops, hay and pasture, and woodland. They are moderately well suited to buildings and moderately well suited or poorly suited to septic tank absorption fields. Seasonal wetness, the hazard of erosion, moderately slow to very slow permeability, and the shrink-swell potential are management concerns. Also, soil blowing is a hazard on the Haskins soils unless a dense plant cover is maintained.

7. Sandusky-Weyers Association

Nearly level, very poorly drained, moderately coarse textured soils that formed in tufa and marl

This association is on flats on lake plains. It is near seeps of water that has a high content of calcium carbonate. Some slope breaks are near drainageways. Slope is 0 to 2 percent.

This association makes up about 1 percent of the county. It is about 45 percent Sandusky soils, 30 percent Weyers soils, and 25 percent soils of minor extent.

Sandusky soils are on broad flats surrounding the Weyers soils. Permeability is moderate or moderately rapid in the upper part of the profile and slow in the lower part. The content of organic matter is very high. The available water capacity is moderate. Runoff is very slow.

Weyers soils are on flats. Permeability is moderately rapid in the upper part of the profile and moderate to slow in the lower part. The content of organic matter is very high. The available water capacity is moderate. Runoff is very slow.

Of minor extent in this association are Colwood, Fulton, Kibbie, Mermill, Rimer, and Toledo soils. These soils formed in mineral material and have a lower content of organic matter in the surface layer than the major soils. They are in positions on lake plains that do not receive seepage having a high content of calcium carbonate.

This association is used mainly for row crops. Some undrained areas are used as woodland and habitat for wetland wildlife. These soils are well suited or moderately well suited to corn and soybeans. They are poorly suited to woodland and well suited to habitat for wetland wildlife. They are generally unsuited to buildings and septic tank absorption fields. Seasonal wetness, slow permeability, and unavailability of applied plant nutrients are limitations. Sloughing is a hazard in shallow excavations.

Moderately Deep Soils on Lake Plains and Stream Terraces

These soils make up about 10 percent of the county. They are nearly level and gently sloping and are very poorly drained and well drained. They formed in glacial till, glacial outwash, and limestone residuum. They are on flats that have depressions, slight rises, and knolls. They are used mainly as cropland, pasture, or woodland. Bedrock at a depth of 20 to 40 inches, stoniness, moderately slow permeability, droughtiness, the shrink-swell potential, ponding, and the hazard of erosion are management concerns.

8. Millsdale-Castalia-Dunbridge Association

Nearly level and gently sloping, very poorly drained and well drained, moderately fine textured to moderately coarse textured soils that formed in glacial till, limestone or dolomite residuum, and glacial outwash

This association is on flats that have depressions, slight rises, and knolls. Limestone or dolomite bedrock is fairly close to the surface. Slope ranges from 0 to 6 percent.

This association makes up about 10 percent of the county. It is about 40 percent Millsdale soils, 20 percent Castalia soils, 15 percent Dunbridge soils, and 25 percent soils of minor extent (fig. 4).

Millsdale soils are very poorly drained, moderately fine textured, and nearly level. They are on flats and in depressions. Permeability is moderately slow. The content of organic matter is high. The available water capacity is low. Runoff is very slow or ponded.

Castalia soils are very stony, well drained, medium textured, and nearly level and gently sloping. They are on knolls and slight rises. Permeability is rapid. The content of organic matter is high. The available water capacity is very low. Runoff is slow.

Dunbridge soils are well drained, moderately coarse textured, and nearly level and gently sloping. They are on side slopes and the crests of knolls and ridges. Permeability is moderately rapid. The content of organic matter is moderate. The available water capacity is low. Runoff is medium.

Of minor extent in this association are the deep Haskins, Hoytville, Kibbie, Lenawee, Mermill, Nappanee, and Spinks soils. Haskins, Kibbie, and Nappanee soils are on flats and slight rises. Hoytville, Lenawee, and Mermill soils are on flats and in depressions. Spinks soils are on former beach ridges and offshore bars.

This association is used mainly as cropland, pasture, or woodland. These soils are generally unsuited or moderately well suited to cropland and moderately well

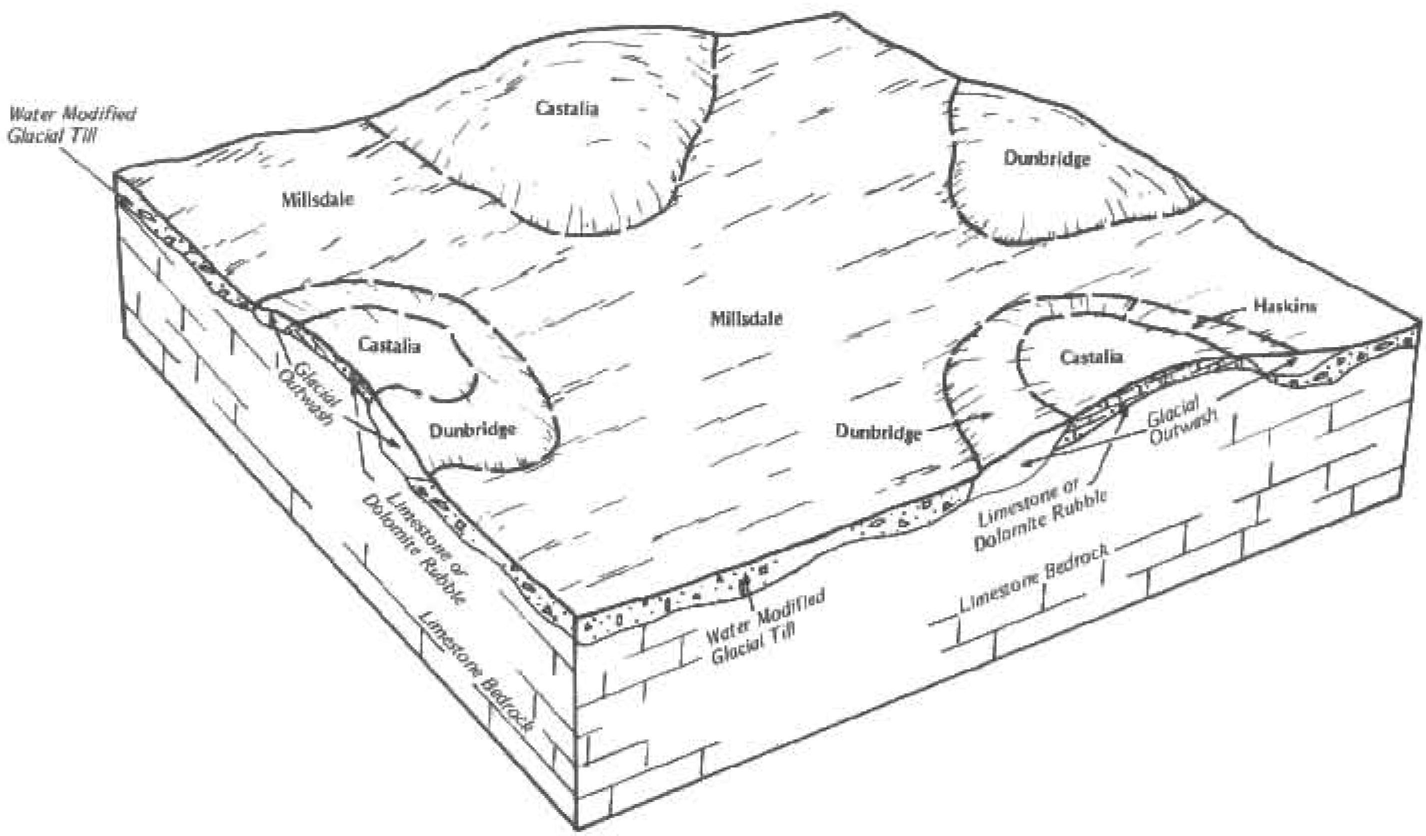


Figure 4.—Typical pattern of soils and parent material in the Millsdale-Castalia-Dunbridge association.

suited or poorly suited to pasture. They are poorly suited or moderately well suited to woodland and buildings. They are poorly suited or generally unsuited to septic tank absorption fields. They are better suited to houses without basements than to houses with basements. Bedrock at a depth of 20 to 40 inches, stoniness, moderately slow permeability, droughtiness, the shrink-swell potential, ponding, and the hazard of erosion are management concerns.

Deep Soils on Beach Ridges, Lake Plains, Deltas, and Former Offshore Bars

These soils make up about 26 percent of the county. They are nearly level and gently sloping and are somewhat poorly drained and well drained. They formed in sandy and loamy deposits and in the underlying lacustrine sediment. They are on broad flats, slight rises, and ridges. These soils are used mainly for farming. Soil blowing, seasonal wetness, seasonal droughtiness, the hazard of erosion, slow or very slow permeability, and the shrink-swell potential are management concerns. Sloughing is a hazard in shallow excavations.

9. Kibbie-Dixboro Association

Nearly level, somewhat poorly drained, moderately coarse textured soils that formed in stratified loamy and sandy sediments

This association is on lake plains and deltas. It is on broad flats that have very slight rises. Some low slope breaks are on the sides of ridges and along drainageways. Slope is 0 to 2 percent.

This association makes up about 15 percent of the county. It is about 40 percent Kibbie soils, 15 percent Dixboro soils, and 45 percent soils of minor extent.

Kibbie soils are on broad flats and very slight rises. Permeability and the content of organic matter are moderate. The available water capacity is high. Runoff is slow.

Dixboro soils are on broad flats and slight rises. Permeability and the content of organic matter are moderate. The available water capacity is moderate or high. Runoff is slow.

Of minor extent in this association are Bixler, Colwood, Gilford, Glenford, Glynwood, Granby, and Lenawee soils. Bixler soils have a surface layer that is lighter colored than that of the major soils. They are on outwash plains and beach ridges. Colwood, Gilford, Granby, and Lenawee soils are very poorly drained. They are on flats and in depressions. Glenford and Glynwood soils are moderately well drained and are slightly higher on the landscape than the Kibbie and Dixboro soils.

This association is used mainly for farming. The main crops are corn, soybeans, small grain, tomatoes, sugar beets, cucumbers, and cabbage. These soils are well suited to corn, soybeans, small grain, hay and pasture, and woodland. They are moderately well suited to buildings and septic tank absorption fields. They are better suited to houses without basements than to houses with basements. Seasonal wetness and soil blowing are management concerns. Sloughing is a hazard in shallow excavations.

10. Spinks-Rimer-Kibbie Association

Gently sloping and nearly level, well drained and somewhat poorly drained, coarse textured and moderately coarse textured soils that formed in sandy and loamy deposits and in the underlying lacustrine sediment

This association is on narrow beach ridges and former offshore bars. Slope ranges from 0 to 6 percent.

This association makes up about 11 percent of the county. It is about 20 percent Spinks soils, 20 percent Rimer soils, 20 percent Kibbie soils, and 40 percent soils of minor extent.

Spinks soils are well drained, coarse textured, and gently sloping. They are on the sides and top of beach ridges and former offshore bars. Permeability is moderately rapid. The content of organic matter is moderately low. The available water capacity is low. Runoff is slow.

Rimer soils are somewhat poorly drained, coarse textured, and nearly level and gently sloping. They are on low beach ridges and along the edges of the higher beach ridges. Permeability is rapid in the upper part of the subsoil and slow or very slow in the lower part of the subsoil and in the substratum. The content of organic matter is moderately low. The available water capacity is moderate. Runoff is slow.

Kibbie soils are somewhat poorly drained, moderately coarse textured, and nearly level. They are along the edges of the higher beach ridges. Permeability and the content of organic matter are moderate. The available water capacity is high. Runoff is slow.

Of minor extent in this association are Belmore, Colwood, Dunbridge, Granby, Mermill, and Tedrow soils. Belmore soils are in landscape positions similar to those of the Spinks soils. They have more gravel than the major soils. Colwood, Granby, and Mermill soils are very poorly drained and are on flats and in depressions. Dunbridge soils are moderately deep to bedrock. They are on the sides of ridges. Tedrow soils are on low beach ridges. They are wetter than the Spinks soils and have more sand in the substratum than the Rimer soils.

This association is used mainly for farming. Corn, soybeans, small grain, vegetables, and tree fruits are the chief crops. These soils are moderately well suited or well suited to corn, soybeans, small grain, hay, and woodland. They are well suited or moderately well suited to buildings and are well suited to poorly suited to septic tank absorption fields. Soil blowing, seasonal droughtiness, seasonal wetness, the hazard of erosion, slow or very slow permeability, and the shrink-swell potential are management concerns. Sloughing is a hazard in shallow excavations.

Deep Soils on Flood Plains and Low Stream Terraces

These soils make up about 1 percent of the county. They are nearly level and are well drained and somewhat poorly drained. They formed in alluvium on broad flats and in narrow areas on flood plains and low stream terraces. They are used mainly for farming. Flooding and seasonal wetness are the major management concerns.

11. Rossburg-Shoals Association

Nearly level, well drained and somewhat poorly drained, medium textured soils that formed in alluvium

This association is on broad flats and in narrow areas on flood plains and low stream terraces. Slope is 0 to 2 percent.

This association makes up about 1 percent of the county. It is about 40 percent Rossburg soils, 20 percent Shoals soils, and 40 percent soils of minor extent.

Rossburg soils are well drained. They are on flood plains and low stream terraces and are occasionally flooded. Permeability is moderate in the subsoil and moderately rapid or rapid in the substratum. The content of organic matter and the available water capacity are high. Runoff is slow.

Shoals soils are somewhat poorly drained. They are on flats, in shallow depressions, and in meander channels on flood plains. They are frequently flooded. Permeability and the content of organic matter are moderate. The available water capacity is high. Runoff is very slow.

Of minor extent in this association are Glenford, Glynwood, Lenawee, Mentor, and Toledo soils. Glenford and Glynwood soils are moderately well drained. Mentor soils have less sand in the subsoil than the major soils. Glenford, Glynwood, and Mentor soils are on slope breaks along flood plains and low stream terraces. Lenawee and Toledo soils are very poorly drained and are on flats and in depressions near the flood plains and low stream terraces.

This association is used for farming. It is well suited to corn, soybeans, and woodland. It is generally unsuited to buildings and septic tank absorption fields. Flooding and seasonal wetness are management concerns. Constructing dikes is difficult.

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 substratum, 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 substratum. They also can differ in slope, stoniness, salinity, 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, Mentor silt loam, 1 to 14 percent slopes, is a phase in the Mentor series.

Some map units are made up of two or more major soils. These map units are called soil complexes. 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. Dixboro-Kibbie complex, 0 to 2 percent slopes, is an example.

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 have little or no soil material and support little or no vegetation. Pits, quarry, 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

An—Aquents, nearly level. These nearly level, dominantly silty soils are in areas where the landscape has been altered by construction activities. They are on flats or in slight depressions. Some areas have been used as a source of borrow material. Slope is 0 to 2 percent. Areas range from 10 to 70 acres.

Typically, the upper 60 inches is silt loam or silty clay loam. It is a mixture of material from the subsoil and substratum of natural soils. In some places much of the surface layer, subsoil, or substratum has been removed. In other places soil material has been added. Much of the original surface has been graded. The soil material in the higher areas has been used to fill depressions. The resulting mixture cannot be classified at the series level.

Tilth is poor. Many areas are calcareous at the surface. The available water capacity varies, and the content of organic matter is generally very low.

Most areas have only a sparse cover of vegetation and are idle. A few areas are farmed. The surface layer crusts after hard rains. This crusting reduces the rate of water infiltration and restricts the emergence and growth of seedlings. These soils have a seasonal high water table in most areas, especially in depressions or bowl-shaped areas where water accumulates. The excessive wetness limits plant growth. Stands of grasses or legumes can be improved by mulching, applying fertilizer, and seeding. The root zone can be improved by blanketing the area with topsoil. The species selected for planting should be those that can withstand alkaline and wet conditions.

The suitability of these soils for building site development and septic tank absorption fields varies. The poor internal drainage is a major limitation. Onsite investigation is needed to determine the suitability for any proposed use. Providing suitable base material and installing a drainage system improve parking lots and local roads.

No land capability classification or woodland ordination symbol is assigned.

BaB—Belmore loam, 2 to 6 percent slopes. This gently sloping, deep, well drained soil is in undulating areas on stream terraces, outwash terraces, and beach ridges. Most areas are long and narrow and range from 10 to 200 acres.

Typically, the surface layer is brown, friable loam about 7 inches thick. The subsoil is brown and dark brown, friable clay loam, gravelly clay loam, and gravelly sandy clay loam about 23 inches thick. The upper part of the substratum is mixed grayish brown and pale brown, mottled, loose gravelly loamy sand and sand. The lower part to a depth of about 60 inches is brown, friable sandy loam. In some areas the surface layer is sandy loam, loamy sand, or silt loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Haskins, Kibbie, and Rimer soils in the lower lying landscape positions. Also included are small areas of Spinks soils. These soils have more sand in the subsoil than the Belmore soil. They are on beach ridges. Included soils make up about 5 percent of most areas.

Permeability is moderately rapid in the subsoil of the Belmore soil and rapid in the substratum. Runoff is medium. The root zone generally is deep. The available water capacity is moderate. The content of organic matter is moderately low. The surface layer can be easily tilled throughout a fairly wide range in moisture content. The subsoil is medium acid or slightly acid in the upper part and slightly acid or neutral in the lower part.

Most of the acreage is used for corn, soybeans, wheat, oats, hay, or pasture. Some areas are used for truck crops or sugar beets. This soil is moderately well suited to corn, soybeans, and small grain. The surface layer reaches the optimum moisture content for tillage soon after rains. The soil dries early in spring. Because of the limited available water capacity, it is better suited to early maturing crops than to crops that mature late in summer.

Droughtiness and the hazard of erosion are the main management concerns in cultivated areas. This soil is well suited to irrigation. A system of conservation tillage that leaves crop residue on the surface, cover crops, and grassed waterways reduce the runoff rate and help to prevent excessive soil loss. Incorporating crop residue or other organic material into the surface layer increases the rate of water infiltration, improves tilth and fertility, helps to prevent excessive crusting, and improves the soil-seed contact. Because plant nutrients are leached at a moderately rapid rate, smaller, more frequent or timely applications of fertilizer and lime are better suited than one large application.

This soil is well suited to deep-rooted grasses and legumes for hay and pasture and to grazing early in spring. Pastures and meadows of shallow-rooted legumes and grasses tend to dry out when rainfall is below normal.

This soil is well suited to trees and shrubs. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is well suited to buildings, septic tank absorption fields, and local roads and streets. Maintaining a plant cover reduces the runoff rate and the risk of erosion during construction. The effluent in septic tank absorption fields drains freely but can pollute underground water supplies. Installing the absorption field in suitable fill material improves the filtering capacity. The soil is suitable for lawns.

The land capability classification is IIe. The woodland ordination symbol is 2a.

BeA—Bennington silt loam, 0 to 2 percent slopes. This nearly level, deep, somewhat poorly drained soil is on broad flats on lake plains. Areas range from 10 to 40 acres. Most are irregular in shape.

Typically, the surface layer is dark grayish brown, friable silt loam about 9 inches thick. The subsoil is grayish brown and brown, mottled, friable and firm silty clay loam and clay loam about 27 inches thick. The substratum to a depth of about 60 inches is brown, mottled, firm silty clay loam. In some areas the surface layer is loam.

Included with this soil in mapping are small areas of Haskins soils on low knolls and the well drained Dunbridge soils, which are moderately deep over bedrock. Haskins soils have less clay in the subsoil than the Bennington soil. Also included are small areas of the very poorly drained Hoytville and Lenawee soils in slight depressions. Included soils make up about 10 percent of most areas.

Permeability is slow in the Bennington soil, and the available water capacity is moderate. The content of organic matter also is moderate. The shrink-swell potential is moderate in the subsoil. The potential for frost action is high. Runoff is slow. Tilth is good. A perched seasonal high water table is at a depth of 12 to 30 inches during extended wet periods. The root zone generally is moderately deep over compact glacial till. The subsoil is medium acid to very strongly acid in the upper part and very strongly acid to neutral in the lower part.

Most areas are farmed. This soil is well suited to row crops and small grain. The wetness is the main limitation. Both surface and subsurface drains are needed. Minimizing tillage and incorporating crop residue or other organic material into the surface layer improve tilth and fertility, increase the rate of water infiltration, help to prevent excessive crusting, and improve the soil-seed contact. Leaving crop residue on the surface in the fall and not plowing until spring help to protect the soil against erosion.

This soil is well suited to pasture and hay, but it is poorly suited to grazing early in spring. Grazing when the soil is wet results in surface compaction, poor tilth, and damage to pasture plants. Proper stocking rates, selection of suitable species for planting, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

This soil is well suited to the trees and shrubs that can withstand some wetness. Removing vines and the less desirable trees and shrubs helps to control plant competition.

Because of the slow permeability and the seasonal wetness, this soil is only moderately well suited to buildings and is poorly suited to septic tank absorption fields. A drainage system is needed. Protective coatings on the exterior of basement walls help to keep basements dry. Grading sites for buildings and septic tank absorption fields can improve surface drainage. Increasing the size of septic tank absorption fields helps to overcome the restricted permeability. Installing perimeter drains around the absorption fields helps to lower the seasonal high water table. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by frost action and low strength.

The land capability classification is IIw. The woodland ordination symbol is 2a.

BkB—Bixler loamy fine sand, 2 to 6 percent slopes. This gently sloping, deep, somewhat poorly drained soil is on ridges and low knolls on outwash plains and beach ridges. Most areas are long and narrow and range from 4 to 50 acres in size.

Typically, the surface layer is very dark grayish brown, friable loamy fine sand about 8 inches thick. The subsurface layer is brown and yellowish brown, very friable loamy fine sand about 14 inches thick. It is mottled in the lower part. The subsoil is about 18 inches thick. The upper part is yellowish brown, mottled, friable fine sandy loam, and the lower part is brown and grayish brown, mottled, firm silty clay loam. The substratum to a depth of about 60 inches is gray, mottled, friable silt loam. In some areas the surface layer is sandy loam or fine sandy loam. In other areas the soil is moderately well drained.

Included with this soil in mapping are small areas of the very poorly drained Colwood and Lenawee soils in depressions and small areas of Kibbie soils. Kibbie soils have more clay in the upper part than the Bixler soil. Their positions on the landscape are similar to those of the Bixler soil. Included soils make up about 15 percent of most areas.

Permeability is rapid in the upper part of the Bixler soil and moderate in the lower part. The available water capacity is moderate. The content of organic matter is moderately low or low. Runoff is slow. The subsoil is slightly acid to mildly alkaline. The surface layer can be worked throughout a wide range of moisture content. A seasonal high water table is at a depth of 24 to 42 inches during extended wet periods. The root zone is deep.

Most areas are farmed. This soil is moderately well suited to corn, soybeans, wheat, and specialty crops. The seasonal wetness and the hazards of erosion and soil blowing are the main management concerns. Also, the soil is droughty during extended dry periods. Soil blowing occurs when the vegetative cover is sparse or the surface is bare. Applying a conservation tillage system that leaves crop residue on the surface, planting cover crops, and establishing grassed waterways conserve moisture and help to control soil blowing and erosion. Returning crop residue to the soil or adding other organic material improves fertility and increases the rate of water infiltration. Because of the uneven landscape, most areas of cropland are drained by randomly spaced subsurface drains.

This soil is moderately well suited to pasture and hay. A cover of hay or pasture plants helps to control soil blowing. No-till reseeding helps to control soil blowing and erosion.

This soil is well suited to trees and shrubs. Establishing seedlings is difficult during the drier part of the year. Planting seedlings that have been transplanted once reduces the seedling mortality rate. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is only moderately well suited to buildings and septic tank absorption fields because of seasonal wetness and seepage. Because of the wetness, it is better suited to dwellings without basements than to dwellings with basements. Drainage ditches and subsurface drains help to lower the seasonal high water table. Grading building sites helps to provide good surface drainage away from foundations.

Installing perimeter drains around septic tank absorption fields helps to lower the seasonal high water table in this soil. The soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in the pollution of ground water supplies. Providing suitable fill material improves the filtering capacity. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by frost action and wetness.

The land capability classification is IIe. The woodland ordination symbol is 2s.

BoA—Blount silt loam, 0 to 2 percent slopes. This nearly level, deep, somewhat poorly drained soil is in broad areas on till plains. Most areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is brown, friable silt loam about 7 inches thick. The subsoil is yellowish brown, mottled, firm clay loam about 24 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, firm clay loam.

Included with this soil in mapping are small areas of the moderately well drained Glynwood and somewhat poorly drained Haskins soils on low knolls and the very poorly drained Pewamo soils in depressions and along drainageways. Included soils make up about 15 percent of most areas.

Permeability is slow or moderately slow in the Blount soil, and the available water capacity is moderate. The content of organic matter also is moderate. Runoff is slow. The upper part of the subsoil ranges from very strongly acid to slightly acid and the lower part from medium acid to mildly alkaline. This soil crusts easily after heavy rains. A perched seasonal high water table is at a depth of 12 to 36 inches during extended wet periods. The root zone generally is restricted by the compact glacial till at a depth of 24 to 45 inches.

Most areas are farmed. This soil is well suited to corn, soybeans, wheat, and oats. The seasonal wetness is the main limitation. It delays planting and limits the choice of crops. Surface drains and land smoothing are commonly needed. Subsurface drains are used to lower the seasonal high water table. Applying a system of conservation tillage that leaves crop residue on the surface and incorporating crop residue or other organic material into the surface layer improve tilth and fertility, help to prevent excessive crusting, and increase the infiltration rate.

The soil is well suited to pasture and hay. Surface compaction, poor tilth, a decreased infiltration rate, and retarded plant growth result from overgrazing or grazing during wet periods, when the soil is soft and sticky. Proper stocking rates, selection of suitable species for planting, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

A few areas support native hardwoods. This soil is well suited to the trees and shrubs that can withstand some wetness. Seedling mortality and the windthrow hazard are severe. Planting seedlings that have been transplanted once or mulching reduces the seedling mortality rate. The windthrow hazard can be reduced by harvesting techniques that do not leave the remaining trees widely spaced.

Because of the slow or moderately slow permeability and the seasonal high water table, this soil is only moderately well suited to buildings and is poorly suited to septic tank absorption fields. Ditches and subsurface drains are needed. Grading building sites can keep surface water away from the foundation. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. Increasing the size of septic tank absorption fields helps to overcome the restricted permeability. Installing perimeter drains around the absorption fields helps to lower the seasonal high water table. Local roads can be improved by installing a drainage system and providing suitable base material.

The land capability classification is IIw. The woodland ordination symbol is 3c.

Bt—Bono silty clay. This deep, nearly level, very poorly drained soil is in depressions. It is subject to ponding. Most areas range from 3 to 20 acres and are irregular in shape. Slope is 0 to 2 percent.

Typically, the surface layer is very dark gray and black, firm silty clay about 11 inches thick. The subsoil is dark gray and gray, mottled, firm silty clay and clay about 43 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled, firm clay. In some areas the dark surface layer is thinner.

Included with this soil in mapping are small areas of the somewhat poorly drained Fulton soils on slight rises. These soils make up about 5 percent of most areas.

Permeability is slow or very slow in the Bono soil, and the available water capacity is moderate. Runoff is very slow or ponded. A seasonal high water table is near or above the surface during extended wet periods. The subsoil is strongly acid or medium acid in the upper part and mildly alkaline or neutral in the lower part. The content of organic matter is high. The root zone generally is deep.

Most of the acreage is cropland. Corn, soybeans, and small grain are the principal crops. This soil is moderately well suited to corn and soybeans. In some years stands of small grain are poor in areas that are inadequately drained. Most areas have been drained. Where drainage outlets are available, subsurface drains are commonly used to lower the seasonal high water table. They should be closely spaced for uniform drainage. Surface drains and drainage ditches are used in many areas to remove excess surface water. Dikes and pumps are used in some areas where drainage outlets are not available. The soil should be worked within a narrow range of moisture content because it becomes compacted and cloddy if tilled, grazed, or harvested when wet. It cracks as it dries. Planting cover crops and returning crop residue to the soil improve tilth and increase the rate of water infiltration.

This soil is moderately well suited to woodland (fig. 5). The use of planting and harvesting equipment is limited by wetness. The trees should be logged and planted during the drier parts of the year. The species selected for planting should be those that can withstand wetness and a high clay content in the surface layer and subsoil. Planting seedlings that have been transplanted once reduces the seedling mortality rate. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is poorly suited to buildings and generally unsuited to septic tank absorption fields. Grading building sites helps to keep surface water away from the foundation. Backfilling along foundations with material that has a low shrink-swell potential and installing drains at the base of footings help to prevent the structural damage caused by shrinking and swelling and help to keep basements dry. Protective coatings on the exterior of basement walls also help to keep basements dry. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by low strength, ponding, and shrinking and swelling.

The land capability classification is IIIw. The woodland ordination symbol is 3w.

ChB—Castalia very stony loam, 1 to 6 percent slopes. This moderately deep, nearly level and gently sloping, well drained soil is on knolls and slight rises on lake plains. Stones are on the surface. They are subrounded or angular and range from 10 inches to almost 4 feet across. They are about 5 to 30 feet apart. Most areas are oval or irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is very dark gray, friable very stony loam about 6 inches thick. The subsoil is dark brown, friable very flaggy loam about 12 inches thick. The substratum is dark brown, very friable extremely

Figure 5.—An area of Bono silty clay used as woodland.

flaggy loam about 6 inches thick. Dolomitic limestone is at a depth of about 24 inches.

Included with this soil in mapping are small areas of Dunbridge and Millsdale soils. Dunbridge soils have fewer coarse fragments and more clay throughout than the Castalia soil. The very poorly drained Millsdale soils are in depressions. Also included are a few areas of soils underlain by massive, unfractured bedrock, nearly level and concave areas where water ponds during extended wet periods, small areas of rock outcrops, and areas where bedrock is at a depth of 10 to 20 inches. Included soils make up about 10 percent of most areas.

Permeability is rapid in the Castalia soil, and the available water capacity is very low. This soil is quite droughty during dry periods. Runoff is slow. The subsoil typically is mildly alkaline. The content of organic matter is high. The root zone is moderately deep.

Some areas are pastured. This soil is generally not suited to cultivation. It is poorly suited to pasture. It can be grazed early in spring. Surface stones and droughtiness are the main management concerns. The grasses and legumes that can withstand the droughtiness should be selected for planting.

Most of the acreage supports brush. This soil is poorly suited to woodland. The species selected for planting should be those that can withstand droughtiness and a limited root zone. Surface stones limit the use of equipment. In most areas the trees can be logged around the stones.

Because the surface is stony and bedrock is at a depth of 20 to 40 inches, this soil is poorly suited to buildings and septic tank absorption fields. It is better suited to houses without basements than to houses with basements. Blasting of the bedrock is generally needed before a basement can be constructed or underground utilities installed. Stones should be removed prior to construction and before lawns are established. The effluent in septic tank absorption fields can move through fissures in the bedrock and pollute underground water supplies. A central sewage system should be used, or the absorption fields should be installed on elevated mounds in which 4 feet or more of soil with a good filtering capacity covers the bedrock.

The land capability classification is VIs. The woodland ordination symbol is 5f.

Co—Colwood fine sandy loam. This nearly level, deep, very poorly drained soil is on flats and in depressions on lake plains and outwash plains. The lower parts of the depressions can be ponded by runoff from higher lying adjacent soils. Slope is 0 to 2 percent. Most areas are long and narrow and range from 4 to 40 acres.

Typically, the surface layer is black, friable fine sandy loam about 11 inches thick. The subsoil is about 45 inches thick. The upper part is grayish brown and gray, mottled, friable and firm sandy clay loam, and the lower part is gray, mottled, firm silty clay loam. The substratum to a depth of about 65 inches is gray, mottled, firm silty clay loam. In some areas the surface layer is silty clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Bixler, Dixboro, and Kibbie soils on slight rises. Also included are areas of Lenawee soils. These soils contain more clay in the subsoil than the Colwood soil. Their positions on the landscape are similar to those of the Colwood soil. Included soils make up about 10 percent of most areas.

Permeability is moderate in the Colwood soil. The content of organic matter is high. The available water capacity also is high. Runoff is very slow or ponded. The subsoil is slightly acid to mildly alkaline. Tilth is good. The seasonal high water table is near or above the surface during extended wet periods. The root zone is deep.

Most areas are farmed. If well managed, this soil is suited to row crops, such as corn and soybeans, grown year after year. It is well suited to wheat, oats, and specialty crops.

The wetness is the main limitation in cultivated areas. Unless an adequate drainage system is installed, poor stands of wheat and oats can be expected in most years. Surface drains are commonly needed. Subsurface drains are used to lower the seasonal high water table, but suitable outlets are not readily available in some areas. Timely tillage helps to prevent surface compaction. Soil blowing is a hazard. Cover crops and a system of conservation tillage that leaves crop residue on the surface are needed, especially if the soil is used for row crops year after year. Incorporating crop residue or other organic matter into the surface layer increases the rate of water infiltration, helps to maintain tilth, reduces the hazard of soil blowing, and improves the soil-seed contact.

This soil is well suited to grasses and legumes for hay and pasture. Even if the soil is drained, controlled grazing is needed. The surface layer compacts easily if the pasture is grazed during wet periods, when the soil is soft and sticky. Pasture rotation and restricted grazing during wet periods help to keep the pasture in good condition.

A few small areas support native hardwoods. This soil is well suited to water-tolerant trees and shrubs. Removing vines and the less desirable trees and shrubs helps to control plant competition. Wetness limits the use of planting and harvesting equipment in winter and spring. The trees should be logged during the drier parts of the year. Frequent, light thinning and harvesting increase the vigor of the stand and reduce the windthrow hazard. Planting seedlings that have been transplanted once reduces the seedling mortality rate.

Because of ponding, this soil is poorly suited to buildings and generally unsuited to septic tank absorption fields. Surface drains and storm sewers are needed. Subsurface drains also are used to lower the seasonal high water table. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by frost action and ponding. Excavation is limited by the seasonal high water table in winter and spring. Sloughing is a hazard in shallow excavations.

The land capability classification is IIw. The woodland ordination symbol is 2w.

DeA—Del Rey silt loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on slight rises on lake plains. Most areas are irregularly shaped and range from 4 to 40 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 9 inches thick. The subsoil is brown and grayish brown, mottled, firm silty clay loam about 37 inches thick. The substratum to a depth of about 66 inches is grayish brown, mottled, firm silt loam. In a few areas the soil is more sloping. In some areas it contains some gravel throughout. In other areas it contains some gravel in the substratum.

Included with this soil in mapping are small areas of the very poorly drained Lenawee and somewhat poorly drained Fulton and Kibbie soils. Lenawee soils are on flats and in depressions. Fulton soils are in landscape positions similar to those at the Del Rey soil. Kibbie soils are on lake plains, on deltas, and along the edges of the higher beach ridges. Included soils make up about 10 percent of most areas.

Permeability is slow in the Del Rey soil, and the available water capacity is moderate or high. Runoff is slow. A seasonal high water table is at a depth of 12 to 36 inches during extended wet periods. The subsoil is medium acid to neutral in the upper part and slightly acid to moderately alkaline in the lower part. The content of organic matter is moderate. The root zone is moderately deep or deep.

Most of the acreage is cropland. Corn, soybeans, and small grain are the principal crops. Specialty crops are grown in some areas. Drained areas are well suited to crops. Most areas have been drained. The wetness delays planting and limits the choice of crops. Subsurface drains are commonly used to lower the seasonal high water table. The surface layer crusts after hard rains. The crusting hinders seedling emergence. Returning crop residue to the soil, applying a system of conservation tillage that leaves crop residue on the surface, and planting cover crops help to prevent excessive crusting and erosion, improve tilth, and increase the rate of water infiltration. Tilling, harvesting, and grazing when the soil is wet can cause compaction.

This soil is moderately well suited to woodland. The species selected for planting should be those that grow well in a somewhat poorly drained soil that has a fairly high clay content. Planting seedlings that have been transplanted once or mulching reduces the seedling mortality rate. Harvesting techniques that do not leave the remaining trees widely spaced reduce the windthrow hazard.

This soil is moderately well suited to buildings and poorly suited to septic tank absorption fields. Because of the seasonal wetness, it is better suited to buildings without basements than to buildings with basements. Grading building sites and septic tank absorption fields improves surface drainage. Installing drains at the base of footings and coating the exterior basement walls help to keep basements dry. Increasing the size of septic tank absorption fields helps to overcome the restricted permeability. Installing perimeter drains around the absorption fields helps to lower the seasonal high water table. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by frost action and seasonal wetness.

The land capability classification is IIw. The woodland ordination symbol is 3c.

DkA—Dixboro-Kibbie complex, 0 to 2 percent slopes. These deep, nearly level, somewhat poorly drained soils are on broad flats and slight rises on lake plains and deltas. Most areas range from 100 to 200 acres. They are about 65 percent Dixboro sandy loam and 25 percent Kibbie fine sandy loam. The two soils occur as areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the Dixboro soil has a surface layer of very dark grayish brown, friable sandy loam about 9 inches thick. The subsoil is yellowish brown and grayish brown, mottled, friable sandy loam, coarse sandy loam, and fine sandy loam about 29 inches thick. The substratum to a depth of about 60 inches is grayish brown, very friable sandy loam and loose sand. It is commonly mottled. In a few areas the surface layer is gravelly sandy loam.

Typically, the Kibbie soil has a surface layer of very dark grayish brown, friable fine sandy loam about 9 inches thick. The subsoil is yellowish brown, mottled, friable loam and silt loam about 15 inches thick. The substratum to a depth of about 60 inches is grayish brown and gray, mottled, friable, stratified silt loam and fine sandy loam.

Included with these soils in mapping are small areas of Bixler, Colwood, and Tedrow soils. Bixler soils have a surface layer that is lighter colored than that of the Dixboro and Kibbie soils. They are on long, narrow ridges and low knolls. The very poorly drained Colwood soils are in depressions. Tedrow soils have less clay in the subsoil than the Dixboro and Kibbie soils. They are on slight rises. Included soils make up about 10 percent of most areas.

Permeability is moderate in the Dixboro and Kibbie soils. The available water capacity is moderate or high in the Dixboro soil and high in the Kibbie soil. Runoff is slow on both soils. The content of organic matter is moderate. The root zone is deep. The soils can be tilled throughout a wide range of moisture conditions. They have a seasonal high water table at a depth of 12 to 24 inches during extended wet periods. The subsoil of the Dixboro soil is neutral or slightly acid in the upper part and mildly alkaline or moderately alkaline in the lower part. The subsoil of the Kibbie soil is slightly acid or neutral.

Most areas are farmed. These soils are well suited to corn, soybeans, small grain, hay, and specialty crops. The wetness is the main management concern. It delays planting and limits the choice of crops. Subsurface drains are commonly used to lower the seasonal high water table. Soil blowing is a hazard if the vegetative cover is inadequate. Incorporating crop residue or other organic material into the surface layer increases the rate of water infiltration, reduces the hazard of soil blowing, and improves tilth, fertility, and the soil-seed contact.

These soils are well suited to pasture but are poorly suited to grazing early in spring. Surface compaction, retarded plant growth, and a decreased infiltration rate result from overgrazing or grazing during wet periods, when the soil is soft and sticky. Proper stocking rates, selection of suitable species for planting, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

A few areas are used as woodland. These soils are well suited to the trees and shrubs that can withstand some wetness. Removing vines and the less desirable trees and shrubs helps to control plant competition.

These soils are only moderately well suited to buildings and septic tank absorption fields because of the seasonal wetness. They are better suited to houses without basements than to houses with basements. A drainage system is effective in most areas. Grading building sites helps to keep surface water away from the foundations. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. If drains around foundations in the Dixboro soil outlet into a sump, the pump should be large enough to handle a large volume of water. Perimeter drains around septic tank absorption fields help to lower the seasonal high water table. Sloughing is a hazard in shallow excavations, especially when the soils are wet. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by wetness and frost action.

The land capability classification is IIw. The woodland ordination symbol is 2a.

Do—Dumps. This map unit consists mostly of settling basins used by industries for disposal of chemical waste. Individual areas are 15 to 66 acres.

Little or no vegetation grows in these areas. Reclamation is difficult. When the dumps are no longer used as settling basins, they should be filled in with substratum material and then blanketed with topsoil and subsoil material from natural soils.

No land capability classification or woodland ordination symbol is assigned.

DuB—Dunbridge sandy loam, 1 to 4 percent slopes. This nearly level and gently sloping, moderately deep, well drained soil is in irregularly shaped areas on the sides of ridges. Most areas are 10 to 100 acres.

Typically, the surface layer is dark brown and very dark grayish brown, friable sandy loam about 9 inches thick. The subsoil is dark yellowish brown, friable sandy clay loam and clay loam about 21 inches thick. Limestone bedrock is at a depth of about 30 inches. In some areas the surface layer is loam or silt loam.

Included with this soil in mapping are small areas of the deep Belmore and Spinks soils and small areas of the very poorly drained Millsdale soils in depressions. Also included are small areas of Castalia soils. These soils have a higher content of coarse fragments throughout than the Dunbridge soil. They are in landscape positions similar to those of the Dunbridge soil. Included soils make up about 10 percent of most areas.

Permeability is moderately rapid in the Dunbridge soil, and the available water capacity is low. Runoff is slow. This soil is droughty during extended dry periods. The subsoil is slightly acid or neutral in the upper part and neutral or mildly alkaline in the lower part. The content of organic matter is moderate. The root zone is moderately deep.

Most of the acreage of this soil is cropland or pasture. This soil is moderately well suited to small grain, corn, soybeans, hay, and pasture. It is especially well suited to early maturing crops. It warms and dries early in the spring, thus permitting early planting and grazing. Droughtiness is the main management concern. Soil blowing is a hazard. Returning crop residue to the soil, planting cover crops, and applying a system of conservation tillage that leaves crop residue on the surface help to control water erosion and soil blowing, improve tilth, and conserve moisture.

This soil is moderately well suited to woodland. No major hazards or limitations affect planting or harvesting.

This soil is moderately well suited to buildings and poorly suited to septic tank absorption fields. It is better suited to houses without basements than to houses with basements because bedrock is at a depth of 20 to 40 inches. Blasting is sometimes needed in excavations for basements and for underground utilities. Backfilling along foundations with material that has a low shrink-swell potential helps to prevent the structural damage caused by shrinking and swelling.

The effluent in septic tank absorption fields can move through fissures in the bedrock and pollute underground water supplies. A central sewage system should be used, or the absorption field should be installed on elevated mounds in which 4 feet or more of soil with a good filtering capacity covers the bedrock. If the soil is used as a site for local roads and streets, replacing the surface layer and subsoil with good base material helps to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIs. The woodland ordination symbol is 3a.

FuA—Fulton silty clay loam, 0 to 3 percent slopes. This deep, nearly level, somewhat poorly drained soil is on lake plains. It is on slight rises and on slopes along drainageways. Most areas are irregularly shaped and range from 4 to 100 acres.

Typically, the surface layer is dark grayish brown, firm silty clay loam about 12 inches thick. The subsoil is brown and grayish brown, mottled, firm silty clay and clay about 26 inches thick. The substratum to a depth of about 60 inches is light brownish gray, mottled, firm silty clay. In some areas the surface layer is silt loam or loam. In other areas the substratum is silty clay loam.

Included with this soil in mapping are small areas of Del Rey, Lucas, Nappanee, and Toledo soils. Del Rey and Nappanee soils are in landscape positions similar to those of the Fulton soil. Del Rey soils have less clay in the subsoil and substratum than the Fulton soil, and Nappanee soils have a higher content of sand and coarse fragments throughout. The very poorly drained Toledo soils are on flats and in depressions. The moderately well drained Lucas soils are on slope breaks along drainageways. Included soils make up about 5 percent of most areas.

Permeability is slow or very slow in the Fulton soil, and the available water capacity is moderate. The subsoil is slightly acid or neutral in the upper part and neutral to moderately alkaline in the lower part. Runoff is slow. The root zone generally is restricted by the compact, calcareous lacustrine sediments at a moderate depth. A perched seasonal high water table is at a depth of 12 to 30 inches during extended wet periods. The content of organic matter is moderate.

Most of the acreage is cropland. This soil is moderately well suited to corn, soybeans, and small grain. A drainage system is needed. Surface drains are used to lower the seasonal high water table. The soil should be tilled only within a limited range of moisture content because it becomes compacted and cloddy if worked when wet and sticky. The surface layer crusts after a hard rain. The crusting hinders seedling emergence. Cover crops and a system of conservation tillage that leaves crop residue on the surface help to control erosion and improve tilth. Incorporating crop residue or other organic material into the surface layer increases the rate of water infiltration, improves tilth and fertility, helps to prevent excessive crusting, and improves the soil-seed contact.

This soil is moderately well suited to pasture and hay. Surface compaction, a decreased infiltration rate, and retarded plant growth result from overgrazing or grazing during wet periods, when the soil is soft and sticky. Selection of suitable species for planting, pasture rotation, proper stocking rates, timely deferment of grazing, a drainage system, and weed control help to keep the pasture in good condition.

A few areas are used as woodland. This soil is moderately well suited to trees. The species selected for planting should be those that can withstand some seasonal wetness and a high clay content in the subsoil. Planting seedlings that have been transplanted once or mulching reduces the seedling mortality rate. Harvesting techniques that do not leave the remaining trees widely spaced reduce the windthrow hazard.

This soil is poorly suited to buildings and septic tank absorption fields. Because of the seasonal wetness and a high shrink-swell potential, it is better suited to buildings without basements than to buildings with basements. Grading building sites and septic tank absorption fields can improve surface drainage. Coating the exterior of basement walls helps to keep basements dry. Backfilling along foundations with material that has a low shrink-swell material and installing drains at the base of footings help to prevent the structural damage caused by shrinking and swelling and help to keep basements dry. Additional protection against shrinking and swelling can be provided by constructing walls of poured concrete that are reinforced by steel and by pilasters.

Increasing the size of septic tank absorption fields helps to overcome the restricted permeability of this soil. Installing perimeter drains around the absorption fields helps to lower the seasonal high water table. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by a high shrink-swell potential and low strength.

The land capability classification is IIIw. The woodland ordination symbol is 3c.

Ge—Gilford fine sandy loam. This deep, nearly level, very poorly drained soil is on broad flats and in depressions on outwash plains and lake plains. It is subject to ponding. Slope is 0 to 2 percent. Areas range from 10 to 80 acres. Most are irregularly shaped, but some are long and narrow.

Typically, the surface layer is black, friable fine sandy loam about 14 inches thick. The subsoil is gray, grayish brown, and light brownish gray, mottled, friable sandy loam and fine sandy loam about 29 inches thick. The substratum to a depth of about 60 inches is brown and grayish brown, mottled, loose loamy sand.

Included with this soil in mapping are small areas of the somewhat poorly drained Dixboro and Kibbie soils on slight rises. Also included are small areas of Colwood and Granby soils, which are intermingled with areas of the Gilford soil. The subsoil of Colwood soils has more clay than that of the Gilford soil, and the subsoil of Granby soils has less clay. Included soils make up about 15 percent of most areas.

Permeability is moderately rapid in the Gilford soil, and the available water capacity is moderate. Runoff is very slow or ponded. The content of organic matter is moderate. A seasonal high water table is near or above the surface during extended wet periods. The root zone is deep in drained areas.

Most of the acreage is cropland. This soil is well suited to corn, soybeans, and small grain and to some specialty crops. Row crops can be grown year after year if good management is applied. Ponding damages small grain in some years. A drainage system is needed. Subsurface drains are commonly used to lower the seasonal high water table. Soil blowing is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface and by windbreaks.

This soil is well suited to hay and pasture, but it is poorly suited to grazing during wet periods unless it is drained. Grazing when the soil is wet results in surface compaction and damages the plants.

This soil is moderately well suited to trees. The trees selected for planting should be those that can withstand wetness. The use of planting and harvesting equipment is restricted when the soil is wet. The trees should be logged during the drier parts of the year. Removing vines and the less desirable trees and shrubs helps to control plant competition. Planting seedlings that have been transplanted once reduces the seedling mortality rate. The windthrow hazard can be reduced by harvesting techniques that do not leave the remaining trees widely spaced.

Because of ponding, this soil is poorly suited to buildings without basements and generally is unsuited to buildings with basements and to septic tank absorption fields. Grading building sites helps to keep surface water away from the foundation. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. If drains around foundations outlet into a sump, the pump should be large enough to handle an extremely large volume of water. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by ponding and frost action. Suitable fill material can elevate the roads and streets above high ponding levels. Excavation is limited during winter and spring because of ponding and sloughing.

The land capability classification is IIw. The woodland ordination symbol is 4w.

GlB—Glenford silt loam, 2 to 6 percent slopes. This gently sloping, deep, moderately well drained soil is on lake plains and terraces along streams. Most areas are long and narrow or are broad and irregularly shaped. They range from 5 to 30 acres.

Typically, the surface layer is brown, friable silt loam about 9 inches thick. The subsoil is brown and yellowish brown, mottled, friable silty clay loam and silt loam about 32 inches thick. The substratum to a depth of about 60 inches is brown and yellowish brown, mottled, friable silt loam and silty clay loam. In some areas the subsoil has thin layers of very fine sandy loam. In a few areas slopes are more than 6 percent. In a few places the soil is well drained.

Included with this soil in mapping are small areas of the somewhat poorly drained Del Rey and Kibbie soils in the slightly lower landscape positions. Also included are small areas of Colwood and Glynwood soils. The very poorly drained Colwood soils are in depressions. Glynwood soils have a higher content of coarse fragments throughout than the Glenford soil. Also, they are on more undulating topography. Included soils make up about 15 percent of most areas.

Permeability is moderately slow in the Glenford soil. Runoff is medium. A perched seasonal high water table is at a depth of 24 to 42 inches during extended wet periods. The root zone is deep. The available water capacity is moderate or high. The content of organic matter is moderate. The subsoil is medium acid to neutral.

Most of the acreage is cropland. This soil is well suited to corn, soybeans, and small grain. The erosion hazard and surface crusting are the main management concerns. A system of conservation tillage that leaves crop residue on the surface, cover crops, and grassed waterways help to control erosion. Incorporating crop residue or other organic material into the surface layer improves tilth and fertility, increases the rate of water infiltration, helps to prevent excessive crusting, and improves the soil-seed contact. Randomly spaced subsurface drains are needed in areas of the wetter included soils.

This soil is well suited to pasture and hay. Surface compaction, retarded plant growth, poor tilth, and an increased runoff rate result from overgrazing or grazing during wet periods, when the soil is soft and sticky. Proper stocking rates, selection of suitable species for planting, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

A few small areas support native hardwoods. This soil is well suited to trees. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is moderately well suited to buildings and septic tank absorption fields. It is better suited to houses without basements than to houses with basements. Grading building sites helps to keep surface water away from the foundation. Foundation drains and protective exterior coatings on basement walls help to keep basements dry. Backfilling along foundations with material that has a low shrink-swell potential helps to prevent the structural damage caused by shrinking and swelling. The increased runoff and erosion that occur during construction can be controlled by maintaining a plant cover wherever possible.

Increasing the size of septic tank absorption fields helps to overcome the restricted permeability of this soil. Installing perimeter drains around the absorption fields helps to lower the seasonal high water table. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by low strength and frost action.

The land capability classification is IIe. The woodland ordination symbol is 1a.

GwB—Glynwood silt loam, 2 to 6 percent slopes. This gently sloping, deep, moderately well drained soil is on lake plains and till plains. It is on knolls, on ridges, and on side slopes at the head of drainageways. Most areas are long and narrow or irregular in shape. They are 4 to 25 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 9 inches thick. The subsoil is about 27 inches thick. The upper part is dark yellowish brown, mottled, firm clay loam and silty clay, and the lower part is brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is brown, mottled, firm silty clay loam. In places the soil is well drained and has less clay in the subsoil and substratum.

Included with this soil in mapping are small areas of the somewhat poorly drained Bennington, Haskins, and Nappanee soils on the lower parts of slopes; small areas of an eroded soil on the upper parts of slopes; and small areas of the very poorly drained Hoytville soils on the low parts of the landscape. In the eroded soil, the surface layer is silty clay loam or clay loam and tilth is fair. Also included are small areas of Glenford soils. These soils have a lower content of sand and coarse fragments in the subsoil and substratum than the Glynwood soils. They are in landscape positions similar to those of the Glynwood soil. Included soils make up about 15 percent of most areas.

Permeability is slow in the Glynwood soil. The available water capacity and the content of organic matter are moderate. Runoff is medium. The subsoil is medium acid to neutral in the upper part and neutral to moderately alkaline in the lower part. Tilth is good. The root zone is restricted by the compact, calcareous glacial till below a depth of 22 to 40 inches. A perched seasonal high water table is at a depth of 24 to 42 inches during extended wet periods.

Most areas are farmed. This soil is well suited to row crops and small grain. If cultivated crops are grown, erosion is the main hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface, by cover crops, and by grassed waterways. Incorporating crop residue or other organic material into the surface layer improves tilth and fertility, increases the rate of water infiltration, helps to prevent excessive crusting, and improves the soil-seed contact. Randomly spaced subsurface drains are needed in areas of the wetter included soils.

A cover of pasture plants or hay is effective in controlling erosion. Surface compaction, retarded plant growth, poor tilth, and an increased runoff rate result from overgrazing or grazing during wet periods, when the soil is soft and sticky. Proper stocking rates, selection of suitable species for planting, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

A few small areas support native hardwoods. This soil is well suited to trees and shrubs. Removing vines and the less desirable trees and shrubs helps to control plant competition. Planting seedlings that have been transplanted once or mulching reduces the seedling mortality rate. Harvesting techniques that do not leave the remaining trees widely spaced reduce the windthrow hazard.

This soil is only moderately well suited to buildings and is poorly suited to septic tank absorption fields because of the seasonal wetness, the shrink-swell potential, and the slow permeability. If properly designed and installed, a drainage system effectively reduces the wetness and the shrink-swell potential in some areas. The soil is better suited to houses without basements than to houses with basements. Grading building sites helps to keep surface water away from the foundation. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by frost action and low strength. The increased runoff and erosion that occur during construction can be controlled by maintaining a plant cover wherever possible.

Increasing the size of septic tank absorption fields helps to overcome the restricted permeability of this soil. Installing perimeter drains around the absorption fields helps to lower the seasonal high water table.

The land capability classification is IIe. The woodland ordination symbol is 2c.

Gx—Granby loamy sand. This nearly level, deep, very poorly drained soil is on flats and in depressions on lake plains, on toe slopes of beach ridges, and on interbeach ridges. It receives runoff from higher lying adjacent soils and is subject to ponding. Slope is 0 to 2 percent. Most areas are long and narrow or irregular in shape and range from 4 to 20 acres.

Typically, the surface layer is black, very friable loamy sand about 12 inches thick. The subsoil is gray, mottled, very friable loamy sand and sand about 12 inches thick. The substratum to a depth of about 60 inches is gray, mottled, loose sand. In some areas the surface layer is muck about 1 to 5 inches thick. In other areas the substratum is sandy loam.

Included with this soil in mapping are small oval areas of the somewhat poorly drained Tedrow and well drained Spinks soils on slight rises. Also included are small areas of Gilford soils. These soils contain more clay in the subsoil than the Granby soil. Their positions on the landscape are similar to those of the Granby soil. Included soils make up about 15 percent of most areas.

Permeability is rapid in the Granby soil. The root zone is deep in drained areas. The subsoil is slightly acid to mildly alkaline. Runoff is very slow or ponded. A seasonal high water table is near or above the surface during extended wet periods. The available water capacity is low, but the water supply generally is adequate for plant growth even during dry periods. The content of organic matter is high.

Most areas are farmed. This soil is moderately well suited to corn, soybeans, hay, and pasture. The wetness is the major management concern. A surface drainage system is commonly used to remove excess surface water. Subsurface drains are used to lower the water table where adequate outlets are available. They can become filled with fine sand unless some type of filtering material is used. Selecting drains that have a fiber envelope or adding a gravel or crushed stone filter around the drain helps to keep the fine sand from filling the drain. Leaving crop residue on the surface helps to control erosion.

This soil is suited to a variety of pasture plants. Water-tolerant species grow best. Grazing when the soil is wet can damage the plants.

This soil is moderately well suited to woodland. The seasonal wetness limits the use of equipment. The trees should be logged during the drier parts of the year. The trees selected for planting should be those that can withstand wetness. Frequent, light thinning and harvesting increase the vigor of the stand and reduce the windthrow hazard. Removing vines and the less desirable trees and shrubs helps to control plant competition. Planting seedlings that have been transplanted once reduces the seedling mortality rate.

This soil is poorly suited to buildings without basements and generally is unsuited to buildings with basements and to septic tank absorption fields. Excess water can be removed by a drainage system in areas where adequate outlets are available. Grading building sites helps to keep surface water away from the foundation. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. If drains around foundations outlet into a sump, the pump should be large enough to handle an extremely large volume of water. Suitable fill material can elevate local roads and streets above high ponding levels.

The land capability classification is IVw. The woodland ordination symbol is 4w.

HaB—Haskins sandy loam, 1 to 4 percent slopes. This nearly level and gently sloping, deep, somewhat poorly drained soil is on stream terraces, lake plains, and till plains. Most areas are irregular in shape and range from 4 to 30 acres.

Typically, the surface layer is dark grayish brown, friable sandy loam about 9 inches thick. The subsurface layer is grayish brown, mottled, friable sandy loam about 3 inches thick. The subsoil is grayish brown and yellowish brown, mottled, friable and firm sandy clay loam, clay loam, and gravelly clay loam about 6 inches thick. The substratum to a depth of about 60 inches is brown and dark yellowish brown, mottled, firm silty clay loam. In some areas the surface layer is very dark gray. In other areas it is silt loam.

Included with this soil in mapping are small areas of the well drained Belmore soils on knolls and the very poorly drained Hoytville and Mermill soils in drainageways and depressions. Also included are small areas of Bennington soils. These soils contain more clay in the upper and middle parts of the subsoil than the Granby soil. They are in the slightly higher landscape positions. Included soils make up about 10 percent of most areas.

Permeability is moderate in the subsoil of the Haskins soil and slow or very slow in the substratum. Runoff is slow. The available water capacity and the content of organic matter are moderate. The subsoil is strongly acid to neutral. A perched seasonal high water table is at a depth of 12 to 30 inches during extended wet periods.

Most areas are used as cropland. This soil is well suited to corn, soybeans, and small grain. The seasonal wetness and the erosion hazard are the main management concerns. Also, soil blowing is a hazard in areas that do not have an adequate plant cover and in cultivated fields during spring. Most cropped areas are drained by a system of randomly spaced subsurface drains because the landscape is uneven. These drains are more effective if they are installed on or above the slowly permeable or very slowly permeable glacial till or lacustrine material. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material reduces the susceptibility to soil blowing, improves fertility, and increases the rate of water infiltration.

This soil is well suited to grasses and legumes for hay and pasture. The main concerns in managing pasture are overgrazing and grazing during wet periods. Pasture rotation and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to woodland. The species that can withstand some wetness should be selected for planting. Removing vines and the less desirable trees and shrubs helps to control plant competition.

Because of the seasonal wetness and the slow or very slow permeability, this soil is moderately well suited to buildings and poorly suited to septic tank absorption fields. Drainage can be improved by installing surface and subsurface drains. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. Increasing the size of septic tank absorption fields helps to overcome the restricted permeability. Installing perimeter drains around the absorption fields helps to lower the seasonal high water table. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by frost action.

The land capability classification is IIe. The woodland ordination symbol is 2a.

Ht—Hoytville silty clay loam. This nearly level, deep, very poorly drained soil is on broad flats and in depressions on lake plains. It receives runoff from higher lying adjacent soils and is subject to ponding. Slope is 0 to 2 percent. Most areas are irregular in shape. They range from 20 to more than 1,000 acres.

Typically, the surface layer is very dark grayish brown, firm silty clay loam about 8 inches thick. The subsoil is dark grayish brown and grayish brown, mottled, firm clay about 33 inches thick. The substratum to a depth of about 60 inches is grayish brown and gray, mottled, firm clay, silty clay, and silty clay loam. In a few areas the surface layer is silt loam, silty clay, or loam.

Included with this soil in mapping are circular, convex areas and bands of the somewhat poorly drained Nappanee, Haskins, and Kibbie soils. Also included are Mermill and Millsdale soils. Mermill soils contain less clay in the subsoil than the Hoytville soil. They are in drainageways. Millsdale soils are underlain by bedrock at a depth of 20 to 40 inches and are on bedrock-controlled landscapes. Included soils make up about 15 percent of most areas.

Permeability is slow in the Hoytville soil, and the available water capacity is moderate. The content of organic matter is high. Runoff is very slow or ponded. Reaction is slightly acid or neutral in the upper part of the subsoil and neutral or mildly alkaline in the lower part. A seasonal high water table is near or above the surface in extended wet periods. This soil is sticky when wet. It puddles and clods easily.

Most areas are farmed. This soil is well suited to corn, soybeans, and specialty crops. Stands of wheat and oats are poor unless the soil is adequately drained. The wetness is the main limitation. Surface and subsurface drains are commonly needed. The soil should be tilled only within a limited range of moisture content because it becomes compacted and cloddy if worked when wet and sticky. Minimizing tillage, planting cover crops, and incorporating crop residue or other organic material into the surface layer help to maintain tilth and prevent excessive crusting, increase the rate of water infiltration, and improve fertility and the soil-seed contact.

Drained areas of this soil are well suited to pasture and hay, but undrained areas are poorly suited to grazing early in spring. Surface compaction, poor tilth, a decreased infiltration rate and retarded plant growth result from overgrazing or grazing during wet periods, when the soil is soft and sticky. The species that can withstand the wetness should be selected for planting. Proper stocking rates, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

A few small areas support native hardwoods. This soil is well suited to water-tolerant trees and shrubs. The use of logging and planting equipment is limited by wetness. The trees should be logged during the drier parts of the year. Planting seedlings that have been transplanted once reduces the seedling mortality rate. The windthrow hazard can be reduced by harvesting techniques that do not leave the remaining trees widely spaced. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is poorly suited to buildings and generally unsuited to septic tank absorption fields because of the slow permeability, the ponding, and a high shrink-swell potential. A drainage system is needed. Grading building sites helps to keep surface water away from the foundation. The soil is better suited to houses without basements than to houses with basements. Backfilling along foundations with material that has a low shrink-swell potential and installing drains at the base of footings help to prevent the structural damage caused by shrinking and swelling and help to keep basements dry. Protective coatings on the exterior of basement walls also help to keep basements dry.

Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by low strength and frost action. Constructing the roads on raised, well compacted fill material reduces the hazard of ponding.

The land capability classification is IIw. The woodland ordination symbol is 3w.

KbA—Kibbie fine sandy loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on lake plains, on deltas, and along the edges of beach ridges. Most areas are broad and irregular in shape and range from 10 to several hundred acres.

Typically, the surface layer is very dark grayish brown, friable fine sandy loam about 9 inches thick. The subsoil is yellowish brown, mottled, friable silt loam and loam about 15 inches thick. The substratum to a depth of about 60 inches is light brownish gray and grayish brown, mottled, friable silt loam. In some areas the surface layer is dark grayish brown. In other areas coarse fragments are throughout the soil. In a few areas clay loam or silty clay loam glacial till is below a depth of 40 inches. In places the subsoil contains less clay.

Included with this soil in mapping are small areas of Tedrow soils on slight rises, the very poorly drained Colwood and Lenawee soils in depressions, and the moderately well drained Glenford soils along drainageways. Tedrow soils contain less clay in the subsoil than the Kibbie soil. Included soils make up about 10 percent of most areas.

Permeability is moderate in the Kibbie soil, and the available water capacity is high. The content of organic matter is moderate. Runoff is slow. The subsoil is slightly acid or neutral. Tilth is good. A seasonal high water table is at a depth of 12 to 24 inches during extended wet periods.

Most areas are farmed. This soil is well suited to corn, soybeans, wheat, and oats. The wetness is the main limitation. Surface and subsurface drains are commonly needed, but suitable outlets are not readily available in some areas. The soil can be easily tilled throughout a wide range of moisture content. Incorporating crop residue or other organic material into the surface layer increases the rate of water infiltration, improves tilth and fertility, helps to prevent excessive crusting, and improves the soil-seed contact.

This soil is well suited to pasture and hay, but it is poorly suited to grazing early in spring. Surface compaction, poor tilth, retarded plant growth, and a decreased infiltration rate result from overgrazing or grazing during wet periods, when the soil is soft and sticky. Proper stocking rates, selection of suitable species for planting, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

A few areas along streams support native hardwoods. This soil is well suited to the trees and shrubs that can withstand some wetness. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is moderately well suited to buildings without basements and to septic tank absorption fields. A drainage system is effective in most areas. Grading building sites helps to keep surface water away from the foundation. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. Perimeter drains around septic tank absorption fields help to lower the seasonal high water table. Sloughing is a hazard in shallow excavations, especially when the soil is wet. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by wetness and frost action.

The land capability classification is IIw. The woodland ordination symbol is 2a.

Le—Lenawee silty clay loam. This nearly level, deep, very poorly drained soil is on flats and in depressional areas on lake plains. It can be ponded by runoff from higher lying adjacent soils (fig. 6). Slope is 0 to 2 percent. Most areas are broad and irregular in shape and range from 20 to several hundred acres.

Typically, the surface layer is very dark grayish brown, firm silty clay loam about 9 inches thick. The subsoil is grayish brown and gray, mottled, firm silty clay loam and silty clay about 46 inches thick. The substratum to a depth of about 70 inches is gray, mottled, firm silty clay loam. In a few small areas the surface layer is silt loam or silty clay.

Included with this soil in mapping are small areas of Colwood, Toledo, and Del Rey soils. Colwood and Toledo soils are in positions on the landscape similar to those of the Lenawee soil. Colwood soils have less clay in the subsoil than the Lenawee soil, and Toledo soils commonly have more clay in the subsoil. The somewhat poorly drained Del Rey soils are on slight rises. Included soils make up about 15 percent of most areas.

Permeability is moderately slow in the Lenawee soil. The available water capacity and the content of organic matter are high. Runoff is very slow or ponded. Reaction is slightly acid to mildly alkaline in the subsoil. This soil puddles and clods easily. A seasonal high water table is near or above the surface during extended wet periods. The root zone is deep.

Most areas are farmed. If drained, this soil is well suited to corn and soybeans grown year after year. The very poor natural drainage is the main limitation. Unless the soil is adequately drained, stands of wheat and oats are poor in most years. A combination of surface and subsurface drains is commonly needed, but suitable subsurface drainage outlets are not readily available in some areas. The soil should be tilled only within a limited range of moisture content because it becomes compacted and cloddy if worked when wet and sticky. Minimum tillage and cover crops improve tilth. Incorporating crop residue or other organic material into the surface layer increases the rate of water infiltration, improves tilth and fertility, helps to prevent excessive crusting, and improves the soil-seed contact.

This soil is well suited to pasture and hay, but it is poorly suited to grazing early in spring. Surface compaction, poor tilth, retarded plant growth, and a decreased infiltration rate result from overgrazing or grazing during wet periods, when the soil is soft and sticky. Proper stocking rates, selection of suitable species for planting, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

This soil is well suited to water-tolerant trees and shrubs. Removing vines and the less desirable trees and shrubs helps to control plant competition. The trees should be logged during the drier parts of the year. Planting seedlings that have been transplanted once reduces the seedling mortality rate. The windthrow hazard can be reduced by harvesting techniques that do not leave the remaining trees widely spaced.

Because of the moderately slow permeability and the ponding, this soil is poorly suited to buildings and generally unsuited to septic tank absorption fields. It is

Figure 6.—Ponding in an area of Lenawee silty clay loam.

better suited to buildings without basements than to buildings with basements. Surface drains and storm sewers are needed. Grading building sites helps to keep surface water away from the foundation. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by low strength and frost action. Constructing the roads on raised, well compacted fill material reduces the hazard of ponding.

The land capability classification is IIw. The woodland ordination symbol is 2w.

LuB—Lucas silty clay, 2 to 6 percent slopes. This deep, gently sloping, moderately well drained soil is on slope breaks along drainageways on lake plains. Most areas are long and narrow and range from 4 to 50 acres.

Typically, the surface layer is dark grayish brown, firm silty clay about 10 inches thick. The subsoil is brown, mottled, firm silty clay about 18 inches thick. The substratum to a depth of about 60 inches is brown, mottled, firm silty clay and silty clay loam. In some areas the substratum contains less clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Fulton soils along drainageways. These soils make up about 10 percent of most areas.

Permeability is slow or very slow in the Lucas soil, and the available water capacity is moderate. Runoff is medium. The subsoil is slightly acid or neutral in the upper part and neutral to moderately alkaline in the lower part. The content of organic matter is low. A perched seasonal high water table is at a depth of 30 to 48 inches during extended wet periods.

Much of the acreage is cropland. This soil is moderately well suited to corn, soybeans, and small grain. Maintaining tilth and controlling erosion are the main management concerns. A system of conservation tillage that leaves crop residue on the surface, cover crops, and grassed waterways help to control erosion. Including meadow crops in the cropping sequence also helps to control erosion. Incorporating crop residue or other organic material into the surface layer helps to maintain tilth and fertility, increases the rate of water infiltration, and improves the soil-seed contact. The soil should be tilled only within a limited range of moisture content. It becomes compacted and cloddy if worked when wet and sticky.

Some areas are used for pasture. This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing during wet periods, when the soil is soft and sticky, causes surface compaction, retards plant growth, and increases the runoff rate. Proper stocking rates, selection of suitable species for planting, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

Some areas are used as woodland. This soil is moderately well suited to trees. The species selected for planting should be those that can grow well in a soil that has a high clay content in the subsoil. Removing vines and the less desirable trees and shrubs helps to control plant competition. Planting seedlings that have been transplanted once or mulching reduces the seedling mortality rate. The windthrow hazard can be reduced by harvesting techniques that do not leave the remaining trees widely spaced. The trees should be logged and planted during the drier parts of the year.

This soil is moderately well suited to buildings and poorly suited to septic tank absorption fields. Because of the seasonal wetness and a high shrink-swell potential, it is better suited to buildings without basements than to buildings with basements. Grading building sites and septic tank absorption fields can improve surface drainage. Backfilling along foundations with material that has a low shrink-swell potential and installing drains at the base of footings help to prevent the structural damage caused by shrinking and swelling and help to keep basements dry. Protective coatings on the exterior of basement walls also help to keep basements dry.

Increasing the size of septic tank absorption fields helps to overcome the restricted permeability of this soil. Installing perimeter drains around the absorption fields helps to lower the seasonal high water table. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by shrinking and swelling and by low strength.

The land capability classification is IIIe. The woodland ordination symbol is 3c.

MeB—Mentor silt loam, 1 to 4 percent slopes. This deep, nearly level and gently sloping, well drained soil is on lake plains, outwash plains, and terraces along streams. Most areas are long and narrow and range from 15 to 50 acres.

Typically, the surface layer is brown, friable silt loam about 10 inches thick. The subsoil also is brown, friable silt loam. It is about 43 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is dark yellowish brown, mottled, friable, stratified loam and silt loam. In some areas the surface layer is sandy loam or loam. In other areas the subsoil is loam. In places the soil is moderately well drained.

Included with this soil in mapping are small areas of the moderately well drained Glynwood soils in the slightly lower landscape positions, the moderately well drained Saylesville soils on slope breaks, and the very poorly drained Colwood soils in depressions and drainageways. Included soils make up about 15 percent of most areas.

Permeability is moderate in the Mentor soil, and the available water capacity is high. Runoff is medium. Reaction is very strongly acid to medium acid in the upper part of the subsoil and strongly acid to slightly acid in the lower part. The content of organic matter is moderate. A seasonal high water table is at a depth of 48 to 72 inches during extended wet periods.

Most of the acreage is cropland. This soil is well suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is the main hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface, by cover crops, and by grassed waterways. Incorporating crop residue or other organic material into the surface layer improves tilth and fertility, increases the rate of water infiltration, helps to prevent excessive crusting, and improves the soil-seed contact.

This soil is well suited to pasture and hay. Surface compaction, retarded plant growth, and an increased runoff rate result from overgrazing or grazing when the soil is wet. Proper stocking rates, selection of suitable species for planting, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

A few areas support native hardwoods. This soil is well suited to trees. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is well suited to buildings and septic tank absorption fields. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. The increased runoff and erosion that occur during construction can be controlled by maintaining a plant cover wherever possible. Perimeter drains around septic tank absorption fields help to lower the seasonal high water table. Providing suitable base material helps to prevent the damage to local roads and streets caused by low strength.

The land capability classification is IIe. The woodland ordination symbol is 1a.

MeF—Mentor silt loam, 25 to 50 percent slopes. This deep, very steep, well drained soil is on the dissected parts of lake plains and outwash terraces. Most areas are long and narrow and range from 25 to 75 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 4 inches thick. The subsoil is dark brown, brown, and yellowish brown, friable silt loam and silty clay loam about 40 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, friable silt loam. It has thin strata of loam. In some areas, the surface layer is sandy loam or loam and the subsoil is loam. In a few areas the soil is moderately well drained.

Included with this soil in mapping are small areas of the moderately well drained Saylesville and Glynwood soils on the less sloping parts of the landscape. Included soils make up about 15 percent of most areas.

Permeability is moderate in the Mentor soil, and the available water capacity is high. Runoff is very rapid. Reaction is very strongly acid to medium acid in the upper part of the subsoil and strongly acid to slightly acid in the lower part. The content of organic matter is moderately low. A seasonal high water table is at a depth of 48 to 72 inches during extended wet periods.

This soil is generally unsuited to cropland and pasture because of the very steep slope and a severe hazard of erosion.

Most areas are used as woodland. This soil is well suited to woodland and to habitat for woodland wildlife. The slope severely limits the use of planting and logging equipment. Laying out logging roads and skid trails across the slope facilitates the use of equipment. The roads and trails should be protected against erosion by water bars or other measures. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is generally unsuitable as a site for buildings and septic tank absorption fields because of the very steep slope. Erosion is a severe hazard unless a ground cover is maintained. Hillside slippage is a hazard in areas of the wetter included soils and in areas that have been cut and filled.

The land capability classification is VIIe. The woodland ordination symbol is 1r.

Mo—Mermill loam. This nearly level, deep, very poorly drained soil is on flats and in depressions on lake plains, outwash plains, terraces, and till plains. The lower parts of the depressions can be ponded by runoff from higher lying adjacent soils. Slope is 0 to 2 percent. Most areas are 10 to 100 acres. Some, however, are more than 100 acres.

Typically, the surface layer is very dark gray, friable loam about 9 inches thick. The subsoil is about 39 inches thick. The upper part is gray and grayish brown, mottled, friable sandy clay loam, and the lower part is grayish brown and yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is grayish brown, mottled, firm silty clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Haskins soils on slight rises and Hoytville and Lenawee soils in the lower parts of depressions. Also included are small areas of Millsdale soils, which are underlain by limestone or dolomite bedrock at a depth of 20 to 40 inches. Included soils make up about 15 percent of most areas.

Permeability is moderate in the upper part of the subsoil in the Mermill soil and slow or very slow in the lower part of the subsoil and in the substratum. The content of organic matter is high. The available water capacity is moderate. Runoff is very slow or ponded. The subsoil is medium acid to neutral in the upper part and neutral to moderately alkaline in the lower part. A perched seasonal high water table is near or above the surface during extended wet periods. The root zone generally is moderately deep over compact glacial till or lacustrine material.

Most areas are farmed. Drained areas of this soil are well suited to row crops and small grain grown year after year. Stands of wheat and oats are poor unless the soil is adequately drained. The wetness is the main limitation. Surface drains are commonly used. Subsurface drains are needed to lower the seasonal high water table, but suitable outlets are not readily available in some areas. The drains are more effective if they are installed on or above the slowly permeable or very slowly permeable glacial till or lacustrine material. A system of conservation tillage that leaves crop residue on the surface and cover crops are needed, especially if the soil is row cropped year after year. Incorporating crop residue or other organic material into the surface layer increases the rate of water infiltration, helps to prevent excessive crusting, and improves tilth and the soil-seed contact.

This soil is poorly suited to grazing early in spring. Even in drained areas, controlled grazing is needed. The surface layer compacts easily if the pasture is grazed during wet periods, when the soil is soft and sticky.

Scattered small areas support native hardwoods. This soil is well suited to water-tolerant trees. Seedlings survive and grow well if competing vegetation is controlled or removed. Removing vines and the less desirable trees and shrubs helps to control plant competition. Wetness limits the use of planting and harvesting equipment in winter and spring. The trees should be logged during the drier parts of the year. Frequent, light thinning and harvesting increase the vigor of the stand and reduce the windthrow hazard. Planting seedlings that have been transplanted once reduces the seedling mortality rate.

Because of the slow or very slow permeability and the ponding, this soil is poorly suited to buildings and generally unsuited to septic tank absorption fields. Surface drains, subsurface drains, and storm sewers are needed. The soil is better suited to buildings without basements than to buildings with basements. Grading building sites helps to keep surface water away from the foundation. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by frost action. The roads and streets should be elevated above normal ponding levels. Excavation is limited in winter and spring because of wetness.

The land capability classification is IIw. The woodland ordination symbol is 2w.

Mp—Mermill Variant sandy loam. This nearly level, deep, very poorly drained soil is on broad flats and in depressions on lake plains. It receives runoff from higher lying adjacent soils and is subject to ponding. Slope is 0 to 2 percent. Most areas are irregular in shape and range from 50 to several hundred acres.

Typically, the surface layer is black, friable sandy loam about 12 inches thick. The subsoil is dark grayish brown, mottled, firm silty clay loam about 17 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled, firm silty clay loam.

Included with this soil in mapping are circular, convex areas and bands of the somewhat poorly drained Haskins and Rimer soils on slight rises and small areas of Hoytville and Mermill soils in the slightly higher landscape positions. Hoytville soils contain more clay in the subsoil than the Mermill Variant soil. Mermill soils have a layer of glacial outwash that is 20 to 40 inches deep over glacial till or lacustrine material. Included soils make up about 10 percent of most areas.

Permeability is slow in the Mermill Variant soil, and the available water capacity is moderate. Runoff is very slow or ponded. The content of organic matter is high. The subsoil is moderately alkaline. The root zone is mainly shallow or moderately deep. It is restricted by the compact glacial till. A seasonal high water table is near or above the surface during extended wet periods.

Most areas are farmed. This soil is moderately well suited to corn, soybeans, and small grain. Wetness, soil blowing, and alkalinity are the main management concerns. Soil blowing is especially a hazard in areas that do not have an adequate plant cover and in cultivated areas during spring. Surface drains are commonly used to remove excess surface water. Subsurface drains are used to lower the seasonal high water table, but suitable outlets are not readily available in some areas. A system of conservation tillage that leaves crop residue on the surface and cover crops are needed, especially if the soil is used for row crops year after year. Incorporating crop residue or other organic material into the surface layer increases the rate of water infiltration, reduces the hazard of soil blowing, and improves the soil-seed contact. Because of the alkalinity, some applied plant nutrients are unavailable to plants. Acid-base fertilizers should be applied.

Undrained areas of this soil are poorly suited to grazing early in spring. Surface compaction, poor tilth, a decreased infiltration rate, and retarded plant growth result from overgrazing or grazing during wet periods, when the soil is soft. Proper stocking rates, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

This soil is moderately well suited to water-tolerant trees and shrubs. The seedlings that can withstand wetness and an alkaline subsoil should be selected for planting. Removing vines and the less desirable trees and shrubs helps to control plant competition. Wetness limits the use of equipment. The trees should be logged during the drier parts of the year. Frequent, light thinning and harvesting increase the vigor of the stand and reduce the windthrow hazard. Planting seedlings that have been transplanted once reduces the seedling mortality rate.

Because of the ponding and the slow permeability, this soil is poorly suited to buildings and generally unsuited to septic tank absorption fields. It is better suited to houses without basements than to houses with basements. Surface drains, subsurface drains, and storm sewers are needed. Grading building sites helps to keep surface water away from the foundation. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by low strength, ponding, and frost action. Well compacted fill material can elevate the roads and streets above normal ponding levels.

The land capability classification is IIIw. The woodland ordination symbol is 3w.

Ms—Millsdale silty clay loam. This nearly level, moderately deep, very poorly drained soil is on flats and in depressions on lake plains. It receives runoff from higher lying adjacent soils and is subject to ponding. Slope is 0 to 2 percent. Most areas are irregular in shape and range from 10 to less than 100 acres.

Typically, the surface layer is very dark gray, firm silty clay loam about 10 inches thick. The subsurface layer is very dark grayish brown, mottled, firm silty clay loam about 3 inches thick. The subsoil is dark gray and grayish brown, mottled, firm silty clay about 11 inches thick. Dolomite bedrock is at a depth of about 24 inches.

Included with this soil in mapping are small areas of the deep Hoytville and Lenawee soils, the well drained

Dunbridge soils on slight rises and knolls, and soils that have bedrock within a depth of 20 inches. Included soils make up about 15 percent of most areas.

Permeability is moderately slow in the Millsdale soil, and the available water capacity is low. The content of organic matter is high. Runoff is very slow or ponded. Reaction is neutral or slightly acid in the upper part of the subsoil and neutral to moderately alkaline in the lower part. Tilth is fair. The root zone is moderately deep. A seasonal high water table is near or above the surface during extended wet periods.

Many areas are farmed. If drained, this soil is moderately well suited to corn and soybeans. Stands of wheat and oats are poor unless the soil is adequately drained. The wetness and the moderately deep root zone are the main limitations. Surface drains are commonly needed. Subsurface drains are also used, but the bedrock interferes with installation. The soil should be tilled only within a limited range of moisture content because it becomes compact and cloddy if worked when wet and sticky. Applying a system of conservation tillage that leaves crop residue on the surface, planting cover crops, and incorporating crop residue or other organic material into the surface layer help to maintain tilth, increase the rate of water infiltration, and improve fertility.

This soil is moderately well suited to pasture and hay, but it is poorly suited to grazing early in spring. Surface compaction, poor tilth, a decreased infiltration rate, and retarded plant growth result from overgrazing or grazing during wet periods, when the soil is soft and sticky. The soil is best suited to the hay and pasture plants that can withstand the wetness.

A few small areas support native hardwoods. The soil is well suited to water-tolerant trees and shrubs. Wetness limits the use of planting and harvesting equipment. The trees should be logged during the drier parts of the year. Seedlings grow well if competing vegetation is controlled or removed by good site preparation or by spraying, girdling, or mowing. Planting seedlings that have been transplanted once reduces the seedling mortality rate. The windthrow hazard can be reduced by harvesting techniques that do not leave the remaining trees widely spaced.

Because of the moderately slow permeability, the moderate depth to bedrock, the ponding, and a high shrink-swell potential, this soil is poorly suited to buildings and generally unsuited to septic tank absorption fields. It is better suited to buildings without basements than to buildings with basements. Backfilling along foundations with material that has a low shrink-swell potential helps to prevent the structural damage caused by shrinking and swelling. A drainage system is needed. Grading building sites helps to keep surface water away from the foundation. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by frost action and low strength. The roads should be elevated above normal ponding levels.

The land capability classification is IIIw. The woodland ordination symbol is 2w.

NpA—Nappanee silt loam, 0 to 3 percent slopes. This nearly level, deep, somewhat poorly drained soil is on lake plains. It is on slight rises and low slope breaks along drainageways. Most areas are irregular in shape and range from 4 to 100 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 6 inches thick. The subsoil is yellowish brown and dark yellowish brown, mottled, firm clay and clay loam about 24 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown, mottled, firm silty clay loam.

Included with this soil in mapping are small areas of the very poorly drained Hoytville soils in depressions. Also included are small areas of the moderately well drained Glynwood soils on knolls, ridges, and side slopes along drainageways and areas of Haskins soils near beach ridges. Haskins soils have less clay in the subsoil than the Nappanee soil. Included soils make up about 15 percent of most areas.

Permeability is slow in the Nappanee soil, and the available water capacity is moderate. The content of organic matter also is moderate. Runoff is slow. The upper part of the subsoil is slightly acid or neutral, and the lower part is neutral or mildly alkaline. The soil crusts and puddles after heavy rains. A perched seasonal high water table is at a depth of 12 to 24 inches during extended wet periods. The root zone mainly is moderately deep over compact glacial till.

Most areas are farmed. If drained, this soil is well suited to corn, soybeans, and small grain. The seasonal wetness is the main limitation. It delays planting and limits the choice of crops. Surface drains are commonly needed. Subsurface drains are used to lower the seasonal high water table, but the movement of water into these drains is slow. Minimizing tillage and incorporating crop residue or other organic material into the surface layer improve tilth and fertility, help to prevent excessive crusting, and increase the rate of water infiltration. The soil can be worked only within a narrow range of moisture content. Surface compaction occurs if the soil is tilled or crops are harvested during wet periods, when the soil is soft and sticky.

This soil is well suited to pasture and hay, but it is poorly suited to grazing early in spring. Surface compaction, poor tilth, a decreased infiltration rate, and retarded plant growth result from overgrazing or grazing during wet periods, when the soil is soft and sticky. The species that can withstand the wetness should be selected for planting. Proper stocking rates, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

A few areas support native hardwoods. This soil is moderately well suited to the trees and shrubs that can withstand some wetness and a clayey subsoil. Removing vines and the less desirable trees and shrubs helps to control plant competition. Planting seedlings that have been transplanted once or mulching reduces the seedling mortality rate. The windthrow hazard can be reduced by harvesting techniques that do not leave the remaining trees widely spaced.

This soil is poorly suited to buildings and septic tank absorption fields. Because of the seasonal wetness, it is better suited to buildings without basements than to buildings with basements. Grading building sites helps to keep surface water away from the foundation. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. Installing these drains and backfilling along basement walls with material that has a low shrink-swell potential help to prevent the structural damage caused by shrinking and swelling. Additional protection against shrinking and swelling can be provided by constructing walls of poured concrete that are reinforced by steel and by pilasters.

Perimeter drains around septic tank absorption fields help to lower the seasonal high water table in this soil. Enlarging the absorption field helps to overcome the restricted permeability. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by seasonal wetness, low strength, frost action, and shrinking and swelling.

The land capability classification is IIIw. The woodland ordination symbol is 3c.

Pe—Pewamo silty clay loam. This deep, nearly level, very poorly drained soil is in shallow depressions and drainageways on till plains. The lower parts of the depressions can be ponded by runoff from higher lying adjacent soils. Most areas are irregular in shape and range from 5 to 100 acres. Slope is 0 to 2 percent.

Typically, the surface layer is black, friable silty clay loam about 11 inches thick. The subsoil is dark gray, gray, and yellowish brown, mottled, firm silty clay loam about 39 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, firm silty clay loam.

Included with this soil in mapping are small areas of Mermill soils and small areas of the somewhat poorly drained Blount soils on slight rises. Mermill soils contain less clay in the subsoil than the Pewamo soil. Their landscape positions are similar to those of the Pewamo soil. Included soils make up about 10 percent of most areas.

Permeability is moderately slow in the Pewamo soil. Runoff is very slow or ponded. The root zone is influenced by the water table. It is deep in drained areas. The available water capacity is high. The content of organic matter also is high. The subsoil is slightly acid to mildly alkaline. A seasonal high water table is near or above the surface during extended wet periods. The soil puddles and clods easily.

Most areas are farmed. If drained, this soil is well suited to corn, soybeans, wheat, and oats. In inadequately drained areas, however, stands of wheat and oats are poor in most years. The seasonal wetness is the main limitation. A combination of surface and subsurface drains is commonly needed. The soil should be tilled only within a limited range of moisture content because it becomes compacted and cloddy if worked when wet and sticky. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent excessive cloddiness, and increases the infiltration rate.

Drained areas of this soil are well suited to pasture and hay. Overgrazing and grazing during wet periods, when the soil is soft and sticky, are the principal concerns in managing pasture. The surface layer compacts easily if the pasture is grazed when the soil is wet. Proper stocking rates, pasture rotation, and deferment of grazing during wet periods help to keep the pasture in good condition.

Scattered small areas support native hardwoods. This soil is well suited to trees. Water-tolerant trees should be selected for planting. Removing vines and the less desirable trees and shrubs helps to control plant competition. Wetness limits the use of planting and harvesting equipment during winter and spring. The trees should be logged during the drier parts of the year. Planting seedlings that have been transplanted once reduces the seedling mortality rate. The windthrow hazard can be reduced by harvesting techniques that do not leave the remaining trees widely spaced.

Because of the ponding and the moderately slow permeability, this soil is poorly suited to buildings and generally unsuited to septic tank absorption fields. It is better suited to houses without basements than to houses with basements. Grading building sites helps to keep surface water away from the foundation. Backfilling along foundations with material that has a low shrink-swell potential and installing drains at the base of footings help to prevent the structural damage caused by shrinking and swelling and help to keep basements dry. Protective coatings on the exterior of basement walls also help to keep basements dry. Surface drains and storm sewers are needed. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by low strength, ponding, and frost action.

The land capability classification is IIw. The woodland ordination symbol is 2w.

Pq—Pits, quarry. This map unit consists of surface-mined areas from which limestone or dolomite bedrock has been removed for use in construction. The remaining bedrock generally is close to the surface. Typically, the quarries are adjacent to Castalia, Millsdale, and Dunbridge soils. Most range from 4 to more than 400 acres. They generally have a high wall on one or more sides.

The material that remains after mining is poorly suited to plants. Most inactive quarries hold water and are used for fishing, swimming, and other water sports.

No land capability classification or woodland ordination symbol is assigned.

RoB—Rimer loamy fine sand, 1 to 4 percent slopes. This nearly level and gently sloping, deep, somewhat poorly drained soil is on low beach ridges and along the edges of the higher beach ridges. Most areas are long and narrow or are irregular in shape. They range from 4 to 60 acres.

Typically, the surface layer is very dark grayish brown, friable loamy fine sand about 8 inches thick. The subsurface layer is brown, dark grayish brown, and yellowish brown, mottled, very friable loamy sand about 19 inches thick. The subsoil is about 10 inches of brown, mottled, friable sandy loam and firm silty clay loam. The substratum to a depth of about 60 inches is brown, mottled, firm silty clay loam. In some areas the moderately fine textured or fine textured material is at a greater depth.

Included with this soil in mapping are small areas of Dixboro and Tedrow soils on lake plains and deltas, the moderately well drained Seward soils on low knolls, and the very poorly drained Mermill soils in depressions and along drainageways. Dixboro and Tedrow soils contain less clay in the lower part than the Rimer soil. Included soils make up about 15 percent of most areas.

Permeability is rapid in the upper part of the subsoil in the Rimer soil and slow or very slow in the lower part and in the substratum. The available water capacity is moderate. The content of organic matter is moderately low. Runoff is slow. Reaction is neutral to strongly acid in the upper part of the subsoil and slightly acid to mildly alkaline in the lower part. The surface layer can be worked throughout a wide range of moisture content. A perched seasonal high water table is at a depth of 12 to 30 inches during extended wet periods. The root zone generally is moderately deep to compact lakebed sediment.

Most areas are farmed. This soil is well suited to corn, soybeans, wheat, and oats. It can be used for row crops year after year if good management is applied.

The hazards of erosion and soil blowing and the wetness are the main management concerns in cultivated areas. Also, the soil is droughty during extended dry periods. It is suited to irrigation. A system of conservation tillage that leaves crop residue on the surface, cover crops, and applications of barnyard manure increase the organic matter content, conserve moisture, and reduce the susceptibility to erosion and soil blowing. Subsurface drains are commonly used to lower the seasonal high water table. They are more effective if they are installed on or above the slowly permeable or very slowly permeable lakebed sediment in the lower part of the subsoil. The drains can become filled with fine sand unless some type of filtering material is used. Selecting drains that have a fiber envelope or adding a gravel or crushed stone filter around the drain helps to keep the fine sand from filling the drain.

This soil is well suited to pasture and hay. Undrained areas are poorly suited to grazing early in spring. Retarded plant growth can result from overgrazing or grazing during wet periods, when the soil is soft. Proper stocking rates, selection of suitable species for planting, pasture rotation, timely deferment of grazing, and weed control help to keep the pasture in good condition.

This soil is well suited to the trees that can withstand seasonal droughtiness as well as seasonal wetness. Removing vines and the less desirable trees and shrubs helps to control plant competition. Planting seedlings that have been transplanted once or mulching reduces the seedling mortality rate.

Because of the slow or very slow permeability, the seasonal wetness, and a high shrink-swell potential in the lower part of the profile, this soil is moderately well suited to buildings and poorly suited to septic tank absorption fields. Drainage ditches and subsurface drains help to lower the seasonal high water table. Grading building sites and septic tank absorption fields can improve surface drainage. The soil is better suited to houses without basements than to houses with basements. Backfilling along foundations with material that has a low shrink-swell potential and installing drains at the base of footings help to prevent the structural damage caused by shrinking and swelling and help to keep basements dry. Protective coatings on the exterior of basement walls also help to keep basements dry.

Subsurface drains around septic tank absorption fields help to lower the seasonal high water table in this soil. Installing the distribution lines close to the surface or in suitable fill material helps to overcome the restricted permeability. Some type of filtering material should be used around subsurface drains to keep fine sand from moving into the drains. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by wetness and frost action. Sloughing is a hazard in shallow excavations, especially if the soil is wet.

The land capability classification is IIe. The woodland ordination symbol is 2s.

Rs—Rossburg silt loam, occasionally flooded. This nearly level, deep, well drained soil is on flood plains and low stream terraces. It is commonly on the highest part of the flood plain and is occasionally flooded. Most areas are 10 to 100 acres. Slope is 0 to 2 percent.

Typically, the surface layer is very dark grayish brown, friable silt loam about 9 inches thick. The subsurface layer is dark brown, friable silt loam about 12 inches thick. The subsoil is brown, dark yellowish brown, and yellowish brown, friable loam and fine sandy loam about 28 inches thick. It is mottled in the middle part. The substratum to a depth of about 60 inches is dark yellowish brown, friable fine sandy loam. In some areas the surface layer is lighter colored. In other areas the dark surface soil is more than 24 inches thick. In a few areas the surface layer is sandy loam or fine sandy loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Shoals soils in narrow channels and in depressions. Also included are very poorly drained soils in old meander channels and a few small areas where bedrock is at a depth of 30 to 40 inches. Included soils make up about 10 percent of most areas.

Permeability is moderate in the subsoil of the Rossburg soil and moderately rapid or rapid in the substratum. The available water capacity and the content of organic matter are high. Runoff is slow. The subsoil is neutral. Tilth is good. This soil can be worked throughout a wide range of moisture content. It has a deep root zone.

Most areas are farmed. This soil is well suited to row crops grown year after year and to hay and pasture. In most years row crops can be planted and harvested during periods when the soil is not subject to flooding. Winter grain can be damaged by floodwater. Dikes help to control flooding. Applying a system of conservation tillage that leaves crop residue on the surface, incorporating crop residue into the surface layer, and planting cover crops help to maintain tilth and prevent excessive crusting. They also help to protect the surface layer in areas that are subject to scouring during floods.

This soil is well suited to trees and other plants that provide food and cover for wildlife. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is generally unsuitable as a site for buildings and septic tank absorption fields because of the flooding hazard. On sites for roads, bridges, and recreational facilities, special design is needed to prevent flood damage. Elevating the structure above the known high water level helps to prevent this damage. Fill material on sites for roads should not block the flow of floodwater. Levees are used to protect the soil in a few areas, but they tend to increase the water level on unprotected land nearby.

The land capability classification is IIw. The woodland ordination symbol is 1a.

Sa—Sandusky gravelly coarse sandy loam. This nearly level, deep, very poorly drained soil is on flats on lake plains. It is near seeps of water that has a high content of calcium carbonate. Slope is 0 to 2 percent. Most areas are irregular in shape and range from 100 to 350 acres.

Typically, the surface layer is very dark gray, very friable gravelly coarse sandy loam about 9 inches thick. The upper part of the substratum is light brownish gray and very pale brown, mottled, very friable gravelly coarse sandy loam and fine sandy loam. The next part is pale brown, very friable gravelly coarse sandy loam. The lower part to a depth of about 65 inches is light gray and gray, mottled, very friable loam and firm silty clay loam and silt loam. In some areas lacustrine sediments are below a depth of 40 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Fulton and Rimer soils on slight rises. Also included are small areas of Toledo soils. These soils have more clay throughout than the Sandusky soil. They are near the edge of the mapped areas. Included soils make up about 15 percent of most areas.

Permeability is moderate or moderately rapid in the upper part of the Sandusky soil and slow in the lower part. Available water capacity is moderate. The content of organic matter is very high. The substratum is moderately alkaline. Runoff is very slow. A seasonal high water table is near the surface during extended wet periods.

Most areas are farmed. This soil is well suited to corn and soybeans. Wetness and alkalinity are the main limitations. Open ditches are used to remove excess water. In areas where adequate outlets are available, subsurface drains are used to lower the seasonal high water table. They are more effective if they are installed on or above the slowly permeable lacustrine material. Tufa fragments interfere with cultivation. Because of the alkalinity, some applied plant nutrients are unavailable to plants. Acid-base fertilizers should be applied. Water-tolerant grasses should be selected for hay and pasture. Overgrazing or grazing during wet periods damages the plants and compacts the soil.

Many areas are used for wetland wildlife habitat. Some are wooded. This soil is poorly suited to woodland and well suited to habitat for wetland wildlife. The species that can withstand the prolonged wetness and the alkalinity should be selected for planting. The use of harvesting equipment is limited by wetness. The trees should be logged during the drier parts of the year. Installing a drainage system and planting seedlings that have been transplanted once reduce the seedling mortality rate. The windthrow hazard can be reduced by harvesting techniques that do not leave the remaining trees widely spaced. Removing vines and the less desirable trees and shrubs helps to control plant competition. The soil is well suited to shallow water impoundments.

Because of the seasonal wetness and the slow permeability in the lower part of the profile, this soil is generally unsuitable as a site for buildings and septic tank absorption fields. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by wetness and frost action.

The land capability classification is IIIw. The woodland ordination symbol is 4w.

SbC2—Saylesville silty clay loam, 6 to 12 percent slopes, eroded. This deep, sloping, moderately well drained soil is on slope breaks along drainageways on lake plains. Erosion has removed part of the original surface layer. The remaining surface layer is a mixture of the original surface layer and subsoil material. Most areas are long and narrow and range from 5 to 20 acres.

Typically, the surface layer is brown, firm silty clay loam about 9 inches thick. The subsoil is about 30 inches thick. The upper part is brown, mottled, firm silty clay, and the lower part is yellowish brown, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, friable silt loam. In some areas the surface layer is silty clay or loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Del Rey and Fulton soils on the less sloping parts of the landscape. Also included are small areas of the well drained Mentor soils on the less sloping as well as the steeper parts of the landscape. Included soils make up about 10 percent of most areas.

Permeability is moderately slow in the Saylesville soil, and the available water capacity is moderate or high. Runoff is rapid. The subsoil is neutral or mildly alkaline. The content of organic matter is moderately low. A seasonal high water table is at a depth of 36 to 72 inches during extended wet periods.

Much of the acreage is cropland. This soil is moderately well suited to corn, soybeans, small grain, hay, and pasture. Improving tilth and controlling erosion are the main management concerns. Applying a system of conservation tillage that leaves crop residue on the surface, planting cover crops, and returning crop residue to the soil help to prevent excessive erosion, improve tilth, and increase the rate of water infiltration. Grassed waterways are used in areas where runoff concentrates. Tilling, harvesting, or grazing when the soil is wet causes surface compaction and cloddiness.

A few areas support native hardwoods. This soil is well suited to woodland. Removing vines and the less desirable trees and shrubs helps to control plant competition.

Because of the slope, the seasonal wetness, a moderate shrink-swell potential, and the moderately slow permeability, this soil is moderately well suited to buildings and poorly suited to septic tank absorption fields. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. Buildings should be designed so that they conform to the natural slope of the land. Backfilling along foundations with material that has a low shrink-swell potential helps to prevent the structural damage caused by shrinking and swelling.

Perimeter drains around septic tank absorption fields help to lower the seasonal high water table in this soil. Installing the distribution lines on the contour helps to prevent excessive seepage of effluent to the surface. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by low strength and frost action. The increased runoff and erosion that occur during construction can be controlled by maintaining a protective plant cover wherever possible.

The land capability classification is IIIe. The woodland ordination symbol is 2a.

SeB—Seward loamy fine sand, 2 to 6 percent slopes. This gently sloping, deep, moderately well drained soil is on beach ridges and outwash plains. Most areas are long and narrow and range from 4 to 30 acres.

Typically, the surface layer is brown, very friable loamy fine sand about 9 inches thick. The subsurface layer is brownish yellow and light yellowish brown, very friable loamy fine sand about 17 inches thick. It is mottled in the lower part. The subsoil is yellowish brown, mottled, friable sandy loam about 9 inches thick. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled, firm silty clay loam. In some areas it is silt loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Rimer and Haskins soils in slight depressions and the well drained Spinks soils on the higher crests. Included soils make up about 15 percent of most areas.

Permeability is rapid in the upper part of the Seward soil and slow or very slow in the substratum. The available water capacity is low. The content of organic matter is moderately low. Runoff is slow in cultivated areas. The subsoil is strongly acid to neutral. The surface layer can be worked throughout a wide range of moisture content. The root zone generally is moderately deep over compact glacial till or lacustrine sediments. A perched seasonal high water table is at a depth of 36 to 72 inches during extended wet periods.

Most areas are farmed. This soil is well suited to corn, soybeans, wheat, and oats. Droughtiness, soil blowing, and erosion are the main management concerns. Soil blowing is especially a hazard in areas that do not have an adequate plant cover and in cultivated areas during spring. Maintaining fertility and the content of organic matter is difficult. This soil is suited to irrigation. A system of conservation tillage that leaves crop residue on the surface, cover crops, and grassed waterways help to control erosion. Incorporating crop residue or other organic material into the surface layer increases the rate of water infiltration and conserves moisture.

A cover of hay or pasture plants helps to control erosion and soil blowing. Deep-rooted grasses and legumes should be selected for planting. No-till seeding reduces the susceptibility to soil blowing and erosion.

This soil is well suited to trees. Drought-tolerant species should be selected for planting. Seedlings are difficult to establish during the drier parts of the year. They should be planted early in spring. Planting seedlings that have been transplanted once or mulching reduces the seedling mortality rate. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is moderately well suited to buildings and septic tank absorption fields. The seasonal wetness, the slow or very slow permeability, and a high shrink-swell potential in the substratum are limitations. Maintaining as much vegetation as possible on the site during construction helps to control soil blowing and erosion. Grading building sites helps to keep surface water away from the foundation. The soil is better suited to buildings without basements than to buildings with basements. Backfilling along foundations with material that has a low shrink-swell potential and installing drains at the base of footings help to prevent the structural damage caused by shrinking and swelling and help to keep basements dry. Lawns seeded during dry periods should be mulched and watered.

Subsurface drains around septic tank absorption fields help to lower the seasonal high water table in this soil. Installing the distribution lines close to the surface or in suitable fill material helps to overcome the restricted permeability. Some type of filtering material should be used around subsurface drains to keep fine sand from moving into the drains. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by frost action. Sloughing is a hazard in shallow excavations.

The land capability classification is IIe. The woodland ordination symbol is 2s.

Sh—Shoals silt loam, frequently flooded. This nearly level, deep, somewhat poorly drained soil occurs as narrow strips in high-water channels on wide flood plains. It commonly makes up the entire flood plain along small streams. It is frequently flooded for brief periods in fall, winter, and spring. Slope is 0 to 2 percent. Most areas range from 10 to 100 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 11 inches thick. The subsoil is dark grayish brown and brown, mottled, friable silt loam about 37 inches thick. The substratum to a depth of about 60 inches is grayish brown and brown, mottled, friable loam, fine sandy loam, and sandy loam. In some areas it has a higher content of coarse fragments. In a few areas bedrock is at a depth of 30 to 40 inches.

Included with this soil in mapping are small areas of the well drained Rossburg soils on the higher part of the flood plains. Also included are very poorly drained soils in depressions. Included soils make up about 10 percent of most areas.

Permeability is moderate in the Shoals soil, and the available water capacity is high. The content of organic matter is moderate. Runoff is very slow. The substratum is slightly acid to mildly alkaline. A seasonal high water table is at a depth of 6 to 18 inches during extended wet periods. The root zone is deep.

Most areas are used as cropland or pasture. The flooding and the wetness delay planting in most years and limit the choice of crops. This soil is well suited to row crops that can be planted after the major threat of flooding. Unless it is controlled, the flooding severely damages winter grain. Subsurface drains are commonly used, but outlets are not readily available in some areas. Applying a system of conservation tillage that leaves crop residue on the surface, incorporating crop residue into the surface layer, and planting cover crops help to maintain tilth and prevent excessive crusting. They also help to protect the surface layer in areas that are subject to scouring during floods.

This soil is moderately well suited to pasture. Maintaining tilth and desirable forage stands is difficult unless the soil is drained and grazing is controlled. Overgrazing or grazing during wet periods, when the soil is soft and sticky, causes surface compaction and poor tilth. Pasture rotation and deferment of grazing during wet periods help to keep the pasture in good condition.

A few areas are wooded. This soil is well suited to trees and other plants that provide food and cover for wildlife. The species that can withstand some wetness should be selected for reforestation. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is generally unsuitable as a site for buildings and septic tank absorption fields because of the flooding hazard and the wetness. Constructing local roads and streets on raised, well compacted fill material, providing suitable base material, and installing a drainage system help to prevent the damage caused by flooding, wetness, and frost action. Fill material on sites for roads should not block the flow of floodwater.

The land capability classification is IIw. The woodland ordination symbol is 2a.

SoB—Spinks fine sand, 2 to 6 percent slopes. This gently sloping, deep, well drained soil is on former beach ridges and offshore bars. Most areas are long and narrow and range from 3 to 100 acres.

Typically, the surface layer is dark grayish brown, very friable fine sand about 4 inches thick. The subsurface layer is yellowish brown and brownish yellow, very friable loamy fine sand about 16 inches thick. The next layer is yellowish brown, loose fine sand and sand about 40 inches thick. It has thin bands of dark brown loamy sand. In some areas the subsoil contains gravel.

Included with this soil in mapping are small areas of Belmore, Dunbridge, Granby, Seward, and Tedrow soils. Belmore soils have more gravel in the subsoil than the Spinks soil. They are on side slopes. Dunbridge soils have limestone bedrock at a depth of 20 to 40 inches. The very poorly drained Granby soils are in depressions and drainageways. The somewhat poorly drained Tedrow soils are on slight rises. The moderately well drained Seward soils are in the transition zone between the Spinks soil and soils that formed in glacial till. Also included, on the sides of beach ridges, are areas where the slope is more than 12 percent. Included soils make up about 15 percent of most areas.

Permeability is moderately rapid in the Spinks soil, and the available water capacity is low. The content of organic matter is moderately low. Runoff is slow. The subsoil is medium acid to neutral. The root zone is deep.

Most areas are farmed. This soil is moderately well suited to corn, soybeans, wheat, hay, and pasture. If irrigated, it is well suited to cultivated crops and specialty crops. It is especially well suited to deep-rooted crops. The low available water capacity and the sandy surface layer are the major limitations. Crops can be planted earlier in spring on this soil than on most other soils in the county. Because applied nutrients are rapidly leached from the soil, smaller, more frequent or more timely applications of fertilizer and lime are better suited than one large application. Soil blowing and water erosion are hazards. The abrasive action of windblown sand damages seedlings. Crop residue management and cover crops help to maintain the organic matter content, conserve moisture, and reduce the susceptibility to erosion.

This soil is moderately well suited to drought-tolerant trees. Seedling mortality is a hazard during dry periods. Planting seedlings that have been transplanted once or mulching reduces the seedling mortality rate. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is well suited to buildings and septic tank absorption fields. Sloughing is a hazard in shallow excavations. Erosion and soil blowing are hazards on construction sites. They can be controlled by maintaining as much vegetation on the site as possible during construction. Because of seepage, the effluent from sanitary facilities can pollute ground water in some areas. Lawns seeded during the drier parts of the growing season should be mulched and watered.

The land capability classification is IIIs. The woodland ordination symbol is 3s.

TeA—Tedrow loamy fine sand, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on low beach ridges and sand dunes. Most areas are long and narrow or are circular. They range from 4 to 40 acres.

Typically, the surface layer is brown, very friable loamy fine sand about 8 inches thick. The subsoil is yellowish brown and dark yellowish brown, mottled, very friable loamy fine sand about 28 inches thick. The substratum to a depth of about 60 inches is grayish brown and dark grayish brown, mottled, loose loamy fine sand. In some areas it has layers of gravelly sandy loam or loam.

Included with this soil in mapping are small areas of the well drained Spinks soils on the higher beach ridges and the very poorly drained Gilford and Granby soils in drainageways and depressions. Also included are small areas of Kibbie soils, which contain more clay in the subsoil than the Tedrow soil. Included soils make up about 10 percent of most areas.

Permeability is rapid in the Tedrow soil, and the available water capacity is low. Runoff is slow. The content of organic matter is moderately low. The subsoil is slightly acid or neutral in the upper part and slightly acid to mildly alkaline in the lower part. A seasonal high water table is at a depth of 12 to 24 inches during extended wet periods.

Much of the acreage is used for cash grain. This soil is moderately well suited to corn, soybeans, small grain, vegetables, and orchards (fig. 7). Seasonal droughtiness, seasonal wetness, and soil blowing are the main management concerns. Subsurface drains are used to lower the seasonal high water table. They can become filled with fine sand unless some type of filtering material is used. Selecting drains that have a fiber envelope or adding a gravel or crushed stone filter around the drain helps to keep the fine sand from filling the drain. Applying a system of conservation tillage that leaves crop residue on the surface, planting cover crops, and returning crop residue to the soil help to control soil blowing, conserve moisture, delay surface drying, and increase the organic matter content.

This soil is moderately well suited to hay and pasture. It is poorly suited to grazing early in spring because of seasonal wetness. A vegetative cover helps to control soil blowing. Shallow-rooted plants do not grow well during extended periods of below normal rainfall. Timely deferment of grazing, pasture rotation, selection of suitable species for planting, and weed control help to keep the pasture in good condition.

Some areas support native hardwoods. This soil is moderately well suited to trees. The species that can withstand seasonal droughtiness as well as seasonal wetness should be selected for planting. Planting seedlings that have been transplanted once or mulching reduces the seedling mortality rate.

Because of the seasonal wetness, this soil is poorly suited to buildings with basements and is moderately well suited to buildings without basements and to septic tank absorption fields. Grading building sites and septic tank absorption fields can improve surface drainage. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry. If drains

Figure 7.—An orchard on Tedrow loamy fine sand, 0 to 2 percent slopes.

around foundations outlet into a sump, the pump should be large enough to handle a large volume of water.

Perimeter drains around septic tank absorption fields help to lower the seasonal high water table in this soil. The effluent drains freely but can pollute underground water supplies. Installing the absorption field in suitable fill material improves the filtering capacity. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by frost action and seasonal wetness. Sloughing is a hazard in shallow excavations, especially if the soil is wet.

The land capability classification is IIIs. The woodland ordination symbol is 3s.

TfA—Tedrow-Dixboro complex, 0 to 2 percent slopes. These deep, nearly level, somewhat poorly drained soils are on broad flats and slight rises on lake plains and deltas. Areas range from 100 to 200 acres. They are about 65 percent Tedrow loamy fine sand and

25 percent Dixboro sandy loam. The two soils occur as areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the surface layer of the Tedrow soil is brown, very friable loamy fine sand about 8 inches thick. The subsoil is yellowish brown and dark yellowish brown, mottled, very friable loamy fine sandy about 28 inches thick. The substratum to a depth of about 60 inches is dark grayish brown and grayish brown, mottled, very friable loamy fine sand.

Typically, the surface layer of the Dixboro soil is very dark grayish brown, very friable sandy loam about 9 inches thick. The subsoil is yellowish brown, brown, and grayish brown, mottled, friable sandy loam and fine sandy loam about 29 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled, friable, stratified loamy sand, sandy loam, and sand. In some areas the subsoil has more clay.

Included with these soils in mapping are small areas of Bixler, Gilford, and Granby soils. Bixler soils have more clay in the lower part than the Tedrow and Dixboro soils. They are in positions on the landscape similar to those of the Tedrow and Dixboro soils. The very poorly drained Gilford and Granby soils are in depressions and drainageways. Included soils make up about 10 percent of most areas.

Permeability is rapid in the Tedrow soil and moderate in the Dixboro soil. The available water capacity of the Tedrow soil is low, and that of the Dixboro soil is moderate or high. Surface runoff is slow on both soils. The content of organic matter is moderately low in the Tedrow soil and moderate in the Dixboro soil. The subsoil of the Tedrow soil is slightly acid or neutral in the upper part and slightly acid to mildly alkaline in the lower part. The subsoil of the Dixboro soil is neutral or slightly acid in the upper part and mildly alkaline or moderately alkaline in the lower part. Both soils can be tilled within a wide range of moisture conditions. They have a seasonal high water table at a depth of 12 to 24 inches during extended wet periods.

Most areas are used for farming. These soils are moderately well suited to corn, soybeans, small grain, hay, and specialty crops. Crop yields are higher on the Dixboro soil than on the Tedrow soil.

Seasonal droughtiness, soil blowing, and seasonal wetness are the main management concerns in cultivated areas. Applying a conservation tillage system that leaves crop residue on the surface, returning crop residue to the soil, and regularly adding other organic material delay drying of the soil surface, conserve moisture, and help to control soil blowing. Seeds can be uncovered or young plants damaged by soil blowing when the soil dries out in the spring. In areas where adequate outlets are available, subsurface drains are commonly used to lower the seasonal high water table. They can become filled with fine sand unless some type of filtering material is used. Selecting drains that have a fiber envelope or adding a gravel or crushed stone filter around the drain helps to keep the fine sand from filling the drain.

These soils are moderately well suited to pasture. They are poorly suited to grazing early in spring because of seasonal wetness. A vegetative cover helps to control soil blowing. Shallow-rooted plants do not grow well during extended periods of below normal rainfall. Timely deferment of grazing, pasture rotation, selection of suitable species for planting, and weed control help to keep the pasture in good condition.

A few areas are used as woodland. These soils are moderately well suited to trees. The species that can withstand some seasonal wetness should be selected for planting on both soils. Those planted on the Tedrow soil should also be drought tolerant. Plant competition on the Dixboro soil can be controlled by removing vines and the less desirable trees and shrubs. Planting seedlings that have been transplanted once or mulching reduces the seedling mortality rate on the Tedrow soil.

These soils are moderately well suited to buildings and septic tank absorption fields. Because of the seasonal wetness, they are better suited to buildings without basements than to buildings with basements. Grading building sites and septic tank absorption fields can improve surface drainage. Foundation drains and protective coatings on the exterior of basement walls help to keep basements dry.

Perimeter drains around septic tank absorption fields help to lower the seasonal high water table in these soils. If the water table in the Tedrow soil is lowered, the effluent drains freely. It can pollute underground water supplies, however, because the soil has a poor filtering capacity. Providing suitable fill material improves the filtering capacity. Providing suitable base material and installing a drainage system help to prevent the damage to local roads and streets caused by frost action and seasonal wetness. Lawns dry up during periods of low rainfall in summer. Newly seeded lawns should be mulched and watered. Sloughing is a hazard in shallow excavations.

The land capability classification is IIIs. The Tedrow soil is assigned to woodland ordination symbol 3s, the Dixboro soil to woodland ordination symbol 2a.

To—Toledo silty clay. This deep, nearly level, very poorly drained soil is on broad flats and in long, narrow concave areas on lake plains. It is ponded for short periods. Most areas range from 50 to more than 100 acres. Slope is 0 to 2 percent.

Typically, the surface layer is very dark gray, firm silty clay about 7 inches thick. The subsoil is dark grayish brown and gray, mottled, firm silty clay and clay about 37 inches thick. The substratum to a depth of about 60 inches is grayish brown and gray, mottled, firm clay and silty clay. In some areas the surface layer is lighter colored or thinner. In other areas it is loam or fine sandy loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Fulton soils on slight rises and side slopes along drainageways, Lenawee soils along drainageways, and Sandusky soils near seeps. Lenawee soils contain less clay in the subsoil than the Toledo soil. Sandusky soils have tufa fragments in the upper part. Included soils make up about 10 percent of most areas.

Permeability is slow in the Toledo soil, and the available water capacity is moderate. Runoff is very slow or ponded. A seasonal high water table is near or above the surface during extended wet periods. The subsoil is slightly acid to mildly alkaline. The content of organic matter is high. The root zone is deep.

Most of the acreage is cropland. Corn, soybeans, and small grain are the principal crops. Specialty crops are also grown in some areas. This soil is moderately well suited to crops. Most of the acreage has been drained. Subsurface drains are commonly used to lower the seasonal high water table where outlets are available. Open ditches and surface drains are used to remove excess surface water. Gullies form where water enters open ditches (fig. 8). Drop structures help to control gullying. The soil is sticky and plastic when wet. It should be tilled only within a narrow range of moisture content because it becomes compacted and cloddy if worked when wet. Planting cover crops and returning crop residue to the soil improve tilth and increase the rate of water infiltration.

This soil is moderately well suited to woodland. Trees should be planted and harvested during the drier parts of the year. The species selected for planting should be those that can withstand wetness and a clayey surface layer and subsoil. The windthrow hazard can be reduced by harvesting techniques that do not leave the remaining trees widely spaced. Planting seedlings that have been transplanted once reduces the seedling mortality rate. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is poorly suited to buildings and generally unsuited to septic tank absorption fields. Grading building sites helps to keep surface water away from the foundation. Backfilling along foundations with material that has a low shrink-swell potential and installing drains at the base of footings help to prevent the structural damage caused by shrinking and swelling and help to keep basements dry. Protective coatings on the exterior of basement walls also help to keep basements dry. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by low strength, ponding, and frost action.

The land capability classification is IIIw. The woodland ordination symbol is 3w.

Tp—Toledo silty clay loam, ponded. This deep, nearly level, very poorly drained soil is in long, narrow concave areas along drainageways and on broad flats on lake plains. It is ponded for long periods. Most areas range from 5 to more than 100 acres. Slope is 0 to 2 percent.

Typically, the surface layer is very dark gray, firm silty clay loam about 8 inches thick. The subsurface layer is dark gray, mottled, firm silty clay loam about 4 inches thick. The subsoil is gray and light gray, mottled, firm silty clay about 39 inches thick. The substratum to a depth of about 60 inches is gray and dark gray, mottled, firm silty clay. In some areas the surface layer is mucky silty clay loam. In some places it is thicker. In other places it is lighter colored.

Permeability is slow. A seasonal high water table is near or above the surface most of the year. The available water capacity is moderate. The subsoil is slightly acid to mildly alkaline. Runoff is very slow or ponded. The content of organic matter is high. The root zone is influenced by the water table. It is deep in drained areas.

Areas that are diked and drained by pumps are moderately well suited to grain crops. Undrained areas are generally not suited to crops. Levees, open ditches, subsurface and surface drains, and pumps can improve drainage. The soil is plastic and sticky when wet. It should be tilled only within a narrow range of moisture content because it becomes compacted and cloddy if worked when wet.

Most of the acreage is used for wildlife refuges or hunting preserves. This soil is generally not suited to woodland. It provides excellent habitat for wetland wildlife. In large areas the water level is controlled by levees and pumps. Because of these measures, drainage ditches, and surface and subsurface drains, soybeans and buckwheat can be grown and the areas can be flooded during the migration of wetland waterfowl.

This soil is generally unsuitable as a site for buildings and septic tank absorption fields because of the ponding, a high shrink-swell potential, and the slow permeability.

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

Un—Udorthents, strongly sloping. These soils occur as areas of elevated fill. The areas are mostly piles of debris from limestone quarrying. Slope ranges from 12 to 25 percent. Most areas are 5 to 100 acres.

Typically, the upper 60 inches is silt loam or loam. It contains varying amounts of stones and coarse fragments. The available water capacity is dominantly low or very low in the root zone, but it varies. Internal water movement and runoff also vary. Hard rains tend to seal the surface in poorly vegetated areas. As a result, the water infiltration rate is reduced and the emergence

Figure 8.—A gully in an area of Toledo silty clay.

and growth of plants are restricted. The root zone generally is mildly alkaline. In most places erosion is a hazard. Some areas are subject to gullying and commonly are a source of sediment.

Most areas have only a sparse cover of vegetation and are idle. These soils generally are unsuited to cropland and are poorly suited to pasture and trees. Stands of grasses or legumes can be improved by mulching, applying fertilizer, and seeding. The root zone can be improved by blanketing the area with topsoil. The species selected for planting should be those that can withstand alkaline conditions. The suitability of these soils for building site development and septic tank absorption fields varies. Onsite investigation is needed to determine the suitability for any proposed use.

No land capability classification or woodland ordination symbol is assigned.

Wa—Weyers coarse sandy loam. This nearly level, deep, very poorly drained soil is on flats on lake plains. It is near seeps of water that has a high content of calcium carbonate. Slope is 0 to 2 percent. Most areas are irregular in shape and range from 50 to several hundred acres.

Typically, the surface layer is very dark gray, very friable coarse sandy loam about 10 inches thick. The subsurface layer also is very dark gray, very friable coarse sandy loam. It is about 4 inches thick. The upper part of the substratum is grayish brown and dark gray, mottled, friable and very friable gravelly coarse sandy loam, loam, and coarse sandy loam. The lower part to a depth of about 72 inches is pale brown, very pale brown, and white, loose gravelly coarse sandy loam and very friable silt loam. In some areas the surface layer is loam or silt loam. In a few areas the lower part of the soil contains lacustrine sediments.

Included with this soil in mapping are small areas of the somewhat poorly drained Fulton soils on slight rises. Also included are small areas of Toledo soils. These soils have more clay throughout than the Weyers soil. They are near the edge of the mapped areas. Included soils make up about 10 percent of most areas.

Permeability is moderately rapid in the upper part of the Weyers soil and moderate to slow in the lower part. The available water capacity is moderate. The content of organic matter is very high. The substratum is moderately alkaline. Runoff is very slow. A seasonal high water table is near the surface during extended wet periods.

Some areas are used as cropland. This soil is moderately well suited to corn and soybeans. Wetness and alkalinity are the main limitations. Open ditches are used to remove excess water. Subsurface drains are used to lower the seasonal high water table where adequate outlets are available. Because of the alkalinity, some applied plant nutrients are unavailable to plants. Acid-base fertilizers should be applied. Water-tolerant grasses should be selected for hay and pasture. Overgrazing or grazing during wet periods damages the plants and compacts the soil.

Many areas are used for wetland wildlife habitat. A few are wooded. This soil is poorly suited to woodland and well suited to habitat for wetland wildlife. The trees that can withstand the prolonged wetness and the alkalinity should be selected for planting. The use of harvesting equipment is severely limited by the wetness and the very high content of organic matter. The trees should be logged during the drier parts of the year. Installing a drainage system and planting seedlings that have been transplanted once reduce the seedling mortality rate. The windthrow hazard can be reduced by harvesting techniques that do not leave the remaining trees widely spaced. Removing vines and the less desirable trees and shrubs helps to control plant competition.

This soil is generally unsuitable as a site for buildings and septic tank absorption fields because of the seasonal wetness and the slow permeability. Installing a drainage system and providing suitable base material help to prevent the damage to local roads and streets caused by wetness and frost action.

The land capability classification is IIIw. The woodland ordination symbol is 4w.

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 223,098 acres in Sandusky County, or more than 85 percent of the total acreage, meets the requirements for prime farmland. This land is mainly in associations 1, 2, 3, 5, 6, 7, 9, and 11, which are described under the heading "General Soil Map Units." About 198,383 acres of the prime farmland occurs as somewhat poorly drained or very poorly drained soils. A drainage system is needed in these areas.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. 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 in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help 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 woodland; 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 potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

John E. Battles, district conservationist, Soil Conservation Service, helped write 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.

In 1981, approximately 180,850 acres in the county was used for crops and pasture (*7*). Of this total, 125,600 acres was used for row crops, mainly corn and soybeans; 34,500 acres for close-grown crops, mainly wheat and oats; 11,350 acres for specialty crops; and 9,400 acres for hay.

The potential is good for increased food production in the county. Food production can be increased by applying the latest technology to all the cropland in the county. This soil survey can greatly facilitate the application of such technology. The main management concerns on the cropland and the pasture in this county are wetness, water erosion, soil blowing, fertility, and tilth.

Soil drainage is the major management concern on about 84 percent of the acreage in the county. Some soils are naturally so wet that the production of the crops commonly grown in the county generally is not possible unless a drainage system is installed. Examples are the very poorly drained Bono, Colwood, Gilford, Granby, Hoytville, Lenawee, Mermill, Mermill Variant, Millsdale, Pewamo, Sandusky, Toledo, and Weyers soils, which make up about 50 percent of the county.

Unless drained, the somewhat poorly drained soils are so wet that crops are damaged in most years and planting or harvesting is delayed. Examples are Bennington, Bixler, Blount, Del Rey, Dixboro, Fulton, Haskins, Kibbie, Nappanee, Rimer, Shoals, and Tedrow soils, which make up about 34 percent of the county. In some soils a filter may be needed on subsurface drains to keep the drain lines from filling with silt and very fine sand. Examples are Granby, Rimer, and Tedrow soils.

Included in many areas of the moderately well drained Glenford, Glynwood, Lucas, Saylesville, and Seward soils are depressions and pockets along drainageways and in swales. A drainage system is needed in some of these areas.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of surface and subsurface drains is needed in most areas of the very poorly drained soils that are intensively row cropped. Drains should be more closely spaced in slowly permeable or very slowly permeable soils than in the more permeable soils. Subsurface drainage is slow or very slow in Bono, Fulton, Nappanee, and Toledo soils. Good drainage cannot be obtained without an adequate outlet (fig. 9). Locating adequate outlets for subsurface drains is difficult in the depressed areas of uplands and on the broad flats of lake plains.

A pump drainage system can be used in some areas where a gravity outlet is not available. Specific information about the design of drainage systems for each kind of soil can be obtained from the local office of the soil conservation district.

Water erosion is a problem on about 22 percent of the acreage in the county. It is a hazard in areas where the slope is more than 2 percent. Belmore, Bixler, Castalia, Dunbridge, Glenford, Glynwood, Haskins, Lucas, Mentor, Rimer, Saylesville, Seward, and Spinks are examples of soils that have slopes of more than 2 percent. The Saylesville soils are eroded. Eroded spots are included with some of the other soils in mapping.

Figure 9.—An outlet for a subsurface drain.

Loss of the surface layer through erosion reduces productivity and results in sedimentation of streams and deterioration of tilth. Productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Erosion especially reduces the productivity of soils that tend to be droughty, such as Belmore and Spinks soils. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water for municipal use, for recreation, and for fish and other wildlife. Preparing a good seedbed and tilling are more difficult in the eroded Saylesville soils than in uneroded soils because part of the original friable surface layer has been removed by erosion.

Erosion-control measures provide a protective cover, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps a plant cover on the soil for extended periods can reduce soil losses to an amount that will not decrease the productive capacity of the soil. Including legumes and grasses in the cropping system reduces the risk of erosion, increases the supply of nitrogen, and improves tilth.

Slopes are so short and irregular that contour tillage is not practical in most areas of the gently sloping and sloping Belmore, Bixler, Castalia, Dunbridge, Glenford, Glynwood, Haskins, Lucas, Mentor, Rimer, Saylesville, Seward, and Spinks soils. Unless tillage is kept to a minimum on these soils, a cropping system that provides a substantial plant cover is needed to control erosion.

Minimizing tillage and leaving crop residue on the surface increase the rate of water infiltration and reduce the hazards of runoff and erosion. Minimum tillage and crop residue management can be applied on most soils in the county. No-tillage is effective in reducing the hazard of erosion on sloping land. Ridge planting is suited to the very poorly drained soils.

Diversions can control runoff and erosion on long slopes. They are most practical on soils that have smooth slopes. Most soils in the county are not well suited to terraces or diversions because of an irregular slope, a clayey subsoil, or bedrock at a depth of 20 to 40 inches.

Grassed waterways are natural or constructed outlets that are protected by a plant cover. Natural drainageways are the best sites for grassed waterways. They commonly require a minimal amount of shaping. They should be wide and flat, so that farm machinery can cross them easily.

Soil blowing is a hazard on Bixler, Dixboro, Dunbridge, Gilford, Granby, Haskins, Kibbie, Rimer, Seward, Spinks, and Tedrow soils (fig. 10). Maintaining a plant cover, a surface mulch, or a rough surface through proper tillage reduces the hazard of soil blowing. Cover crops, strips of sod in row-cropped areas, and field windbreaks are used primarily to protect truck crops.

Specific information about the design of measures that control erosion and soil blowing on each kind of soil can be obtained from the local office of the soil conservation district.

Soil fertility is naturally low in some of the sandy soils, such as Tedrow and Spinks soils. Soils on lake plains, such as Bono, Colwood, Hoytville, Mermill, Mermill Variant, Lenawee, and Toledo soils, commonly have a high natural fertility level. Applications of lime are needed to raise the pH of acid soils.

On all soils additions of lime and fertilizer should be based on the results of soil tests, on the needs of the crop, and on the expected level of yields. The Cooperative Extensive Service can help in determining the kinds and amounts of fertilizer and lime to be applied.

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

Most soils that are used for crops in the county have a loam, silt loam, sandy loam, fine sandy loam, or silty clay loam surface layer that has a high to moderately low content of organic matter. Generally, the structure of these soils is moderate or weak. Following an intense rainfall, the silt loam, loam, or silty clay loam surface layer crusts as it dries. The crust is hard when dry and is nearly impervious to water. It reduces the rate of water infiltration and increases the runoff rate. Regular additions of crop residue, manure, and other organic material improve soil structure and reduce the likelihood of crusting.

Fall plowing is not a good management practice on Bixler, Dixboro, Dunbridge, Haskins, Kibbie, Rimer, Seward, Spinks, and Tedrow soils. The exposed surface is susceptible to soil blowing and water erosion. A winter cover crop helps to control soil blowing. All sloping soils and some nearly level, light colored soils also are susceptible to erosion and soil blowing if they are plowed in the fall.

The surface layer of the dark Bono, Hoytville, Lenawee, Millsdale, Pewamo, and Toledo soils contains more clay than that of most light colored soils. Because the darker soils often stay wet until late in spring, maintaining good tilth is a problem. If plowed when wet, these soils tend to become cloddy as they dry. As a result, preparing a good seedbed is difficult. Plowing these dark soils in the fall generally results in better tilth in the spring.

Field crops grown in the county include corn, soybeans, wheat, oats, grain sorghum, sunflowers, rye, and barley. Bromegrass, timothy, fescue, redtop, bluegrass, and clover can be used as a seed source.

Pasture makes up only about 3 percent of the land in the county (*20*). Some permanent pasture is on eroded soils that formerly were cultivated. It is also in narrow strips and in irregularly shaped areas on flood plains. Open woodlots are pastured, but they generally provide poor-quality grazing because forage plants are sparse.

Figure 10.—Soil blowing on unprotected sandy soils.

Many permanent pastures near farmsteads are used as feedlots or access lanes.

Most of the soils in the county can be used for high-quality permanent pasture. Pasture plants grow well on Glenford, Glynwood, and Saylesville soils, but these soils are subject to erosion if the plant cover is overgrazed. If livestock are allowed to trample these soils during wet periods, soil compaction is severe.

The Rossburg and Shoals soils on flood plains are well suited to permanent pasture because they are fertile and have a high available water capacity. Flooding during the growing season damages grain crops but is much less damaging to permanent pastures. Surface and subsurface drains are needed to remove excess water in areas of the somewhat poorly drained or very poorly drained Blount, Fulton, and Hoytville soils.

Good management is needed before permanent pasture can be highly productive. Lime and fertilizer should be applied at rates indicated by soil tests. Weeds can be controlled by periodic clipping and by applying recommended herbicides. Proper seeding rates and controlled grazing help to keep well established permanent pastures in good condition. Specific information about seeding mixtures, herbicide treatment, and other management practices for specific soils can be obtained from the local office of the Cooperative Extension Service or the Soil Conservation Service.

Irrigation is not extensive in Sandusky County. The county generally receives ample rainfall for crop moisture requirements. Intervals commonly occur, however, when rainfall is not timely or is not well distributed. During these periods irrigation should be considered, particularly if specialty crops are grown.

Many soils in the county can be irrigated if water is available. Irrigation is needed on Belmore and Spinks soils during droughty periods. If the somewhat poorly drained or very poorly drained Bixler, Dixboro, Gilford, Granby, Kibbie, Lenawee, Rimer, and Tedrow soils are irrigated, a subsurface drainage system is needed to remove excess water when a heavy rain follows irrigation. Some soils in the county are not well suited to irrigation because of excessive slope, a slow intake rate, surface crusting, or poor natural drainage. Further information about irrigation is available from the Cooperative Extension Service or the local office of the soil conservation district.

Specialty crops, such as cabbage, pickling cucumbers, sugar beets, and tomatoes, are commonly grown in the county. Smaller acreages of melons, potatoes, and sweet corn also are grown. Information on specific management practices, fertilization rates, and seed varieties can be obtained from the local office of the Cooperative Extension Service or from commercial packing and processing companies.

Sugar beets grow well on soils that have a high available water capacity, a high content of organic matter, and a pH between 6.5 and 7.0. Deep, dark, medium textured or moderately fine textured soils are well suited to sugar beets. Good tilth and aeration are important. Bixler, Colwood, Dixboro, Gilford, Hoytville, Kibbie, Lenawee, Mermill, Tedrow, Toledo, and Weyers are the soils used most extensively for sugar beets. Surface crusting and restricted aeration, however, are limitations in areas where these soils have a silty clay loam or silty clay surface layer.

Tomatoes grow best on dark, medium textured or moderately fine textured soils that have a deep root zone, a high available water capacity, and a high content of organic matter. Bixler, Colwood, Dixboro, Gilford, Hoytville, Kibbie, Lenawee, Mermill, Rimer, Toledo, and Weyers soils are well suited to tomatoes. Tomato plants have deep roots and cannot withstand excess water in the root zone for a very long period. Surface ponding damages tomatoes within hours. Consequently, good drainage is essential on the surface and within the root zone. Dark, very poorly drained soils that have a good surface and subsurface drainage system and adequate soil aeration are commonly used for tomatoes.

Cucumbers grow best on dark, medium textured or moderately fine textured soils that have a high available water capacity and a high content of organic matter. Colwood, Dixboro, Gilford, Hoytville, Kibbie, Lenawee, and Mermill soils are well suited to cucumbers. Irrigation is beneficial during dry periods. Both surface and subsurface drains are needed on wet soils.

Deep, loamy, well drained soils that have good subsurface drainage are well suited to cabbage, potatoes, and sweet corn. These soils warm up early in spring, have a good water intake rate, and can be tilled throughout a wide range of moisture content without severe compaction or damage to soil structure.

Orchards are well suited to the well drained Belmore, Dunbridge, and Spinks soils. Specific information about varieties and fertilization rates can be obtained from the local office of the Cooperative Extension Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. 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 land capability classification of each map unit also is shown in the table.

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 6 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 (*18*). 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 acreage of soils in each capability class and subclass is shown in table 7. The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Woodland Management and Productivity

Nearly all of Sandusky County was forested at the time of settlement. The original forest cover types were beech, elm-ash swamp forest, oak-sugar maple, fresh-water marshes and fens, and mixed oak forest (*10*). The elm-ash swamp forest is associated with the Black Swamp, of which Sandusky County was a part at one time. The elm-ash swamp forest also occurs in other areas of wet soils.

As a result of clearing, the acreage of woodland has been reduced to 11,316 acres, or slightly more than 4 percent of the county (*20*). Most of the remaining areas are in small farm woodlots. The steepest, wettest, shallower, and less accessible parts of the farms have typically remained wooded. Most of the woodland has been cut over. Areas that are moderately deep to bedrock and very stony are reverting to woodland.

Compared to the returns from the sale of other farm products, income from the sale of wood products is small. Some good-quality logs of red and white oaks and black walnut are still being cut from the better managed woodlots. Farmlots are a source of firewood. The Ohio Department of Natural Resources, Division of Forestry, can provide information about managing woodland.

Table 8 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each suitable 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 important trees. It is based on the site index of the species listed first in the *common trees* column. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. 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*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted rooting depth; *c*, clay in the upper part of the soil; *s*, sandy texture; and *f*, high content of coarse fragments in the soil profile. The letter *a* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: r, x, w, t, d, c, s, and f.

In table 8, *slight*, *moderate*, and *severe* indicate the degree of the major soil limitations to be considered in management.

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

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

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

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that few trees may be blown down by strong winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. 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.

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

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 (fig. 11).

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 9 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 9 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 a commercial nursery or from local offices of the Soil Conservation Service; the Ohio Department of Natural Resources, Division of Forestry; or the Cooperative Extension Service.

Recreation

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public 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 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to

Figure 11.—A windbreak of Scotch pine and shrubs on Glynwood silt loam, 2 to 6 percent slopes.

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.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

A scarcity of cover affects the wildlife population in Sandusky County. It results from extensive fall plowing and from the clearing of fence rows and woodlots. The Rossburg-Shoals association, along the streams in the county, provides good cover and water for wildlife, but the mortality rate is high because of flood damage to nesting areas. The very steep Mentor soils and escarpments along the streams are used as habitat for wildlife. Drainage ditches throughout the county also provide good habitat for wildlife.

Marsh areas and undrained areas of Bono and Toledo soils provide ideal habitat for wetland wildlife. These areas are adjacent to Sandusky Bay and are along the major streams and their tributaries.

Most of the wooded areas have been cut over once and are covered with brush and young trees. These areas provide ideal habitat for deer. The deer population is increasing.

Information about managing or improving wildlife habitat can be obtained from the Ohio Department of Natural Resources, Division of Wildlife; the Cooperative Extension Service; or the Soil Conservation Service.

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

The potential of the soil is rated good, fair, poor, or very poor (*1*). 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, timothy, 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 foxtail, goldenrod, smartweed, ragweed, and fescue.

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, poplar, cherry, sweetgum, maple, hawthorn, dogwood, hickory, blackberry, and black walnut. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are shrub honeysuckle, autumn-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 juniper.

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, duckweed, reed canarygrass, cordgrass, 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 shallow 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 bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

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 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and 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 13 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for 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 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage 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 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench 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 14 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help 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 14, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are 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 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, 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.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and 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.

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. These results are reported in table 19.

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 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each 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 (fig. 12). "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.

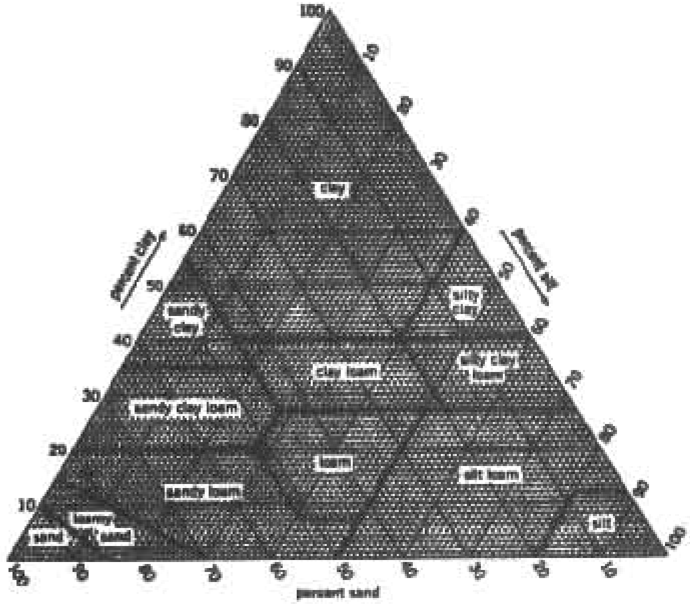


Figure 12.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Classification of the soils is determined according to the Unified soil classification system (*4*) and the system adopted by the American Association of State Highway and Transportation Officials (*3*).

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 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, 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 17, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter 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 18 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 18, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *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 18 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 18.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

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.

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.

Physical and Chemical Analyses of Selected Soils

Many of the soils in Sandusky County were sampled by the Soil Characterization Laboratory, Department of Agronomy, Ohio State University, Columbus, Ohio. The physical and chemical data obtained from the samples include particle-size distribution, reaction, organic matter content, calcium carbonate equivalent, and extractable cations.

These data were used in classifying and correlating the soils and in evaluating their behavior under various land uses. Six pedons were selected as representative of their respective series and are described in the section "Soil Series and Their Morphology." These series and their laboratory identification numbers are Dixboro series (SN-17), Fulton series (SN-13), Hoytville series (SN-16), Sandusky series (SN-19), Toledo series (SN-15), and Weyers series (SN-18).

In addition to the Sandusky County data, laboratory data for many of the same soils are also available from nearby counties in northwestern Ohio. Data from these counties and from Sandusky County are on file at the Department of Agronomy, Ohio State University; the Ohio Department of Natural Resources, Division of Soil and Water Conservation; and the Soil Conservation Service, State Office, Columbus, Ohio.

Engineering Index Test Data

Table 19 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the Ohio Department of Transportation, Division of Highways, Bureau of Testing, Soils and Foundation Section.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*19*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 20 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. 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 Aqualf (*Aqu*, meaning water, 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 Ochraqualfs (*Ochr*, meaning light colored surface layer, plus *aqualf*, the suborder of the Alfisols that has an aquic moisture 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 *Aeric* identifies the subgroup that is drier than the typical great group. An example is Aeric Ochraqualfs.

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, mesic Aeric Ochraqualfs.

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 substratum 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* (*17*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*19*). 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."

Belmore Series

The Belmore series consists of deep, well drained soils on beach ridges, stream terraces, and outwash plains. These soils formed in loamy over sandy and loamy, water-sorted material. Permeability is moderately rapid in the solum and rapid in the substratum. Slope ranges from 2 to 6 percent.

Belmore soils are commonly adjacent to Dunbridge, Haskins, Kibbie, Rimer, and Spinks soils. Dunbridge soils have limestone bedrock at a depth of 20 to 40 inches. Haskins, Kibbie, and Rimer soils are somewhat poorly drained and are on the lower part of slopes and on slight rises. Spinks soils are sandy throughout. They are on beach ridges.

Typical pedon of Belmore loam, 2 to 6 percent slopes, in York Township; approximately 248 feet north and 760 feet east of the southwest corner of sec. 16, T. 4 N., R. 17 E.

Ap—0 to 7 inches; brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; weak medium and fine granular structure; friable; common roots; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

Bt1—7 to 12 inches; brown (7.5YR 5/4) clay loam; moderate medium and coarse subangular blocky structure; friable; few roots; few faint brown (7.5YR 5/4) clay films bridging sand grains; about 4 percent coarse fragments; medium acid; clear smooth boundary.

2Bt2—12 to 17 inches; dark brown (7.5YR 4/4) gravelly clay loam; moderate coarse and medium subangular blocky structure; friable; few roots; common distinct dark reddish brown (5YR 3/4) clay films bridging sand grains; about 20 percent coarse fragments; slightly acid; clear smooth boundary.

2Bt3—17 to 23 inches; dark brown (7.5YR 4/4) gravelly clay loam; weak fine subangular blocky structure; friable; few roots; common distinct dark reddish brown (5YR 3/4) clay films bridging sand grains; about 15 percent coarse fragments; slightly acid; clear smooth boundary.

2Bt4—23 to 30 inches; dark brown (7.5YR 4/4) gravelly sandy clay loam; weak fine subangular blocky structure; friable; common distinct dark reddish brown (5YR 3/4) clay films bridging sand grains; about 30 percent coarse fragments; neutral; abrupt smooth boundary.

2C1—30 to 47 inches; mixed grayish brown (10YR 5/2) and pale brown (10YR 6/3) gravelly loamy sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grained; loose; about 30 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

2C2—47 to 56 inches; mixed grayish brown (10YR 5/2) and pale brown (10YR 6/3) sand; few fine distinct yellowish brown (10YR 5/4) mottles; single grained; loose; about 5 percent coarse fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.

2C3—56 to 60 inches; brown (10YR 4/3) sandy loam; massive; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 55 inches and commonly is the same as the depth to free carbonates. In some pedons tongues of the B horizon extend to a depth of more than 55 inches. The content of gravel ranges from 2 to 15 percent in the A and Bt horizons, from 15 to 30 percent in the 2Bt horizon, and from 3 to 40 percent in the 2C horizon. The A and Bt horizons are slightly acid or medium acid, and the 2Bt horizon is slightly acid or neutral.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. It is typically loam but is sandy loam, fine sandy loam, or silt loam in some pedons. The Bt horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is clay loam, sandy clay loam, sandy loam, or loam. The 2Bt horizon generally has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. In some pedons, however, it has thin subhorizons with hue of 5YR. It is dominantly the gravelly analogs of clay loam, sandy clay loam, loam, or sandy loam. Some pedons, however, have thin strata of clay loam, loam, or sandy loam. The 2C horizon has hue of 10YR or 7.5YR, value of 4 to 7, and chroma of 2 to 5. It is stratified loamy sand, sand, sandy loam, or the gravelly or very gravelly analogs of these textures.

Bennington Series

The Bennington series consists of deep, somewhat poorly drained, slowly permeable soils on lake plains. These soils formed in loamy glacial till. Slope is 0 to 2 percent.

Bennington soils are commonly adjacent to Glynwood and Haskins soils and are similar to Blount, Del Rey, and Nappanee soils. Blount soils have fewer shale fragments throughout than the Bennington soils and formed in glacial till that has a higher calcium carbonate equivalent. Del Rey soils formed in lacustrine sediments and have less sand and fewer coarse fragments in the subsoil and substratum than the Bennington soils. Glynwood soils are moderately well drained and are on knolls, on ridges, and on side slopes at the head of drainageways. Haskins soils have less clay in the upper part of the subsoil than the Bennington soils. Their landscape positions are similar to those of the Bennington soils. Nappanee soils have more clay in the subsoil and substratum than the Bennington soils.

Typical pedon of Bennington silt loam, 0 to 2 percent slopes, in York Township; approximately 745 feet west and 1,240 feet north of the southeast corner of sec. 13, T. 4 N., R. 17 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine and medium granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

BE—9 to 14 inches; brown (10YR 5/3) silty clay loam; common medium distinct yellowish brown (10YR 5/6), many medium faint pale brown (10YR 6/3), and few fine faint grayish brown (10YR 5/2) mottles; weak medium and fine subangular blocky structure; friable; many roots; many distinct grayish brown (10YR 5/2) silt coatings on faces of peds; about 2 percent coarse fragments; very strongly acid; clear smooth boundary.

Btg—14 to 20 inches; grayish brown (10YR 5/2) clay loam; common medium distinct yellowish brown (10YR 5/6) and few medium faint brown (10YR 5/3) mottles; weak medium and fine subangular blocky structure; firm; common roots; common distinct grayish brown (10YR 5/2) clay films on faces of peds; about 2 percent coarse fragments; very strongly acid; clear wavy boundary.

Bt—20 to 30 inches; brown (10YR 5/3) clay loam; common medium faint yellowish brown (10YR 5/4) and many coarse distinct dark grayish brown (10YR 4/2) mottles; weak medium and fine subangular blocky structure; firm; few roots; many distinct grayish brown (10YR 5/2) silt coatings and common distinct grayish brown (10YR 5/2) clay films on faces of peds; about 2 percent coarse fragments; very strongly acid; clear smooth boundary.

BC—30 to 36 inches; brown (10YR 5/3) silty clay loam; common medium faint grayish brown (10YR 5/2) and common fine distinct yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure; firm; few fine light gray (10YR 7/1) lime concretions; about 5 percent coarse fragments; neutral; clear smooth boundary.

C—36 to 60 inches; brown (10YR 5/3) silty clay loam; common medium distinct yellowish brown (10YR 5/6), common medium faint grayish brown (10YR 5/2), and few fine faint light brownish gray (10YR 6/2) mottles; massive; firm; few fine light gray (10YR 7/1) lime concretions; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 28 to 50 inches. The depth to carbonates ranges from 26 to 46 inches. The content of coarse fragments is 0 to 5 percent to a depth of 20 inches and 2 to 10 percent below that depth.

The Ap horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is commonly silt loam but is loam in some pedons. It is medium acid to neutral. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 6. It is clay loam, silty clay, or silty clay loam. It is medium acid to very strongly acid in the upper part and very strongly acid to neutral in lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 to 4. It is clay loam, silty clay loam, or loam. It is mildly alkaline or moderately alkaline and contains free carbonates.

Bixler Series

The Bixler series consists of deep, somewhat poorly drained soils on outwash plains and beach ridges. These soils formed in glacial outwash over stratified lacustrine material. Permeability is rapid in the outwash and moderate in the lacustrine material. Slope ranges from 2 to 6 percent.

Bixler soils are commonly adjacent to Colwood, Dixboro, Kibbie, Lenawee, and Rimer soils and are similar to Haskins and Rimer soils. The very poorly drained Colwood and Lenawee soils are on flats and in depressions. Haskins soils have more clay in the subsoil and substratum than the Bixler soils. Dixboro and Kibbie soils are on lake plains and deltas and along the edges of the higher beach ridges. They have a surface layer that is darker than that of the Bixler soils. Also, Kibbie soils have more clay in the upper part. Rimer soils have more clay in the lower part of the subsoil and in the substratum than the Bixler soils. They are on beach ridges and lake plains.

Typical pedon of Bixler loamy fine sand, 2 to 6 percent slopes, in Riley Township; approximately 165 feet north and 2,310 feet east of the southwest corner of sec. 34, T. 5 N., R. 16 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy fine sand, pale brown (10YR 6/3) dry; weak fine granular structure; friable; many roots; neutral; clear smooth boundary.

E1—8 to 18 inches; brown (10YR 4/3) loamy fine sand; weak medium and fine granular structure; very friable; many roots; common faint dark brown (10YR 3/3) coatings on faces of peds; common very dark grayish brown (10YR 3/2) wormcasts; slightly acid; clear smooth boundary.

E2—18 to 22 inches; yellowish brown (10YR 5/4) loamy fine sand; many medium faint yellowish brown (10YR 5/6), few fine distinct grayish brown (10YR 5/2), and few fine distinct light brownish gray (10YR 6/2) mottles; weak medium and fine granular structure; very friable; few roots; few very dark grayish brown (10YR 3/2) wormcasts; slightly acid; abrupt smooth boundary.

Bt1—22 to 24 inches; yellowish brown (10YR 5/4) fine sandy loam; many medium faint yellowish brown (10YR 5/6), few fine distinct grayish brown (10YR 5/2), and few fine distinct light brownish gray (10YR 6/2) mottles; weak medium and fine granular structure; friable; few roots; common distinct dark yellowish brown (10YR 4/4) clay films bridging sand grains; few very dark grayish brown (10YR 3/2) wormcasts; slightly acid; abrupt smooth boundary.

2Bt2—24 to 29 inches; brown (10YR 5/3) silty clay loam; few fine faint light brownish gray (10YR 6/2), few medium distinct yellowish brown (10YR 5/6), and many medium distinct dark brown (7.5YR 4/4) mottles; strong coarse subangular blocky structure; firm; few roots; common faint brown (10YR 5/3) clay films on faces of peds; few fine very dark gray (10YR 3/1) concretions (iron and manganese oxides); slightly acid; clear smooth boundary.

2Bt3—29 to 40 inches; grayish brown (10YR 5/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6), many medium distinct dark brown (7.5YR 4/4), and few fine faint gray (10YR 6/1) mottles; strong coarse subangular blocky structure; firm; few roots; common faint grayish brown (10YR 5/2) clay films on faces of peds; neutral; clear smooth boundary.

2C—40 to 60 inches; gray (10YR 6/1) silt loam; many coarse prominent yellowish brown (10YR 5/6) and many coarse distinct brown (7.5YR 5/4) mottles; appears massive but has weak horizontal bedding planes; friable; gray (10YR 6/1) coatings on bedding planes; lenses of brownish yellow (10YR 6/6) very fine sand, less than 1/16 inch thick, that have many medium distinct strong brown (7.5YR 5/6) mottles; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 28 to 55 inches. The Ap or A horizon has hue of 10YR, value of 2 to 4, and chroma of 1 to 3. It is typically loamy fine sand but is fine sand in some pedons. It ranges from medium acid to neutral. The E and Bt horizons are slightly acid or neutral. The E horizon has hue of 10YR, value of 4 to 6, and chroma of 3 or 4. It is loamy fine sand or fine sand. The Bt horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 6. It is fine sandy loam, loam, or sandy loam. The 2Bt horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 or 3. It is silty clay loam, fine sandy loam, silt loam, or loam. It ranges from slightly acid to mildly alkaline.

The 2C horizon is neutral in hue or has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 3. It is stratified silt loam, silty clay loam, silt, or very fine sand. It ranges from neutral to moderately alkaline.

Blount Series

The Blount series consists of deep, somewhat poorly drained, slowly permeable or moderately slowly permeable soils on till plains. These soils formed in calcareous glacial till high in content of lime. Slope is 0 to 2 percent.

Blount soils are commonly adjacent to Glynwood, Haskins, and Pewamo soils and are similar to Bennington, Del Rey, and Nappanee soils. Bennington soils have more shale fragments throughout than the Blount soils and formed in glacial till lower in calcium carbonate equivalent. Del Rey soils formed in lacustrine sediments and have less sand and fewer coarse fragments in the subsoil and substratum than the Blount soils. Glynwood soils are moderately well drained and are in the higher landscape positions. Haskins soils have less clay in the upper part of the subsoil than the Blount soils. Their landscape positions are similar to those of the Blount soils. Nappanee soils have more clay in the subsoil and substratum than the Blount soils. Pewamo soils are very poorly drained and are in drainageways and shallow depressions. They have a mollic epipedon.

Typical pedon of Blount silt loam, 0 to 2 percent slopes, in York Township; approximately 42 feet north and 75 feet west of the southeast corner of sec. 31, T. 4 N., R. 17 E.

Ap—0 to 7 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak fine granular structure; friable; about 1 percent coarse fragments; neutral; abrupt smooth boundary.

Bt1—7 to 12 inches; yellowish brown (10YR 5/4) clay loam; many fine distinct grayish brown (10YR 5/2) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; common distinct grayish brown (10YR 5/2) clay films on faces of peds; about 2 percent coarse fragments; strongly acid; clear smooth boundary.

Bt2—12 to 19 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct light brownish gray (10YR 6/2) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; common distinct grayish brown (10YR 5/2) clay films on faces of peds; about 2 percent coarse fragments; medium acid; clear smooth boundary.

Bt3—19 to 27 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct light brownish gray (10YR 6/2) mottles; weak coarse prismatic structure parting to moderate coarse subangular blocky; firm; common distinct grayish brown (10YR 5/2) clay films on faces of peds; common very dark brown (10YR 2/2) stains (iron and manganese oxides); about 2 percent coarse fragments; slightly acid; clear smooth boundary.

BC—27 to 31 inches; yellowish brown (10YR 5/4) clay loam; common medium faint yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure; firm; many distinct grayish brown (10YR 5/2) coatings on vertical faces of peds; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

C1—31 to 38 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct yellowish brown (10YR 5/8) and grayish brown (10YR 5/2) mottles; massive; firm; common distinct light gray (10YR 7/2) calcium carbonate coatings in vertical partings; about 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—38 to 60 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct yellowish brown (10YR 5/8) and grayish brown (10YR 5/2) mottles; massive; firm; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum commonly is 28 to 40 inches but ranges from 24 to 45 inches. The depth to free carbonates ranges from 24 to 40 inches. The content of coarse fragments generally increases with increasing depth. It is 0 to 2 percent in the Ap horizon, 2 to 5 percent in the B horizon, and 5 to 12 percent in the C horizon.

The Ap horizon has hue of 10YR, value of 4 to 6, and chroma of 1 to 3. It is typically silt loam but is loam in some pedons. It is slightly acid or neutral. The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 4. It is silty clay loam, clay loam, silty clay, or clay. It ranges from slightly acid to very strongly acid in the upper part and from medium acid to mildly alkaline in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 4. It is silty clay loam or clay loam.

Bono Series

The Bono series consists of deep, very poorly drained soils in depressions on lake plains. These soils formed in lacustrine sediments. Permeability is slow or very slow. Slope is 0 to 2 percent.

These soils are considerably more acid in the upper part of the solum than is definitive for the Bono series. This difference, however, does not alter the usefulness or behavior of the soils.

Bono soils are commonly adjacent to Fulton and Toledo soils and are similar to Toledo soils. The somewhat poorly drained Fulton soils are on slight rises and on slopes along drainageways. Toledo soils have a dark surface layer that is thinner than that of the Bono soils. Their landscape positions are similar to those of the Bono soils.

Typical pedon of Bono silty clay, in Riley Township; approximately 1,980 feet west and 1,650 feet south of the northeast corner of sec. 2, T. 5 N., R. 16 E.

Ap1—0 to 6 inches; very dark gray (N 3/0) silty clay, gray (10YR 5/1) dry; few medium distinct dark brown (7.5YR 4/4) and few coarse distinct grayish brown (2.5Y 5/2) mottles; moderate medium and coarse granular structure; firm; many roots; strongly acid; clear smooth boundary.

Ap2—6 to 11 inches; black (N 2/0) silty clay, gray (10YR 5/1) dry; few medium distinct dark brown (7.5YR 4/4) and few coarse distinct grayish brown (2.5Y 5/2) mottles; moderate medium granular structure; firm; many roots; strongly acid; gradual smooth boundary.

Bg1—11 to 18 inches; dark gray (N 4/0) silty clay; few medium distinct dark brown (7.5YR 4/4) and common fine distinct dark reddish brown (5YR 3/2) and grayish brown (2.5Y 5/2) mottles; weak medium and fine subangular blocky structure; firm; common roots; strongly acid; abrupt smooth boundary.

Bg2—18 to 24 inches; dark gray (N 4/0) clay; few medium distinct grayish brown (2.5Y 5/2) and many coarse distinct reddish brown (5YR 4/4) mottles; strong coarse prismatic structure; firm; common roots; many distinct gray (N 5/0) coatings on faces of peds; slightly acid; abrupt smooth boundary.

Bg3—24 to 54 inches; gray (5Y 6/1) clay; many coarse distinct yellowish brown (10YR 5/4) and few fine distinct gray (5YR 5/1) mottles; weak coarse prismatic structure; firm; neutral; clear smooth boundary.

Cg—54 to 60 inches; grayish brown (10YR 5/2) clay; many coarse distinct brown (10YR 4/3) and few fine distinct gray (5YR 5/1) mottles; appears massive but has weak horizontal bedding planes; firm; slight effervescence; mildly alkaline.

The mollic epipedon ranges from 10 to 22 inches in thickness. The thickness of the solum and the depth to carbonates range from 50 to 60 inches. The content of clay in the control section typically is 40 to 55 percent. In some pedons, however, it varies because of stratification.

The Ap or A horizon is neutral in hue or has hue of 10YR to 5Y. It has value of 2 or 3 and chroma of 0 to 2. It is typically silty clay but is silty clay loam in some pedons. The B horizon is neutral in hue or has hue of 10YR to 5Y. It has value of 4 to 6 and chroma of 0 to 2. It is clay, silty clay, or silty clay loam. It is strongly acid or medium acid in the upper part and neutral or mildly alkaline in the lower part. The C horizon is neutral in hue or has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. It is clay, silty clay, or silty clay loam.

Castalia Series

The Castalia series consists of moderately deep, well drained soils on knolls and slight rises on lake plains. These soils formed in material weathered from limestone or dolomite. Permeability is rapid. Slope ranges from 1 to 6 percent.

Castalia soils are commonly adjacent to Dunbridge and Millsdale soils. The adjacent soils have fewer rock fragments throughout than the Castalia soils. Dunbridge soils are in landscape positions similar to those of the Castalia soils. The very poorly drained Millsdale soils are in depressions.

Typical pedon of Castalia very stony loam, 1 to 6 percent slopes, in Woodville Township; approximately 1,980 feet north and 540 feet east of the southwest corner of sec. 9, T. 6 N., R. 13 E.

A—0 to 6 inches; very dark gray (10YR 3/1) very stony loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; friable; many roots; about 25 percent coarse fragments; mildly alkaline; clear smooth boundary.

Bw—6 to 18 inches; dark brown (7.5YR 4/4) very flaggy loam; weak medium granular structure; friable; few fine roots; very few faint dark brown (7.5YR 4/2) clay films bridging sand grains; about 60 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

C—18 to 24 inches; dark brown (7.5YR 4/4) extremely flaggy loam; weak medium granular structure; very friable; few fine roots; about 90 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

R—24 to 30 inches; fractured dolomite bedrock.

The content of coarse fragments ranges from 30 to 80 percent in the B horizon and from 70 to 90 percent in the C horizon. The depth to bedrock ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The fine-earth fraction of this horizon is typically loam but is silt loam or sandy loam in some pedons. The fine-earth fraction of the Bw and C horizons is loam, silt loam, or sandy loam. The Bw horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 6. The C horizon has hue of 7.5YR or 5YR, value of 4 to 6, and chroma of 3 or 4.

Colwood Series

The Colwood series consists of deep, very poorly drained, moderately permeable soils on flats and in depressions on lake plains and outwash plains. These soils formed in stratified loamy and sandy lakebed sediments. Slope is 0 to 2 percent.

Colwood soils are commonly adjacent to Bixler, Gilford, Kibbie, Lenawee, and Mermill soils and are similar to Gilford and Mermill soils. The somewhat poorly drained Bixler and Kibbie soils are on slight rises. Gilford soils have less clay and Lenawee soils more clay in the subsoil than the Colwood soils. Mermill soils have a dark surface layer that is thinner than that of the Colwood soils. Gilford, Lenawee, and Mermill soils are in landscape positions similar to those of the Colwood soils. Also, Mermill soils are on till plains and terraces.

Typical pedon of Colwood fine sandy loam, in Riley Township; approximately 875 feet south and 1,900 feet west of the northeast corner of sec. 32, T. 5 N., R. 16 E.

Ap—0 to 11 inches; black (10YR 2/1) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; many roots; slightly acid; clear smooth boundary.

Bg1—11 to 20 inches; grayish brown (2.5Y 5/2) sandy clay loam; few medium prominent yellowish brown (10YR 5/6) and many fine distinct dark yellowish brown (10YR 4/4) mottles; moderate coarse and medium subangular blocky structure; friable; many roots; common faint grayish brown (10YR 5/2) coatings on faces of peds; few very dark gray (10YR 3/1) wormcasts; slightly acid; clear smooth boundary.

Bg2—20 to 28 inches; grayish brown (2.5Y 5/2) sandy clay loam; many medium distinct yellowish brown (10YR 5/4 to 5/8) mottles; moderate coarse subangular blocky structure; firm; common fine roots; common faint grayish brown (10YR 5/2) coatings bridging sand grains; few very dark gray (10YR 3/1) wormcasts; neutral; clear smooth boundary.

Bg3—28 to 37 inches; gray (10YR 5/1) sandy clay loam; many coarse prominent strong brown (7.5YR 5/8), many medium prominent yellowish brown (10YR 5/6), and few medium prominent dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; few roots; common faint dark gray (10YR 4/1) and gray (10YR 5/1) coatings on faces of peds; neutral; clear smooth boundary.

BCg—37 to 56 inches; gray (10YR 5/1) silty clay loam; many coarse prominent strong brown (7.5YR 5/6) and few medium faint light gray (10YR 7/1) mottles; weak coarse and medium subangular blocky structure; firm; few roots; few fine very dark gray (10YR 3/1) concretions (iron and manganese oxides); neutral; clear smooth boundary.

Cg—56 to 65 inches; gray (10YR 5/1) silty clay loam; many coarse prominent brown (7.5YR 4/4) mottles; appears massive but has weak horizontal bedding planes; firm; slight effervescence; mildly alkaline.

The solum ranges from 36 to 60 inches in thickness. It is slightly acid to mildly alkaline.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is typically fine sandy loam but is silt loam, loam, or very fine sandy loam in some pedons. The B horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is silty clay loam, loam, sandy clay loam, clay loam, silt loam, or fine sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is stratified silt loam, fine sand, silty clay loam, or very fine sand. It is mildly alkaline or moderately alkaline.

Del Rey Series

The Del Rey series consists of deep, somewhat poorly drained, slowly permeable soils on lake plains. These soils formed in lacustrine sediments. Slope is 0 to 2 percent.

Del Rey soils are commonly adjacent to Kibbie and Lenawee soils and are similar to Bennington, Blount, and Nappanee soils. Bennington, Blount, and Nappanee soils formed in glacial till and have a higher content of coarse fragments throughout than the Del Rey soils. Also, Nappanee soils have more clay in the subsoil and substratum. Kibbie soils have more sand and less silt and clay in the upper part of the subsoil than the Del Rey soils. They are on lake plains, on deltas, and along the edges of the higher beach ridges. The very poorly drained Lenawee soils are on flats and in depressions.

Typical pedon of Del Rey silt loam, 0 to 2 percent slopes, in Green Creek Township; approximately 990 feet east and 745 feet south of the northwest corner of sec. 9, T. 4 N., R. 16 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; weak medium and fine granular structure; friable; many fine roots; neutral; clear smooth boundary.

BE—9 to 14 inches; brown (10YR 5/3) silty clay loam; many coarse distinct yellowish brown (10YR 5/6), few fine faint dark grayish brown (10YR 4/2), and few medium distinct dark yellowish brown (10YR 4/4) mottles; moderate coarse and medium subangular blocky structure; firm; common fine roots; common faint grayish brown (10YR 5/2) silt coatings on faces of peds; slightly acid; clear smooth boundary.

Bt1—14 to 22 inches; brown (10YR 4/3) silty clay loam; few medium distinct yellowish brown (10YR 5/6), many medium distinct dark brown (7.5YR 4/4), and few fine faint dark grayish brown (10YR 4/2) mottles; strong coarse subangular blocky structure; firm; common fine roots; many distinct dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) coatings on faces of peds; common distinct grayish brown (10YR 5/2) clay films on faces of peds; neutral; clear smooth boundary.

Bt2—22 to 29 inches; brown (10YR 4/3) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate coarse subangular blocky structure; firm; few fine roots; common distinct dark grayish brown (10YR 4/2) clay films and many distinct grayish brown (10YR 5/2) coatings on faces of peds; neutral; clear smooth boundary.

BCg—29 to 46 inches; grayish brown (10YR 5/2) silty clay loam; few medium distinct yellowish brown (10YR 5/6) and many coarse faint brown (10YR 5/3) mottles; weak coarse prismatic structure; firm; few fine roots; common distinct dark grayish brown (10YR 4/2) clay films on face of peds; few light gray (10YR 7/1) calcium carbonate concretions; few dark grayish brown (10YR 4/2) fillings in root channels; strong effervescence; mildly alkaline; clear smooth boundary.

Cg—46 to 66 inches; grayish brown (10YR 5/2) silt loam; few medium distinct yellowish brown (10YR 5/6) and few medium prominent brownish yellow (10YR 6/6) mottles; appears massive but has weak horizontal bedding planes; few vertical partings; firm; few fine roots; grayish brown (10YR 5/2) coatings in vertical partings; common light gray (10YR 7/1) calcium carbonate concretions; strong effervescence; moderately alkaline.

The solum ranges from 24 to 48 inches in thickness. It is medium acid to neutral in the upper part and slightly acid to moderately alkaline in the lower part.

The Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. It is typically silt loam but is silty clay loam or loam in some pedons. The B horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 6. It is silty clay loam or silty clay. Thin lenses of silt loam are in the lower part of the B horizon in some pedons. The C horizon has hue of 10YR, value of 4 to 6, and chroma of 1 to 6. It is typically silt loam or silty clay loam, but some pedons are stratified with thin layers of loam, fine sandy loam, or sandy loam.

Dixboro Series

The Dixboro series consists of deep, somewhat poorly drained, moderately permeable soils on lake plains and deltas. These soils formed in stratified sandy and loamy sediments. Slope is 0 to 2 percent.

Dixboro soils are commonly adjacent to Colwood and Spinks soils. The very poorly drained Colwood soils are on broad flats and in depressions. The well drained Spinks soils have more sand in the solum than the Dixboro soils. They are on former beach ridges and offshore bars.

Typical pedon of Dixboro sandy loam, in an area of Dixboro-Kibbie complex, 0 to 2 percent slopes, in Ballville Township; approximately 1,070 feet west and 100 feet south of the northeast corner of sec. 33, T. 4 N., R. 15 E.

Ap1—0 to 5 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; few roots; specks of yellowish brown (10YR 5/6) subsoil material; about 2 percent course fragments; neutral; clear smooth boundary.

Ap2—5 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; weak medium and fine granular structure; friable; few roots; specks of yellowish brown (10YR 5/4) subsoil material; few fine dark brown (7.5YR 3/2) concretions (iron and manganese oxides); about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

Bt1—9 to 19 inches; yellowish brown (10YR 5/4) sandy loam; many medium distinct yellowish brown (10YR 5/8) and common medium distinct grayish brown (10YR 5/2) mottles; weak medium and fine subangular blocky structure; friable; few roots; few distinct grayish brown (10YR 5/2) clay films bridging sand grains; few fine dark brown (7.5YR 3/2) concretions (iron and manganese oxides); about 2 percent coarse fragments; neutral; clear smooth boundary.

Bt2—19 to 29 inches; yellowish brown (10YR 5/4) coarse sandy loam; many medium distinct light brownish gray (10YR 6/2) and common medium faint brown (10YR 5/3) mottles; weak medium and coarse subangular blocky structure; friable; few roots; few distinct grayish brown (10YR 5/2) clay films bridging sand grains; dark brown (7.5YR 3/2) concretions (iron and manganese oxides); about 3 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

BCg—29 to 38 inches; grayish brown (10YR 5/2) fine sandy loam; common fine distinct olive yellow (2.5Y 6/6) and common fine distinct yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; friable; few roots; very few faint grayish brown (10YR 5/2) clay films bridging sand grains; few very dark grayish brown (10YR 3/2) krotovinas; about 1 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

Cg1—38 to 42 inches; grayish brown (10YR 5/2) sandy loam; massive; very friable; few roots; about 4 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—42 to 48 inches; grayish brown (10YR 5/2) sandy loam; few medium distinct light yellowish brown (10YR 6/4) and many coarse distinct yellowish brown (10YR 5/6) mottles; massive; very friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cg3—48 to 60 inches; grayish brown (10YR 5/2) sand; many coarse distinct yellowish brown (10YR 5/6) mottles; single grained; loose; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 44 inches and the depth to carbonates from 19 to 40 inches. The solum is neutral or slightly acid in the upper part and mildly alkaline or moderately alkaline in the lower part. The content of gravel is 0 to 5 percent in the B and C horizons.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is typically sandy loam but is fine sandy loam, loamy fine sand, or very fine sandy loam in some pedons. The Bt horizon has hue of 10YR, value of 4 to 6, and chroma of 3 or 4. It is sandy loam, fine sandy loam, or coarse sandy loam. The C horizon has hue of 10YR, value of 5 or 6, and chroma of 1 to 4. It is stratified loamy sand, fine sandy loam, sand, coarse sandy loam, sandy loam, or silt loam.

Dunbridge Series

The Dunbridge series consists of moderately deep, well drained soils on lake plains and stream terraces. These soils formed in loamy glacial outwash or till over limestone or dolomite bedrock. Permeability is moderately rapid. Slope ranges from 1 to 4 percent.

Dunbridge soils are commonly adjacent to Castalia, Millsdale, and Spinks soils. Castalia soils are in landscape positions similar to those of the Dunbridge soils. They have a higher content of coarse fragments throughout than the Dunbridge soils. The very poorly drained Millsdale soils are in depressions. Spinks soils are deep over bedrock and have more sand throughout than the Dunbridge soils. They are on beach ridges.

Typical pedon of Dunbridge sandy loam, 1 to 4 percent slopes, in Madison Township; approximately 1,240 feet east and 1,240 feet south of the northwest corner of sec. 25, T. 5 N., R. 13 E.

Ap1—0 to 5 inches; dark brown (10YR 3/3) sandy loam, grayish brown (10YR 5/2) dry; weak medium and fine granular structure; friable; many roots; about 5 percent coarse fragments; neutral; abrupt smooth boundary.

Ap2—5 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; weak medium and coarse granular structure; friable; many roots; about 5 percent coarse fragments; neutral; abrupt smooth boundary.

Bt1—9 to 13 inches; dark yellowish brown (10YR 4/4) sandy clay loam; weak coarse and medium subangular blocky structure; friable; few fine roots; common distinct brown (10YR 4/3) clay films; few very dark grayish brown (10YR 3/2) wormcasts; about 3 percent coarse fragments; neutral; clear wavy boundary.

Bt2—13 to 20 inches; dark yellowish brown (10YR 4/4) clay loam; weak medium and coarse subangular blocky structure; friable; few roots; common distinct brown (10YR 4/3) clay films bridging sand grains; about 1 percent coarse fragments; neutral; clear smooth boundary.

Bt3—20 to 25 inches; dark yellowish brown (10YR 4/4) sandy clay loam; weak coarse and medium subangular blocky structure; friable; few roots; common distinct dark yellowish brown (10YR 4/4) clay films bridging sand grains; about 4 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bt4—25 to 30 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium and coarse subangular blocky structure; friable; few roots; common distinct brown (10YR 4/3) clay films; about 2 percent gray (10YR 6/1) and yellowish brown (10YR 5/4) weathered limestone fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

2R—30 to 35 inches; fractured limestone bedrock.

The thickness of the solum and the depth to bedrock commonly are 20 to 35 inches but range from 20 to 40 inches. The depth to bedrock commonly varies within short distances. The content of coarse fragments ranges from 1 to 15 percent in the A horizon, from 1 to 35 percent in the B horizon, and from 15 to 90 percent in the C horizon. The fragments are dominantly partially weathered cobblestones or angular pebbles but are stones in some pedons. The solum is neutral or slightly acid in the upper part and neutral or mildly alkaline in the lower part.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is sandy loam, loamy sand, loamy fine sand, or the gravelly analogs of these textures. The B horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6. It is fine sandy loam, sandy loam, sandy clay loam, clay loam, or the gravelly analogs of these textures.

Fulton Series

The Fulton series consists of deep, somewhat poorly drained soils on lake plains. These soils formed in lacustrine sediments. Permeability is slow or very slow. Slope is 0 to 3 percent.

Fulton soils are commonly adjacent to Lucas, Saylesville, and Toledo soils. The moderately well drained Lucas and Saylesville soils are on slope breaks along drainageways. Saylesville soils have less clay in the subsoil and substratum than the Fulton soils. The very poorly drained Toledo soils are on broad flats and in narrow depressions.

Typical pedon of Fulton silty clay loam, 0 to 3 percent slopes, in Rice Township; approximately 580 feet east and 1,360 feet south of the northwest corner of sec. 4, T. 5 N., R. 15 E.

Ap—0 to 12 inches; dark grayish brown (10YR 4/2) silty clay loam, very pale brown (10YR 7/3) dry; weak medium granular structure; firm; many fine roots; specks of yellowish brown (10YR 5/6) subsoil material; neutral; abrupt smooth boundary.

Bt1—12 to 20 inches; brown (10YR 4/3) silty clay; many medium distinct yellowish brown (10YR 5/6) and few fine faint grayish brown (10YR 5/2) mottles; strong coarse subangular blocky structure; firm; few fine roots; many distinct grayish brown (10YR 5/2) coatings and common distinct grayish brown (10YR 5/2) clay films on faces of peds; few fine black (10YR 2/1) concretions (iron and manganese oxides); neutral; clear smooth boundary.

Bt2—20 to 26 inches; brown (10YR 4/3) clay; few medium distinct dark brown (7.5YR 4/4) and many medium distinct yellowish brown (10YR 5/6) mottles; strong coarse subangular blocky structure; firm; few fine roots; many distinct grayish brown (10YR 5/2) coatings and common distinct grayish brown (10YR 5/2) clay films on faces of peds; common fine black (10YR 2/1) concretions (iron and manganese oxides); neutral; clear smooth boundary.

Btg—26 to 30 inches; grayish brown (10YR 5/2) silty clay; few fine faint gray (10YR 6/1) and many medium prominent yellowish brown (10YR 5/6) mottles; strong coarse subangular blocky structure; firm; common distinct grayish brown (10YR 5/2) clay films on faces of peds; few fine black (10YR 2/1) concretions (iron and manganese oxides); slight effervescence; mildly alkaline; abrupt smooth boundary.

BCg—30 to 38 inches; grayish brown (10YR 5/2) silty clay; common medium prominent yellowish brown (10YR 5/6) mottles; strong coarse subangular blocky structure; firm; common distinct brown (10YR 4/3) clay films on faces of peds; few fine black (10YR 2/1) concretions (iron and manganese oxides); slight effervescence; moderately alkaline; abrupt smooth boundary.

Cg—38 to 60 inches; light brownish gray (10YR 6/2) silty clay; common medium prominent yellowish brown (10YR 5/6) and few medium distinct brown (10YR 4/3) mottles; massive; firm; common distinct light gray (10YR 7/1) calcium carbonate coatings on vertical partings; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 24 to 40 inches. Reaction is neutral or slightly acid in the A horizon and in the upper part of the B horizon and is neutral or mildly alkaline in the lower part of the B horizon.

The Ap horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is typically silty clay loam but is silt loam or loam in some pedons. The Bt horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 1 to 4. It is silty clay or clay. The content of clay in this horizon ranges from 45 to 60 percent. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 6. It is dominantly silty clay or clay but has thin strata of silty clay loam, silt loam, loam, or fine sand in some pedons.

Gilford Series

The Gilford series consists of deep, very poorly drained soils on flats and in depressions on outwash plains and lake plains. These soils formed in loamy and sandy sediments. Permeability is moderately rapid. Slope is 0 to 2 percent.

Gilford soils are commonly adjacent to Bixler, Colwood, and Kibbie soils and are similar to Colwood and Mermill soils. The somewhat poorly drained Bixler and Kibbie soils are on slight rises. Colwood and Mermill soils have more clay in the subsoil than the Gilford soils. Colwood soils are in landscape positions similar to those of the Gilford soils.

Typical pedon of Gilford fine sandy loam, in Sandusky Township; approximately 1,060 feet north and 660 feet east of the southwest corner of sec. 24, T. 5 N., R. 15 E.

Ap1—0 to 6 inches; black (N 2/0) fine sandy loam, dark gray (10YR 4/1) dry; weak medium and fine granular structure; friable; many fine roots; slightly acid; clear smooth boundary.

Ap2—6 to 14 inches; black (N 2/0) fine sandy loam, dark gray (10YR 4/1) dry; weak coarse and medium granular structure; friable; common fine roots; slightly acid; clear wavy boundary.

Bg1—14 to 19 inches; dark gray (10YR 4/1) fine sandy loam; common fine prominent yellowish brown (10YR 5/6) and few medium faint grayish brown (10YR 5/2) mottles; weak coarse and medium subangular blocky structure; friable; common fine roots; common distinct very dark gray (10YR 3/1) coatings on faces of peds; few grayish brown (10YR 5/2) wormcasts; few fine very dark gray (N 3/0) concretions (iron and manganese oxides); slightly acid; clear smooth boundary.

Bg2—19 to 26 inches; grayish brown (10YR 5/2) sandy loam; common medium prominent yellowish brown (10YR 5/6) and few medium prominent dark brown (7.5YR 4/4) mottles; weak coarse and medium subangular blocky structure; friable; few fine roots; common distinct gray (10YR 5/1) coatings on faces of peds; few gray (10YR 5/1) wormcasts; few fine very dark gray (10YR 3/1) concretions (iron and manganese oxides); slightly acid; clear smooth boundary.

Bg3—26 to 33 inches; light brownish gray (10YR 6/2) fine sandy loam; few medium prominent brownish yellow (10YR 6/8) and few medium prominent yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; friable; few fine roots; common faint gray (10YR 6/1) coatings on faces of peds; few dark gray (10YR 4/1) krotovinas; few fine very dark gray (10YR 3/1) concretions (iron and manganese oxides); slightly acid; clear smooth boundary.

Bg4—33 to 43 inches; light brownish gray (10YR 6/2) fine sandy loam; few medium distinct brownish yellow (10YR 6/6) mottles; weak coarse subangular blocky structure; friable; common faint light brownish gray (10YR 6/2) coatings on faces of peds; slightly acid; clear smooth boundary.

C—43 to 48 inches; brown (10YR 5/3) loamy sand; many fine prominent yellowish brown (10YR 5/8), common fine faint grayish brown (10YR 5/2), and many coarse faint dark grayish brown (10YR 4/2) mottles; single grained; loose; slightly acid; clear smooth boundary.

Cg—48 to 60 inches; grayish brown (10YR 5/2) loamy sand; few coarse prominent yellowish brown (10YR 5/8) and many coarse faint gray (10YR 5/1) mottles; single grained; loose; neutral.

The solum ranges from 30 to 45 inches in thickness. It is slightly acid or neutral. The content of fine gravel ranges from 0 to 8 percent throughout the profile. The thickness of the mollic epipedon ranges from 10 to 22 inches.

The Ap horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 0 to 2. It is typically fine sandy loam but is sandy loam or loam in some pedons. The B horizon has hue of 10YR to 5Y, value of 3 to 6, and chroma of 1 or 2. It is dominantly fine sandy loam or sandy loam but has thin layers of sandy clay loam, loam, or loamy sand in some pedons. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 1 to 3. It is loamy sand, sand, or fine sand.

Glenford Series

The Glenford series consists of deep, moderately well drained, moderately slowly permeable soils on lake plains and on terraces along streams. These soils formed in silty lacustrine deposits. Slope ranges from 2 to 6 percent.

Glenford soils are commonly adjacent to Colwood, Del Rey, Glynwood, and Kibbie soils and are similar to Mentor soils. The very poorly drained Colwood soils are on flats and in depressions. The somewhat poorly drained Del Rey and Kibbie soils are in the slightly lower landscape positions. Also, Kibbie soils have a dark surface layer. Glynwood soils formed in glacial till. They have a higher content of coarse fragments throughout than the Glenford soils. Also, they are more undulating. Mentor soils are well drained.

Typical pedon of Glenford silt loam, 2 to 6 percent slopes, in Washington Township; approximately 1,560 feet west and 825 feet south of northeast corner of sec. 4, T. 5 N., R. 14 E.

Ap—0 to 9 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate medium and fine granular structure; friable; few fine roots; medium acid; abrupt smooth boundary.

Bt1—9 to 27 inches; brown (7.5YR 4/4) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; common fine distinct light brownish gray (10YR 6/2) mottles below a depth of about 16 inches; moderate coarse and medium prismatic structure parting to weak thin platy; friable; few fine roots; common distinct brown (10YR 4/3) clay films on faces of peds; few fine black (10YR 2/1) stains (iron and manganese oxides); medium acid; clear smooth boundary.

Bt2—27 to 33 inches; yellowish brown (10YR 5/4) silt loam; common medium distinct grayish brown (10YR 5/2) and common medium distinct yellowish brown (10YR 5/8) mottles; weak coarse and medium prismatic structure parting to weak thin platy; friable; few fine roots; common distinct brown (10YR 4/3) clay films on faces of peds; few fine black (10YR 2/1) stains (iron and manganese oxides); slightly acid; abrupt smooth boundary.

BC—33 to 41 inches; yellowish brown (10YR 5/4) silt loam; common medium faint yellowish brown (10YR 5/6) and common medium distinct grayish brown (10YR 5/2) mottles; weak coarse subangular blocky structure parting to weak thin platy; friable; few fine roots; common distinct grayish brown (10YR 5/2) coatings on faces of peds; neutral; clear smooth boundary.

C1—41 to 46 inches; brown (10YR 5/3) silt loam; common medium distinct yellowish brown (10YR 5/8) and common medium distinct light brownish gray (10YR 6/2) mottles; appears massive but has weak horizontal bedding planes; friable; slight effervescence; mildly alkaline; clear smooth boundary.

C2—46 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; common medium distinct grayish brown (10YR 5/2), few fine faint yellowish brown (10YR 5/6), and few fine distinct brown (7.5YR 5/4) mottles; appears massive but has weak horizontal bedding planes; friable; few light gray (10YR 7/2) calcium carbonate concretions; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 60 inches. Reaction is medium acid in the upper part of the Bt horizon and slightly acid or neutral in the lower part.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. The B and C horizons have hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 6. The C horizon is commonly stratified silt loam and silty clay loam but has thin strata of loam, fine sandy loam, or silty clay in some pedons.

Glynwood Series

The Glynwood series consists of deep, moderately well drained soils on lake plains and till plains. These soils formed in glacial till. Permeability is slow. Slope ranges from 2 to 6 percent.

Glynwood soils are commonly adjacent to Bennington, Blount, Glenford, Nappanee, and Pewamo soils. The somewhat poorly drained Bennington, Blount, and Nappanee soils are on flats and slight rises. Glenford soils formed in lacustrine sediments and have less sand and fewer coarse fragments in the subsoil and substratum than the Glynwood soils. Their landscape positions are similar to those of the Glynwood soils. The very poorly drained Pewamo soils are in depressions and drainageways.

Typical pedon of Glynwood silt loam, 2 to 6 percent slopes, in Woodville Township; approximately 990 feet west and 1,485 feet south of the northeast corner of sec. 17, T. 6 N., R. 13 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; weak medium granular structure; friable; many fine roots; specks of yellowish brown (10YR 5/6) subsoil material; about 1 percent coarse fragments; neutral; abrupt smooth boundary.

Bt1—9 to 14 inches; dark yellowish brown (10YR 4/4) silty clay; common coarse distinct strong brown (7.5YR 5/6) and common medium distinct brown (10YR 5/3) mottles; strong coarse and medium subangular blocky structure; firm; common fine roots; common distinct dark brown (7.5YR 4/4) clay films on faces of peds; about 3 percent coarse fragments; neutral; clear smooth boundary.

Bt2—14 to 20 inches; dark yellowish brown (10YR 4/4) clay loam; few medium distinct reddish brown (5YR 4/4), few fine distinct strong brown (7.5YR 5/6), and few fine distinct grayish brown (10YR 5/2) mottles; strong coarse prismatic structure; firm; few fine roots; common distinct dark brown (7.5YR 4/4) clay films on faces of peds; few fine black (N 2/0) concretions (iron and manganese oxides); about 3 percent coarse fragments; neutral; clear smooth boundary.

BC—20 to 36 inches; brown (10YR 4/3) clay loam; few fine distinct light brownish gray (10YR 6/2), few fine distinct yellowish red (5YR 5/6), and few medium distinct strong brown (7.5YR 5/8) mottles; moderate coarse subangular blocky structure; firm; few fine roots; few faint brown (10YR 4/3) clay films on faces of peds; few distinct light gray (10YR 7/1) calcium carbonate coatings on vertical faces of peds; about 8 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C1—36 to 48 inches; brown (10YR 4/3) silty clay loam; few fine distinct yellowish brown (10YR 5/6) and few medium distinct reddish brown (5YR 5/3) mottles; massive; firm; few distinct light gray (10YR 7/1) calcium carbonate coatings on a few vertical partings; about 8 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C2—48 to 60 inches; brown (10YR 4/3) silty clay loam; few medium distinct dark brown (7.5YR 4/4), gray (10YR 6/1), and yellowish brown (10YR 5/6) mottles; massive; firm; thin patchy light gray (10YR 7/2) calcium carbonate coatings on a few vertical partings; about 3 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 22 to 40 inches. The depth to free carbonates is 16 to 36 inches. Reaction ranges from medium acid to neutral in the upper part of the solum and from neutral to moderately alkaline in the lower part. The content of coarse fragments ranges from 0 to 5 percent in the A horizon, from 0 to 10 percent in the B horizon, and from 2 to 14 percent in the C horizon.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. It is typically silt loam but is silty clay loam or clay loam in some pedons. Some pedons have an A horizon. This horizon is 1 to 6 inches thick. It has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The Bt horizon has hue of 10YR, value of 4 or 5, and chroma of 2 to 6. It is silty clay, silty clay loam, or clay loam in the upper part and clay loam or silty clay loam in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is clay loam or silty clay loam.

Granby Series

The Granby series consists of very poorly drained, rapidly permeable soils on flats and in depressions on lake plains, on toe slopes of beach ridges, and on interbeach ridges. These soils formed in sandy deposits. Slope is 0 to 2 percent.

Granby soils are commonly adjacent to Colwood, Spinks, and Tedrow soils. Colwood soils have more clay in the subsoil than the Granby soils. They are in landscape positions similar to those of the Granby soils. The well drained Spinks soils are on beach ridges and former offshore bars. The somewhat poorly drained Tedrow soils are on low beach ridges and sand dunes.

Typical pedon of Granby loamy sand, in Green Creek Township; approximately 575 feet north and 85 feet east of the southwest corner of sec. 14, T. 4 N., R. 16 E.

Ap—0 to 12 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; weak medium and fine granular structure; very friable; many fine roots; neutral; abrupt smooth boundary.

Bg1—12 to 16 inches; gray (10YR 5/1) loamy sand; few fine faint dark grayish brown (10YR 4/2) mottles; weak medium and fine granular structure; very friable; common fine roots; common black (10YR 2/1) wormcasts; neutral; abrupt smooth boundary.

Bg2—16 to 21 inches; gray (10YR 5/1) loamy sand; few fine faint brown (10YR 4/3) and few fine faint dark grayish brown (10YR 4/2) mottles; weak medium and fine granular structure; very friable; few roots; neutral; abrupt smooth boundary.

Bg3—21 to 24 inches; gray (10YR 6/1) sand; weak medium and fine granular structure; very friable; neutral; abrupt smooth boundary.

Cg1—24 to 31 inches; grayish brown (10YR 5/2) sand; few medium faint brown (10YR 4/3) mottles; single grained; loose; about 5 percent coarse fragments; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg2—31 to 60 inches; gray (10YR 5/1) sand; few medium distinct brown (10YR 4/3) mottles; single grained; loose; about 1 percent coarse fragments; strong effervescence; moderately alkaline.

The solum ranges from 24 to 42 inches in thickness. It is slightly acid to mildly alkaline.

The Ap horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 0 to 2. It is typically loamy sand but is sand, loamy fine sand, fine sand, fine sandy loam, or sandy loam in some pedons. The B horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 3. It is dominantly fine sand, loamy sand, sand, or loamy fine sand, but some pedons have thin lenses of sandy loam or sandy clay loam. The C horizon has hue of 10YR to 5Y, value of 5 to 7, and chroma of 1 to 4. It is commonly sand, fine sand, or loamy sand, but in some pedons it is gravelly sand or gravelly loamy sand.

Haskins Series

The Haskins series consists of deep, somewhat poorly drained soils on till plains, stream terraces, and lake plains. These soils formed in loamy glacial outwash over glacial till or lacustrine material. Permeability is moderate in the outwash and slow or very slow in the substratum. Slope is 1 to 4 percent.

Haskins soils are commonly adjacent to Bennington, Blount, Hoytville, and Mermill soils and are similar to Bixler and Rimer soils. Bennington and Blount soils formed in glacial till and have more clay in the upper part of the subsoil than the Haskins soils. Also, they commonly are slightly higher on the landscape. The very poorly drained Hoytville and Mermill soils are on flats and in narrow concave areas. Rimer soils have less clay in the upper part of the subsoil and Bixler soils less clay in the subsoil and substratum than the Haskins soils.

Typical pedon of Haskins sandy loam, 1 to 4 percent slopes, in York Township; approximately 990 feet south and 150 feet east of the northwest corner of sec. 32, T. 4 N., R. 17 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) sandy loam, pale brown (10YR 6/3) dry; weak fine granular structure; friable; few fine roots; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

E—9 to 12 inches; grayish brown (10YR 5/2) sandy loam; few fine distinct yellowish brown (10YR 5/4), common medium distinct light gray (10YR 7/2), and few medium faint yellowish brown (10YR 5/6) mottles; weak medium and fine granular structure; friable; few fine roots; about 4 percent coarse fragments; slightly acid; clear smooth boundary.

Btg1—12 to 16 inches; grayish brown (10YR 5/2) sandy clay loam; common fine prominent strong brown (7.5YR 5/6), many coarse distinct yellowish brown (10YR 5/6), and common fine distinct yellowish brown (10YR 5/8) mottles; weak medium and fine subangular blocky structure; friable; few fine roots; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds; few fine very dark grayish brown (10YR 3/2) concretions (iron and manganese oxides); about 1 percent coarse fragments; strongly acid; clear smooth boundary.

Btg2—16 to 20 inches; grayish brown (10YR 5/2) clay loam; few fine distinct light gray (10YR 7/2), many coarse distinct yellowish brown (10YR 5/6), and few coarse distinct dark brown (7.5YR 4/4) mottles; moderate coarse and medium subangular blocky structure; firm; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds; about 1 percent coarse fragments; strongly acid; abrupt smooth boundary.

Bt—20 to 28 inches; yellowish brown (10YR 5/4) sandy clay loam; common medium distinct gray (10YR 5/1) and few fine distinct dark grayish brown (10YR 4/2) mottles; weak coarse and medium subangular blocky structure; friable; many distinct gray (10YR 5/1) coatings on faces of peds; common distinct gray (10YR 5/1) clay films bridging sand grains; few fine very dark grayish brown (10YR 3/2) manganese oxide stains; about 1 percent coarse fragments; strongly acid; clear smooth boundary.

Btg'—28 to 38 inches; grayish brown (10YR 5/2) gravelly clay loam; common medium distinct dark brown (7.5YR 4/2) and few fine prominent strong brown (7.5YR 5/6) mottles; weak medium and coarse subangular blocky structure; friable; common distinct brown (10YR 5/3) clay films bridging sand grains; about 20 percent coarse fragments; few fine very dark gray (N 3/0) concretions (iron and manganese oxides); neutral; abrupt smooth boundary.

2C1—38 to 45 inches; brown (10YR 4/3) silty clay loam; common medium distinct yellowish brown (10YR 5/6) and common medium distinct gray (10YR 6/1) mottles; massive; firm; few fine very dark gray (N 3/0) concretions (iron and manganese oxides); few fine light gray (10YR 7/2) calcium carbonate concretions; about 4 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

2C2—45 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine distinct yellowish brown (10YR 5/8), common medium distinct brown (10YR 5/3), common medium distinct gray (10YR 6/1), and few coarse distinct grayish brown (10YR 5/2) mottles; massive; firm; few fine light gray (10YR 7/2) calcium carbonate concretions; about 8 percent coarse fragments; strong effervescence; moderately alkaline.

The solum ranges from 25 to 50 inches in thickness. The depth to the underlying glacial till or lacustrine sediments ranges from 20 to 40 inches. The content of coarse fragments ranges from 0 to 10 percent in the A horizon, from 0 to 20 percent in the B horizon, and from 0 to 10 percent in the 2C horizon.

The Ap horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is neutral to strongly acid. The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 6. It is dominantly sandy clay loam, clay loam, or the gravelly analogs of these textures. In some pedons, however, it has thin strata of loam, sandy loam, or the gravelly analogs of these textures. The Bt horizon is slightly acid to strongly acid in the upper part and neutral to strongly acid in the lower part. The 2C horizon is neutral in hue or has hue of 10YR or 2.5Y. It has value of 4 or 5 and chroma of 0 to 4. It is dominantly clay, silty clay, clay loam, or silty clay loam. In some pedons, however, it has thin strata of silt loam lacustrine material.

Hoytville Series

The Hoytville series consists of deep, very poorly drained soils on broad flats and in depressions on lake plains. These soils formed in glacial till that has been modified by water action. Permeability is slow. Slope is 0 to 2 percent.

These soils do not have an argillic horizon, which is definitive for the Hoytville series. This difference, however, does not alter the usefulness or behavior of the soils.

Hoytville soils are commonly adjacent to Haskins, Mermill Variant, Millsdale, and Nappanee soils and are similar to Lenawee and Pewamo soils. Haskins and Nappanee soils do not have a dark surface layer. They are on slight rises. Lenawee soils have mixed mineralogy. Mermill Variant soils have less clay in the subsoil than the Hoytville soils. Their landscape positions are similar to those of the Hoytville soils. Millsdale soils have limestone or dolomite bedrock at a depth of 20 to 40 inches. Pewamo soils have a mollic epipedon.

Typical pedon of Hoytville silty clay loam, in Scott Township; approximately 990 feet south and 165 feet west of the northeast corner of sec. 3, T. 4 N., R. 13 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine granular structure; firm; few fine roots; about 1 percent coarse fragments; slightly acid; abrupt smooth boundary.

Btg1—8 to 12 inches; dark grayish brown (10YR 4/2) clay; common medium distinct yellowish brown (10YR 5/6) and few fine faint grayish brown (10YR 5/2) mottles; strong coarse subangular blocky structure; firm; few fine roots; few faint grayish brown (10YR 5/2) clay films on faces of peds; about 2 percent coarse fragments; neutral; clear smooth boundary.

Btg2—12 to 26 inches; grayish brown (10YR 5/2) clay; many medium distinct yellowish brown (10YR 5/6) and few medium faint brown (10YR 5/3) mottles; strong coarse prismatic structure; firm; few fine roots; few faint grayish brown (10YR 5/2) clay films on faces of peds; few very dark grayish brown (10YR 3/2) concretions (iron and manganese oxides); dark grayish brown (10YR 4/2) fillings in root channels; about 2 percent coarse fragments; neutral; clear smooth boundary.

Btg3—26 to 34 inches; grayish brown (10YR 5/2) clay; common medium distinct yellowish brown (10YR 5/6) and few medium prominent brownish yellow (10YR 6/8) mottles; strong coarse prismatic structure; firm; common faint grayish brown (10YR 5/2) clay films on faces of peds; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

BCg—34 to 41 inches; grayish brown (10YR 5/2) clay; common medium distinct yellowish brown (10YR 5/6) and common fine faint pale brown (10YR 6/3) mottles; strong coarse prismatic structure parting to strong coarse subangular blocky; firm; few faint light brownish gray (10YR 6/2) clay films on faces of peds; about 2 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

Cg1—41 to 49 inches; grayish brown (10YR 5/2) silty clay; common coarse distinct dark yellowish brown (10YR 4/4) and common medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 2 percent coarse fragments; slight effervescence; moderately alkaline; abrupt smooth boundary.

Cg2—49 to 55 inches; gray (10YR 5/1) clay; few fine distinct yellowish brown (10YR 5/4) and common medium prominent yellowish brown (10YR 5/6) mottles; massive; firm; about 2 percent coarse fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.

Cg3—55 to 60 inches; gray (10YR 5/1) silty clay loam; common medium distinct yellowish brown (10YR 5/4) and common medium faint dark gray (10YR 4/1) mottles; massive; firm; about 2 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 36 to 55 inches. It commonly is the same as the depth to carbonates. In some pedons, however, the lower part of the BCg horizon is calcareous. The content of coarse fragments ranges from 1 to 5 percent in the B horizon.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is typically silty clay loam but is clay, silty clay, or silt loam in some pedons. It is slightly acid or neutral. The B horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. It is silty clay or clay. It is slightly acid or neutral in the upper part and neutral or mildly alkaline in the lower part. The C horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 to 6. It is clay, silty clay, silty clay loam, or clay loam. It is mildly alkaline or moderately alkaline.

Kibbie Series

The Kibbie series consists of deep, somewhat poorly drained, moderately permeable soils on lake plains, on deltas, and along the edges of the higher beach ridges. These soils formed in stratified loamy and sandy lacustrine sediments. Slope is 0 to 2 percent.

Kibbie soils are commonly adjacent to Bixler, Colwood, Dixboro, Gilford, Glenford, and Lenawee soils. Bixler and Dixboro soils have less clay in the subsoil than the Kibbie soils. Their landscape positions are similar to those of the Kibbie soils. The very poorly drained Colwood, Gilford, and Lenawee soils are on broad flats and in depressions. The moderately well drained Glenford soils have less sand and more silt in the subsoil than the Kibbie soils. They are on lake plains and terraces along streams.

Typical pedon of Kibbie fine sandy loam, 0 to 2 percent slopes, in Ballville Township; approximately 1,070 feet east and 100 feet south of the northwest corner of sec. 15, T. 4 N., R. 15 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak medium and fine granular structure; friable; many fine roots; specks of brown (10YR 5/3) subsoil material; slightly acid; abrupt smooth boundary.

Bt1—9 to 15 inches; yellowish brown (10YR 5/6) loam; common medium faint yellowish brown (10YR 5/4) mottles; weak coarse and medium subangular blocky structure; friable; common fine roots; common distinct brown (10YR 5/3) clay films on faces of peds; few very dark grayish brown (10YR 3/2) wormcasts; neutral; clear smooth boundary.

Bt2—15 to 20 inches; yellowish brown (10YR 5/4) loam; many medium faint yellowish brown (10YR 5/6), few fine faint pale brown (10YR 6/3), and few medium distinct gray (10YR 6/1) mottles; weak coarse and medium subangular blocky structure; friable; few fine roots; common faint yellowish brown (10YR 5/4) clay films on faces of peds; very dark gray (10YR 3/1) wormcasts; neutral; clear smooth boundary.

Bt3—20 to 24 inches; yellowish brown (10YR 5/4) silt loam; few medium distinct light brownish gray (10YR 6/2) and many medium faint yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to weak thick platy; friable; few fine roots; common faint yellowish brown (10YR 5/4) clay films on faces of peds; few very dark gray (10YR 3/1) wormcasts; neutral; clear smooth boundary.

Cg1—24 to 40 inches; grayish brown (10YR 5/2) silt loam; many medium distinct yellowish brown (10YR 5/4 and 5/6) mottles; appears massive but has weak horizontal bedding planes; friable; thin strata of fine sandy loam; about 1 percent coarse fragments; few fine black (10YR 2/1) concretions (iron and manganese oxides); few light gray (10YR 7/2) calcium carbonate concretions; slight effervescence; mildly alkaline; clear smooth boundary.

Cg2—40 to 60 inches; light brownish gray (10YR 6/2) silt loam; few coarse prominent strong brown (7.5YR 5/6) and many medium distinct light olive brown (2.5Y 5/4) mottles; appears massive but has weak horizontal bedding planes; friable; thin strata of loamy very fine sand; about 1 percent coarse fragments; few fine light gray (10YR 7/1) calcium carbonate concretions; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 24 to 48 inches. The solum is slightly acid or neutral.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is typically fine sandy loam but is loam, silt loam, sandy loam, or loamy fine sand in some pedons. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 6. It is sandy clay loam, silt loam, loam, clay loam, or silty clay loam. The sequence of strata in the B horizon varies. The content of clay in this horizon is 18 to 35 percent. The C horizon has hue of 10YR, value of 4 to 6, and chroma of 2 to 4. It is silt loam, loamy very fine sand, fine sandy loam, or loam. The thickness and sequence of different textured layers vary considerably in many pedons. Individual strata range from 0.25 inch to 15 inches in thickness.

Lenawee Series

The Lenawee series consists of deep, very poorly drained soils on flats and in depressions on lake plains. These soils formed in lacustrine sediments. Permeability is moderately slow. Slope is 0 to 2 percent.

Lenawee soils are commonly adjacent to Colwood, Del Rey, Hoytville, and Toledo soils and are similar to Hoytville and Pewamo soils. Colwood and Pewamo soils have a dark surface layer that is thicker than that of the Lenawee soils. Also, Colwood soils have more sand and less clay in the subsoil. The somewhat poorly drained Del Rey soils are on slight rises. Hoytville and Pewamo soils have an argillic horizon. Toledo soils have more clay in the substratum than the Lenawee soils. Colwood, Hoytville, and Toledo soils are in landscape positions similar to those of the Lenawee soils.

Typical pedon of Lenawee silty clay loam, in Ballville Township; approximately 1,320 feet west and 2,390 feet south of the northeast corner of sec. 12, T. 4 N., R. 15 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium and fine granular structure; firm; many fine roots; neutral; clear smooth boundary.

Bg1—9 to 16 inches; gray (10YR 5/1) silty clay loam; common medium distinct dark yellowish brown (10YR 4/4) and few medium prominent yellowish brown (10YR 5/6) mottles; strong coarse subangular blocky structure; firm; common fine roots; many distinct dark gray (10YR 4/1) coatings on faces of peds; common very dark gray (10YR 3/1) fillings in root channels; neutral; abrupt smooth boundary.

Bg2—16 to 24 inches; grayish brown (10YR 5/2) silty clay loam; common medium prominent yellowish brown (10YR 5/6), few fine distinct dark brown (7.5YR 4/4), and few medium distinct dark yellowish brown (10YR 4/4) mottles; strong coarse prismatic structure; firm; few fine roots; many distinct grayish brown (10YR 5/2) coatings on faces of peds; few very dark gray (10YR 3/1) fillings in root channels; neutral; clear smooth boundary.

Bg3—24 to 42 inches; gray (10YR 6/1) silty clay; many medium distinct yellowish brown (10YR 5/6) mottles; strong coarse prismatic structure; firm; few fine roots; common faint gray (10YR 6/1) coatings on faces of peds; few fine black (10YR 2/1) concretions (iron and manganese oxides); few very dark gray (10YR 3/1) fillings in root channels; neutral; clear smooth boundary.

BCg—42 to 55 inches; gray (10YR 6/1) silty clay loam; many medium prominent yellowish brown (10YR 5/6) mottles; moderate coarse prismatic structure; firm; common faint gray (10YR 6/1) coatings on faces of peds; few fine black (10YR 2/1) concretions (iron and manganese oxides); few very dark gray (10YR 3/1) fillings in root channels; slight effervescence; mildly alkaline; gradual smooth boundary.

Cg—55 to 70 inches; gray (10YR 6/1) silty clay loam; many medium prominent yellowish brown (10YR 5/6) mottles; appears massive but has weak horizontal bedding planes; firm; few fine light gray (10YR 7/1) calcium carbonate concretions; few fine black (10YR 2/1) concretions (iron and manganese oxides); strong effervescence; moderately alkaline.

The solum ranges from 25 to 55 inches in thickness. It is slightly acid to mildly alkaline. The content of clay in the 10- to 40-inch control section ranges from 35 to 45 percent.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is typically silty clay loam but is silty clay, silt loam, clay loam, or loam in some pedons. The B horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is dominantly silty clay loam, clay loam, or silty clay but has thin strata of silt loam, clay, or very fine sand in some pedons. The C horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 to 6. It is typically silt loam, silty clay loam, or clay loam but has strata of clay, silty clay, silt, or very fine sand in many pedons.

Lucas Series

The Lucas series consists of deep, moderately well drained soils on lake plains. These soils formed in lacustrine sediments. Permeability is slow or very slow. Slope ranges from 2 to 6 percent.

Lucas soils are commonly adjacent to Fulton and Toledo soils and are similar to Saylesville soils. The somewhat poorly drained Fulton soils are on slight rises and along drainageways. Saylesville soils have less clay in the subsoil and substratum than the Lucas soils. They are in landscape positions similar to those of the Lucas soils. The very poorly drained Toledo soils have a surface layer that is darker than that of the Lucas soils. They are on broad flats and along drainageways.

Typical pedon of Lucas silty clay, 2 to 6 percent slopes, in Riley Township; approximately 330 feet east and 1,400 feet north of the southwest corner of sec. 1, T. 5 N., R. 16 E.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) silty clay, light brownish gray (10YR 6/2) dry; moderate medium granular structure; firm; many fine roots; neutral; abrupt smooth boundary.

Bt1—10 to 15 inches; brown (10YR 4/3) silty clay; many medium faint dark yellowish brown (10YR 4/4) mottles; strong coarse subangular blocky structure; firm; many fine roots; common distinct dark brown (10YR 3/3) clay films on faces of peds; neutral; clear smooth boundary.

Bt2—15 to 28 inches; brown (10YR 4/3) silty clay; few medium faint dark brown (7.5YR 4/4) mottles; strong coarse subangular blocky structure; firm; common fine roots; common distinct brown (10YR 4/3) clay films on faces of peds; dark brown (7.5YR 4/2) stains on faces of peds; neutral; gradual wavy boundary.

C1—28 to 40 inches; brown (10YR 5/3) silty clay loam; many medium distinct yellowish brown (10YR 5/6) and common medium distinct dark brown (7.5YR 4/4) mottles; appears massive but has weak horizontal bedding planes; firm; few fine light gray (10YR 7/1) calcium carbonate concretions; strong effervescence; moderately alkaline; clear wavy boundary.

C2—40 to 60 inches; brown (10YR 4/3) silty clay; few fine distinct yellowish brown (10YR 5/6), common medium distinct dark yellowish brown (10YR 4/4), and common medium distinct grayish brown (10YR 5/2) mottles; massive; firm; few fine very dark gray (10YR 3/1) concretions (iron and manganese oxides); few fine light gray (10YR 7/1) calcium carbonate concretions; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 20 to 40 inches. The Ap horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is typically silty clay but is clay or silty clay loam in some pedons. It is slightly acid or neutral. The B horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 or 4. It is silty clay or clay. It is slightly acid or neutral in the upper part and neutral to moderately alkaline in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is silty clay, clay, or silty clay loam.

Mentor Series

The Mentor series consists of deep, well drained, moderately permeable soils on outwash terraces, lake plains, and terraces along streams. These soils formed in water-deposited sediments. Slope ranges from 1 to 50 percent.

Mentor soils are commonly adjacent to Colwood, Glynwood, and Saylesville soils and are similar to Glenford soils. The very poorly drained Colwood soils are on flats and in depressions. Glenford, Glynwood, and Saylesville soils are moderately well drained. Glenford and Saylesville soils are in the lower lying landscape positions. Glynwood soils formed in glacial till. They have a higher content of coarse fragments throughout than the Mentor soils. They are on till plains and lake plains.

Typical pedon of Mentor silt loam, 1 to 4 percent slopes, in Rice Township; approximately 910 feet east and 2,805 feet south of the northwest corner of sec. 12, T. 5 N., R. 15 E.

Ap—0 to 10 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak fine granular structure; friable; many fine roots; strongly acid; abrupt smooth boundary.

BA—10 to 14 inches; brown (7.5YR 5/4) silt loam; weak medium and fine subangular blocky structure; friable; many fine roots; common faint dark brown (7.5YR 4/4) coatings on faces of peds; strongly acid; clear smooth boundary.

Bt1—14 to 30 inches; brown (7.5YR 5/4) silt loam; weak coarse and medium subangular blocky structure; friable; few fine roots; common distinct dark brown (7.5YR 4/4) clay films on faces of peds; very strongly acid; clear smooth boundary.

Bt2—30 to 53 inches; brown (7.5YR 5/4) silt loam; common medium distinct pinkish gray (7.5YR 6/2) mottles; weak coarse prismatic structure; friable; few fine roots; common distinct dark brown (7.5YR 4/4) clay films on faces of peds; medium acid; clear smooth boundary.

C—53 to 60 inches; dark yellowish brown (10YR 4/4) stratified loam and silt loam; common coarse faint yellowish brown (10YR 5/4) and common medium distinct grayish brown (10YR 5/2) mottles; appears massive but has weak horizontal bedding planes; friable; medium acid.

The thickness of the solum ranges from 36 to 60 inches. Reaction ranges from very strongly acid to medium acid in the upper part of the B horizon and from strongly acid to slightly acid in the lower part. The content of coarse fragments is less than 2 percent in the solum.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. It is typically silt loam but is loam or very fine sandy loam in some pedons. The B and C horizons have hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. The B horizon is silt loam or silty clay loam. The C horizon is commonly stratified silt loam, loam, or silty clay loam but has thin strata of sandy loam in some pedons.

Mermill Series

The Mermill series consists of deep, very poorly drained soils on flats and in depressions on till plains, outwash plains, terraces, and lake plains. These soils formed in glacial outwash and the underlying glacial till or lacustrine material. Permeability is moderate in the upper part of the profile and slow or very slow in the lower part. Slope is 0 to 2 percent.

Mermill soils are commonly adjacent to Haskins, Hoytville, Lenawee, Millsdale, and Rimer soils and are similar to Colwood soils. Colwood soils have less clay in the subsoil than the Mermill soils. The somewhat poorly drained Haskins and Rimer soils are on slight rises. They do not have a dark surface layer. Hoytville and Lenawee soils have more clay in the subsoil than the Mermill soils. They are on the broader parts of lake plains. Millsdale soils have limestone or dolomite bedrock at a depth of 20 to 40 inches.

Typical pedon of Mermill loam, in Jackson Township; approximately 910 feet east and 2,440 feet north of the southwest corner of sec. 13, T. 4 N., R. 14 E.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium and coarse granular structure; friable; common fine roots; specks of yellowish brown (10YR 5/6) subsoil material; neutral; clear smooth boundary.

BAg—9 to 16 inches; gray (10YR 5/1) sandy clay loam; many medium prominent yellowish brown (10YR 5/6) and few fine distinct yellowish brown (10YR 5/4) mottles; weak medium and coarse subangular blocky structure; friable; few fine roots; many distinct very dark gray (10YR 3/1) organic coatings on faces of peds; neutral; clear wavy boundary.

Btg1—16 to 22 inches; grayish brown (10YR 5/2) sandy clay loam; many coarse distinct yellowish brown (10YR 5/6) and few fine distinct dark gray (10YR 4/1) mottles; weak coarse and medium subangular blocky structure; friable; few fine roots; common distinct gray (10YR 5/1) clay films on faces of peds; about 1 percent coarse fragments; few very dark gray (10YR 3/1) wormcasts; neutral; clear smooth boundary.

Btg2—22 to 28 inches; gray (10YR 5/1) sandy clay loam; common medium prominent yellowish brown (10YR 5/6) and few medium distinct pale brown (10YR 6/3) mottles; weak coarse and medium subangular blocky structure; friable; common distinct light brownish gray (10YR 6/2) clay films bridging sand grains; about 1 percent coarse fragments; few very dark gray (10YR 3/1) wormcasts; neutral; clear smooth boundary.

2Btg3—28 to 41 inches; grayish brown (10YR 5/2) clay loam; few fine faint light gray (10YR 6/1) and common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; few distinct gray (10YR 5/1) clay films on faces of peds; about 1 percent coarse fragments; few fine very dark gray (10YR 3/1) concretions (iron and manganese oxides); slight effervescence; mildly alkaline; clear smooth boundary.

2BC—41 to 48 inches; yellowish brown (10YR 5/6) clay loam; few coarse prominent gray (10YR 5/1) and few medium prominent light gray (10YR 6/1) mottles; moderate medium subangular blocky structure; firm; common distinct light gray (10YR 6/1) coatings on faces of peds; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

2Cg—48 to 60 inches; grayish brown (10YR 5/2) silty clay loam; common medium faint light gray (10YR 6/1), common medium distinct yellowish brown (10YR 5/6), and many coarse distinct dark yellowish brown (10YR 4/4) mottles; massive; firm; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 48 inches. The depth to glacial till or lacustrine sediments ranges from 20 to 40 inches. The content of coarse fragments is 0 to 10 percent in the A and B horizons and 0 to 5 percent in the 2C horizon.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is typically loam but is fine sandy loam or silty clay loam in some pedons. It is medium acid to neutral. The B horizon is neutral in hue or has hue of 10YR to 5Y. It has value of 4 to 6 and chroma of 0 to 2. It typically is sandy clay loam, clay loam, or loam but has thin subhorizons on sandy clay in some pedons. It is medium acid to neutral. The 2B horizon is neutral in hue or has hue of 10YR to 5Y. It has value of 4 to 6 and chroma of 0 to 2. It typically is clay loam, silty clay loam, or silty clay but has thin strata of silt loam in some pedons. It is neutral to moderately alkaline. The 2C horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. It is silty clay loam, clay loam, or silty clay.

Mermill Variant

The Mermill Variant consists of deep, very poorly drained soils on broad flats and in depressions on lake plains. These soils formed in a thin layer of loamy glacial outwash and in the underlying glacial till, which has been modified by water action. Permeability is slow. Slope is 0 to 2 percent.

Mermill Variant soils are commonly adjacent to Haskins, Hoytville, Mermill, and Rimer soils. The somewhat poorly drained Haskins and Rimer soils are on slight rises. Hoytville soils have more clay in the surface layer and subsoil than the Mermill Variant soils. Mermill soils formed in 20 to 40 inches of glacial outwash and in the underlying glacial till or lacustrine material. Hoytville and Mermill soils are slightly higher on the landscape than the Mermill Variant soils.

Typical pedon of Mermill Variant sandy loam, in Scott Township; approximately 500 feet west and 1,360 feet south of the northeast corner of sec. 15, T. 4 N., R. 13 E.

Ap—0 to 12 inches; black (N 2/0) sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; common fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

2Bg—12 to 29 inches; dark grayish brown (2.5Y 4/2) silty clay loam; common fine distinct gray (10YR 6/1) and common medium distinct yellowish brown (10YR 5/4) mottles; strong coarse subangular blocky structure; firm; common distinct grayish brown (10YR 5/2) coatings on vertical faces of peds; about 3 percent coarse fragments; few fine white (10YR 8/1) calcium carbonate concretions; strong effervescence; moderately alkaline; clear smooth boundary.

2Cg—29 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine prominent brownish yellow (10YR 6/6), common medium distinct dark yellowish brown (10YR 4/4), and few fine distinct dark brown (7.5YR 4/4) mottles; massive; firm; about 3 percent coarse fragments; few fine white (10YR 8/1) calcium carbonate concretions; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 8 to 30 inches and that of the loamy overwash material from 8 to 20 inches. The Ap horizon is neutral in hue or has hue of 10YR or 2.5Y. It has value of 2 or 3 and chroma of 0 to 2. It is typically sandy loam but is loam or fine sandy loam in some pedons. The 2B and 2C horizons have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. They are silty clay loam or clay loam.

Millsdale Series

The Millsdale series consists of moderately deep, very poorly drained soils on flats and in depressions on lake plains. These soils formed in glacial till over limestone or dolomite bedrock. The glacial till has been modified by water action. Permeability is moderately slow. Slope is 0 to 2 percent.

Millsdale soils are commonly adjacent to Castalia, Dunbridge, Hoytville, and Lenawee soils. The well drained Castalia and Dunbridge soils are on slight rises and knolls. Hoytville and Lenawee soils have bedrock below a depth of 60 inches.

Typical pedon of Millsdale silty clay loam, in Washington Township; approximately 500 feet west and 500 feet south of the northeast corner of sec. 22, T. 5 N., R. 14 E.

Ap—0 to 10 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium and fine granular structure; firm; many fine roots; about 1 percent coarse fragments; slightly acid; clear smooth boundary.

AB—10 to 13 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; few coarse distinct brown (10YR 5/3) and few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; many fine roots; about 1 percent coarse fragments; common black (10YR 2/1) krotovinas; neutral; abrupt smooth boundary.

Btg1—13 to 18 inches; dark gray (10YR 4/1) silty clay; common coarse distinct yellowish brown (10YR 5/6) mottles; strong coarse subangular blocky structure; firm; common fine roots; many distinct dark gray (10YR 4/1) clay films on vertical faces of peds; about 1 percent coarse fragments; neutral; clear smooth boundary.

Btg2—18 to 24 inches; grayish brown (10YR 5/2) silty clay; many medium distinct yellowish brown (10YR 5/6), many medium faint brown (10YR 5/3), and few medium distinct dark brown (7.5YR 4/4) mottles; strong coarse and medium subangular blocky structure; firm; common fine roots; many distinct grayish brown (10YR 5/2) clay films on faces of peds; about 3 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

2R—24 to 30 inches; fractured dolomite bedrock.

The thickness of the solum and the depth to bedrock range from 20 to 40 inches. The content of rock fragments ranges from 1 to 14 percent in the solum.

The Ap horizon is neutral in hue or has hue of 10YR or 2.5Y. It has value of 2 or 3 and chroma of 0 to 2. It is typically silty clay loam but is clay loam, loam, or silt loam in some pedons. It is slightly acid or neutral. The B horizon is neutral in hue or has hue of 10YR to 5Y. It has value of 3 to 5 and chroma of 0 to 4. It is clay loam, silty clay loam, silty clay, or clay. It is slightly acid or neutral in the upper part and neutral to moderately alkaline in the lower part.

Nappanee Series

The Nappanee series consists of deep, somewhat poorly drained soils on lake plains. These soils formed in glacial till that has been modified by water action. Permeability is slow. Slope ranges from 0 to 3 percent.

Nappanee soils are commonly adjacent to Glynwood and Hoytville soils and are similar to Bennington, Blount, and Del Rey soils. Bennington and Blount soils contain less clay in the subsoil than the Nappanee soils. Del Rey soils formed in lacustrine sediments. They have less sand and fewer coarse fragments throughout than the Nappanee soils. The moderately well drained Glynwood soils are on knolls, on ridges, and on side slopes at the head of drainageways. The very poorly drained Hoytville soils are on broad flats.

Typical pedon of Nappanee silt loam, 0 to 3 percent slopes, in Green Creek Township; approximately 1,400 feet east and 745 feet north of the southwest corner of sec. 13, T. 4 N., R. 16 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; weak medium and fine granular structure; friable; many fine roots; about 1 percent coarse fragments; neutral; abrupt smooth boundary.

Bt1—6 to 14 inches; yellowish brown (10YR 5/4) clay; common medium distinct grayish brown (10YR 5/2) mottles; strong coarse subangular blocky structure; firm; few fine roots; many distinct grayish brown (10YR 5/2) coatings on faces of peds; few distinct grayish brown (10YR 5/2) clay films on faces of peds; about 1 percent coarse fragments; slightly acid; clear smooth boundary.

Bt2—14 to 24 inches; yellowish brown (10YR 5/4) clay; common medium distinct grayish brown (10YR 5/2) mottles; strong coarse subangular blocky structure; firm; few fine roots; many distinct grayish brown (10YR 5/2) coatings on faces of peds; common distinct grayish brown (10YR 5/2) clay films on faces of peds; about 3 percent coarse fragments; neutral; clear smooth boundary

BC—24 to 30 inches; dark yellowish brown (10YR 4/4) clay loam; few fine distinct yellowish brown (10YR 5/6) and few fine distinct grayish brown (10YR 5/2) mottles; moderate coarse subangular blocky structure; firm; few fine roots; common distinct grayish brown (10YR 5/2) clay films on faces of peds; about 3 percent coarse fragments; few light gray (10YR 7/2) calcium carbonate concretions; slight effervescence; mildly alkaline; clear smooth boundary.

C1—30 to 46 inches; yellowish brown (10YR 5/4) silty clay loam; many coarse faint yellowish brown (10YR 5/6) and common medium distinct grayish brown (10YR 5/2) mottles; massive; firm; about 1 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C2—46 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam; many medium distinct grayish brown (10YR 5/2) and many medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 3 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates commonly are 24 to 36 inches but range from 18 to 40 inches. The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. It is typically silt loam but is silty clay loam in some pedons. The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 4. It typically is silty clay or clay but has thin subhorizons of silty clay loam or clay loam in some pedons. It is slightly acid or neutral in the upper part and neutral or mildly alkaline in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. It is silty clay loam, clay loam, or silty clay.

Pewamo Series

The Pewamo series consists of deep, very poorly drained soils in shallow depressions on till plains. These soils formed in glacial till. Permeability is moderately slow. Slope is 0 to 2 percent.

Pewamo soils are commonly adjacent to Blount and Mermill soils and are similar to Hoytville and Lenawee soils. Blount soils do not have a mollic epipedon. They are slightly higher on the landscape than the Pewamo soils. Hoytville, Lenawee, and Mermill soils have a dark surface layer that is thinner than that of the Pewamo soils. Mermill soils are in depressions on lake plains, outwash plains, terraces, and till plains.

Typical pedon of Pewamo silty clay loam, in York Township; approximately 120 feet east and 1,815 feet south of the northwest corner of sec. 32, T. 4 N., R. 17 E.

Ap—0 to 11 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; many fine roots; about 1 percent coarse fragments; neutral; abrupt smooth boundary.

Bg—11 to 14 inches; dark gray (10YR 4/1) silty clay loam; few coarse faint gray (10YR 5/1), common fine prominent strong brown (7.5YR 5/6), and few coarse distinct dark brown (7.5YR 4/4) mottles; strong coarse subangular blocky structure; firm; common fine roots; common distinct dark gray (10YR 4/1) coatings on faces of peds; about 1 percent coarse fragments; slightly acid; clear smooth boundary.

Btg1—14 to 18 inches; dark gray (10YR 4/1) silty clay loam; many coarse prominent yellowish brown

(10YR 5/6) and common medium prominent strong brown (7.5YR 5/6) mottles; strong coarse subangular blocky structure; firm; few fine roots; common faint dark gray (10YR 4/1) clay films on faces of peds; about 1 percent coarse fragments; slightly acid; clear smooth boundary.

Btg2—18 to 24 inches; gray (10YR 5/1) silty clay loam; common medium prominent yellowish brown (10YR 5/6) and common medium prominent strong brown (7.5YR 5/6) mottles; strong coarse subangular blocky structure; firm; few fine roots; common faint gray (10YR 5/1) clay films on faces of peds; about 1 percent coarse fragments; slightly acid; clear smooth boundary.

Btg3—24 to 30 inches; gray (10YR 5/1) silty clay loam; many medium prominent yellowish brown (10YR 5/6), common medium prominent strong brown (7.5YR 5/6), and few fine distinct dark grayish brown (10YR 4/2) mottles; strong coarse subangular blocky structure; firm; few fine roots; common distinct gray (10YR 5/1) clay films on faces of peds; about 1 percent coarse fragments; neutral; clear smooth boundary.

Bt—30 to 50 inches; yellowish brown (10YR 5/4) silty clay loam; many fine faint yellowish brown (10YR 5/6) and common medium distinct dark gray (10YR 4/1) mottles; strong coarse subangular blocky structure; firm; few fine roots; common distinct gray (10YR 5/1) clay films on faces of peds; few light gray (10YR 7/2) calcium carbonate concretions; about 1 percent coarse fragments; mildly alkaline; clear smooth boundary.

C—50 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; many coarse faint yellowish brown (10YR 5/6) and common medium distinct gray (10YR 5/1) mottles; massive; firm; about 1 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 70 inches and that of the mollic epipedon from 11 to 14 inches. The content of coarse fragments is 1 to 14 percent throughout the solum.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is typically silty clay loam but is silt loam, silty clay, or clay loam in some pedons. It is slightly acid or neutral. The B horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 to 4. It is silty clay loam, silty clay, clay loam, or clay. It is slightly acid or neutral in the upper part and slightly acid to mildly alkaline in the lower part. The C horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 to 4. It is silty clay loam or clay loam.

Rimer Series

The Rimer series consists of deep, somewhat poorly drained soils on low beach ridges and along the edges of the higher beach ridges. These soils formed in sandy and loamy material and in the underlying lacustrine sediments. Permeability is rapid in the sandy and loamy material and slow or very slow in the underlying lacustrine sediments. Slope ranges from 1 to 4 percent.

Rimer soils are commonly adjacent to Colwood, Lenawee, Merrill, Seward, and Tedrow soils and are similar to Bixler and Haskins soils. Bixler soils contain less clay in the lower part of the subsoil and in the substratum than the Rimer soils. Haskins soils contain more clay in the upper part of the subsoil than the Rimer soils. The very poorly drained Colwood, Lenawee, and Mermill soils are on flats and in depressions. The moderately well drained Seward soils are on the higher beach ridges. Tedrow soils have less clay in the subsoil and substratum than the Rimer soils. They are in landscape positions similar to those of the Rimer soils.

Typical pedon of Rimer loamy fine sand, 1 to 4 percent slopes, in Green Creek Township; approximately 3,380 feet west and 580 feet south of the northwest corner of sec. 13, T. 4 N., R. 16 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; many fine roots; strongly acid; gradual smooth boundary.

E1—8 to 12 inches; dark grayish brown (10YR 4/2) loamy sand; common medium faint brown (10YR 4/3) mottles; weak fine granular structure; very friable; many fine roots; very dark grayish brown (10YR 3/2) organic stains; strongly acid; gradual smooth boundary.

E2—12 to 17 inches; yellowish brown (10YR 5/4) loamy sand; many medium distinct dark grayish brown (10YR 4/2) mottles; weak medium and fine granular structure; very friable; common fine roots; few distinct dark grayish brown (10YR 4/2) coatings on faces of peds; medium acid; gradual smooth boundary.

E3—17 to 27 inches; brown (10YR 5/3) loamy sand; common medium distinct yellowish brown (10YR 5/6) and few medium faint dark grayish brown (10YR 4/2) mottles; weak medium and fine granular structure; very friable; few fine roots; few distinct dark grayish brown (10YR 4/2) clay films bridging sand grains in the lower part; few very dark grayish brown (10YR 3/2) wormcasts; medium acid; clear smooth boundary.

Bt1—27 to 31 inches; brown (10YR 4/3) sandy loam; many coarse distinct strong brown (7.5YR 5/6) and few medium faint grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; few fine roots; common distinct dark grayish brown (10YR 4/2) clay films bridging sand grains; few dark grayish brown (10YR 4/2) fillings in root channels; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

2Bt2—31 to 37 inches; brown (10YR 5/3) silty clay loam; many coarse distinct yellowish brown (10YR 5/6), many medium distinct gray (10YR 5/1), and many fine distinct pinkish gray (7.5YR 6/2) mottles; weak coarse subangular blocky structure; firm; few fine roots; many faint grayish brown (10YR 5/2) coatings on faces of peds; common distinct clay films on faces of peds; about 4 percent coarse fragments; few dark gray (10YR 4/1) fillings in root channels; slight effervescence; mildly alkaline; gradual smooth boundary.

2C1—37 to 42 inches; brown (10YR 4/3) silty clay loam; many coarse distinct gray (N 6/0) mottles; appears massive but has weak horizontal bedding planes; firm; few fine roots; about 6 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

2C2—42 to 60 inches; brown (10YR 4/3) silty clay loam; few coarse distinct gray (10YR 6/1) and common medium distinct strong brown (7.5YR 5/6) mottles; massive; firm; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 48 inches. The depth to the moderately fine textured or fine textured material ranges from 26 to 40 inches.

The Ap horizon has hue of 10YR, value of 3 to 5, and chroma of 1 to 3. It is typically loamy fine sand but is fine sand or loamy sand in some pedons. The E horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is loamy sand, loamy fine sand, or fine sand. It ranges from strongly acid to neutral. The Bt horizon has hue of 10YR, value of 4 to 6, and chroma of 2 to 6. It is dominantly fine sandy loam or sandy loam but has thin subhorizons of fine sandy loam in some pedons. It ranges from strongly acid to neutral. The 2Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 3. It is silty clay loam, clay loam, clay, or silty clay. It ranges from slightly acid to mildly alkaline. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 3. It is silty clay loam, clay loam, or silty clay. It is mildly alkaline or moderately alkaline.

Rossburg Series

The Rossburg series consists of deep, well drained soils on flood plains and low stream terraces. These soils formed in alluvium. Permeability is moderate in the solum and moderately rapid or rapid in the substratum. Slope is 0 to 2 percent.

Rossburg soils are commonly adjacent to Shoals and Toledo soils. The somewhat poorly drained Shoals soils are in the lower lying positions on flood plains. The very poorly drained Toledo soils are on broad flats and in long, narrow concave areas on lake plains.

Typical pedon of Rossburg silt loam, occasionally flooded, in Ballville Township; approximately 580 feet east and 1,815 feet south of the northwest corner of sec. 29, T. 4 N., R. 15 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium and fine granular structure; friable; many fine roots; neutral; clear smooth boundary.

A—9 to 21 inches; dark brown (10YR 3/3) silt loam, brown (10YR 4/3) dry; weak medium and fine subangular blocky structure parting to moderate medium granular; friable; many fine roots; many faint very dark grayish brown (10YR 3/2) organic coatings on faces of peds; neutral; abrupt smooth boundary.

Bw1—21 to 33 inches; brown (10YR 4/3) loam; weak coarse and medium subangular blocky structure; friable; common fine roots; few very dark grayish brown (10YR 3/2) wormcasts; neutral; clear smooth boundary.

Bw2—33 to 41 inches; dark yellowish brown (10YR 4/4) loam; few coarse faint brown (10YR 5/3) and common medium distinct yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; friable; few fine roots; few dark grayish brown (10YR 4/2) wormcasts; few thin strata of very dark grayish brown (10YR 3/2) material; neutral; abrupt smooth boundary.

BC—41 to 49 inches; yellowish brown (10YR 5/4) fine sandy loam; weak fine subangular blocky structure; friable; few thin lenses of silt loam and loam; few fine roots; neutral in the upper part and mildly alkaline in the lower part; clear smooth boundary.

C—49 to 60 inches; dark yellowish brown (10YR 4/4) fine sandy loam; massive; friable; few thin lenses of silt loam and loam; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 60 inches. Free carbonates are in the lower part of the B horizon and in the C horizon in most pedons.

The A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 to 3. It is typically silt loam but is loam in some pedons. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 2 to 4. It typically is silt loam or loam but has subhorizons of silty clay loam or fine sandy loam in some pedons The C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 or 4. It is sandy loam, loam, silt loam, fine sandy loam, loamy sand, or the gravelly analogs of these textures.

Sandusky Series

The Sandusky series consists of deep, very poorly drained soils on flats on lake plains. These soils are near seeps of water that is charged with calcium carbonate. They formed in material weathered from tufa over medium textured to fine textured lacustrine sediments.

Permeability is moderate or moderately rapid in the material weathered from tufa and slow in the lacustrine sediments. Slope is 0 to 2 percent.

Sandusky soils are commonly adjacent to Fulton, Toledo, and Weyers soils and are similar to Weyers soils. Fulton and Toledo soils formed entirely in lacustrine sediments and do not have a mollic epipedon. They are in areas on the lake plains that do not receive seepage charged with calcium carbonate. Weyers soils are closer to the source of seepage than the Sandusky soils. They do not have lacustrine sediments within a depth of 40 inches.

Typical pedon of Sandusky gravelly coarse sandy loam, in Townsend Township; about 670 feet west and 418 feet north of the southeast corner of sec. 12, T. 5 N., R. 17 E.

Ap—0 to 9 inches; very dark gray (10YR 3/1) gravelly coarse sandy loam, gray (10YR 5/1) dry; moderate fine granular structure; very friable; few fine roots; about 15 percent coarse fragments of tufa; few shell fragments; violent effervescence; mildly alkaline; abrupt smooth boundary.

Cg—9 to 13 inches; light brownish gray (2.5Y 6/2) gravelly coarse sandy loam; few fine distinct light yellowish brown (10YR 6/4) mottles; moderate fine granular structure; very friable; few fine roots; about 15 percent coarse fragments of tufa; many distinct grayish brown (10YR 5/2) coatings on faces of peds; few dark grayish brown (10YR 4/2) krotovinas; few shell fragments; violent effervescence; moderately alkaline; abrupt wavy boundary.

C1—13 to 19 inches; very pale brown (10YR 7/3) fine sandy loam; few fine faint light yellowish brown (10YR 6/4) mottles; weak fine granular structure; very friable; few fine roots; few dark grayish brown (10YR 4/2) krotovinas; few shell fragments; few tufa fragments; violent effervescence; moderately alkaline; clear smooth boundary.

C2—19 to 25 inches; pale brown (10YR 6/3) gravelly coarse sandy loam; weak fine granular structure; very friable; few fine roots; common faint grayish brown (10YR 5/2) coatings on faces of peds; about 15 percent coarse fragments of tufa; a thin layer of very dark gray (10YR 3/1) silty clay loam in the lower part; violent effervescence; moderately alkaline; abrupt smooth boundary.

2Cg1—25 to 29 inches; light gray (10YR 7/2) loam; many medium faint light brownish gray (10YR 6/2) and few fine faint very pale brown (10YR 7/4) mottles; massive; very friable; few fine roots; violent effervescence; moderately alkaline; abrupt smooth boundary.

2Cg2—29 to 65 inches; gray (10YR 5/1) silty clay loam grading to silt loam in the lower part; many medium and coarse distinct dark yellowish brown (10YR 4/4) and few fine and medium distinct strong brown (7.5YR 5/6) mottles; some vertical partings in the upper part; firm; strong effervescence; moderately alkaline.

The depth to lacustrine sediments ranges from 20 to 40 inches. The content of coarse fragments of tufa ranges from 15 to 25 percent in the A horizon and from 0 to 50 percent in the subhorizons of the C horizon. It averages 5 to 35 percent in the C horizon. The 2C horizon generally does not have coarse fragments.

The Ap horizon is neutral in hue or has hue of 10YR or 2.5Y. It has value of 2 or 3 and chroma of 0 to 2. It is commonly gravelly coarse sandy loam but is loam, sandy loam, silt loam, or the gravelly analogs of these textures in some pedons. The C horizon has hue of 10YR to 5Y. It dominantly has value of 4 to 8 and chroma of 1 to 3. It does not have chroma of 3 immediately below the mollic epipedon. Thin subhorizons with value of 2 or 3 are in some pedons. The C horizon is loam, sandy loam, fine sandy loam, loamy sand, silt loam, coarse sandy loam, or the gravelly or very gravelly analogs of these textures. It is commonly stratified. The 2C horizon has hue of 10YR to 5Y, value of 4 to 7, and chroma of 1 or 2. It is dominantly silty clay or silty clay loam but has subhorizons of loam or silt loam in many pedons.

Saylesville Series

The Saylesville series consists of deep, moderately well drained soils on lake plains. These soils formed in lacustrine sediments. Permeability is moderately slow. Slope ranges from 6 to 12 percent.

Saylesville soils are commonly adjacent to Del Rey, Fulton, Lucas, and Mentor soils and are similar to Lucas soils. The somewhat poorly drained Del Rey and Fulton soils are on slight rises. Lucas soils contain more clay in the subsoil and substratum than the Saylesville soils. Their landscape positions are similar to those of the Saylesville soils. The well drained Mentor soils have less clay in the subsoil than the Saylesville soils. They are on the less sloping or steeper parts of lake plains, outwash plains, and stream terraces.

Typical pedon of Saylesville silty clay loam, 6 to 12 percent slopes, eroded, in Sandusky Township; approximately 1,310 feet east and 280 feet north of the southwest corner of sec. 12, T. 5 N., R. 15 E.

Ap—0 to 9 inches; brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; weak coarse and medium granular structure; firm; few fine roots; specks of brown (7.5YR 5/4) subsoil material; neutral; clear smooth boundary.

Bt1—9 to 16 inches; brown (7.5YR 4/4) silty clay; few medium distinct strong brown (7.5YR 5/6) mottles; strong coarse subangular blocky structure; firm; few fine roots; many distinct brown (7.5YR 5/4) clay films on faces of peds; neutral; clear smooth boundary.

Bt2—16 to 29 inches; brown (7.5YR 4/4) silty clay; few medium distinct strong brown (7.5YR 5/6) mottles; strong coarse subangular blocky structure; firm; few fine roots; many distinct brown (10YR 5/3) clay films on faces of peds; few fine very pale brown (10YR 7/3) calcium carbonate concretions; neutral; clear smooth boundary.

BC—29 to 39 inches; yellowish brown (10YR 5/4) silty clay loam; many medium faint yellowish brown (10YR 5/6) and many medium distinct light brownish gray (10YR 6/2) mottles; weak coarse prismatic structure parting to weak thick platy; friable; few faint brown (10YR 5/3) clay films on faces of peds; few fine very pale brown (10YR 7/3) calcium carbonate concretions; neutral; clear smooth boundary.

C—39 to 60 inches; yellowish brown (10YR 5/4) silt loam; many coarse distinct strong brown (7.5YR 5/6) and many medium distinct light brownish gray (10YR 6/2) mottles; appears massive but has weak horizontal bedding planes; friable; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to carbonates range from 20 to 40 inches. Reaction is slightly acid or neutral in the A horizon and neutral or mildly alkaline in the B horizon.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. It is typically silty clay loam but is silt loam or loam in some pedons. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is silty clay or silty clay loam. The C horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is typically silt loam or silty clay loam but has thin strata of silty clay, clay, silt, or very fine sandy loam in some pedons.

Seward Series

The Seward series consists of deep, moderately well drained soils on outwash plains and beach ridges. These soils formed in sandy and loamy material over moderately fine textured or fine textured glacial till or lacustrine sediments. Permeability is rapid in the upper part of the solum and slow or very slow in the substratum. Slope ranges from 2 to 6 percent.

Seward soils are commonly adjacent to Dunbridge, Haskins, and Rimer soils. Dunbridge soils have limestone bedrock at a depth of 20 to 40 inches. They are on the sides of ridges. Haskins and Rimer soils are somewhat poorly drained. Haskins soils are on stream terraces, lake plains, and till plains. Rimer soils are in landscape positions similar to those of the Seward soils.

Typical pedon of Seward loamy fine sand, 2 to 6 percent slopes, in Madison Township; approximately 660 feet west and 1,000 feet south of the northeast corner of sec. 33, T. 5 N., R. 13 E.

Ap—0 to 9 inches; brown (10YR 4/3) loamy fine sand; brown (10YR 5/3) dry; weak fine granular structure; very friable; few roots; slightly acid; abrupt smooth boundary.

E1—9 to 18 inches; brownish yellow (10YR 6/6) loamy fine sand; weak fine granular structure; very friable; few roots; slightly acid; clear smooth boundary.

E2—18 to 26 inches; light yellowish brown (10YR 6/4) loamy fine sand; few fine distinct yellowish brown (10YR 5/6) and few fine faint very pale brown (10YR 7/3) mottles; weak fine granular structure; very friable; few roots; medium acid; clear smooth boundary.

Bt—26 to 35 inches; yellowish brown (10YR 5/4) sandy loam; few fine faint brown (10YR 5/3) and common medium distinct strong brown (7.5YR 5/6) mottles; weak medium and coarse subangular blocky structure; friable; common distinct brown (10YR 5/3) clay films; about 1 percent coarse fragments; neutral; clear smooth boundary.

2C1—35 to 47 inches; yellowish brown (10YR 5/4) silty clay loam; few fine faint yellowish brown (10YR 5/6) mottles; massive; firm; about 2 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

2C2—47 to 60 inches; brown (10YR 5/3) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 2 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 25 to 48 inches. The depth to the fine textured or moderately fine textured material ranges from 25 to 40 inches. The content of coarse fragments ranges from 0 to 3 percent in the solum and from 0 to 8 percent in the 2C horizon. Reaction ranges from strongly acid to neutral in the solum and is mildly alkaline or moderately alkaline in the 2C horizon.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 1 to 4. It is typically loamy fine sand but is fine sand or loamy sand in some pedons. The E horizon has hue of 10YR or 7.5YR, value of 4 to 7, and chroma of 4 to 6. It is loamy fine sand, fine sand, or loamy sand. The Bt horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. It typically is sandy loam or fine sandy loam but has thin subhorizons of sandy clay loam in some pedons. Some pedons have a 2Bt horizon, which is silty clay loam or clay loam. The 2C horizon has hue of 10YR, value of 3 to 5, and chroma of 1 to 4. It is silty clay loam, clay loam, silty clay, or clay.

Shoals Series

The Shoals series consists of deep, somewhat poorly drained, moderately permeable soils that formed in alluvium on flood plains. Slope is 0 to 2 percent.

Shoals soils are commonly adjacent to Rossburg and Toledo soils. Rossburg soils are well drained and are higher on the flood plains than the Shoal soils. Toledo soils are very poorly drained and are on broad flats and in long, narrow concave areas on lake plains.

Typical pedon of Shoals silt loam, frequently flooded, in Riley Township; approximately 1,980 feet east and 200 feet north of the southwest corner of sec. 34, T. 5 N., R. 16 E.

Ap—0 to 11 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; weak medium and fine granular structure; friable; many distinct dark brown (10YR 3/3) organic coatings on faces of peds; many fine roots; slightly acid; clear wavy boundary.

Bg1—11 to 25 inches; dark grayish brown (10YR 4/2) silt loam; common medium distinct yellowish brown (10YR 5/4), common fine prominent yellowish brown (10YR 5/8), and few fine faint very dark grayish brown (10YR 3/2) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; friable; common fine roots; dark grayish brown (10YR 4/2) silt and very fine sand coatings on faces of peds; many fine yellowish red (5YR 4/6) stains (iron and manganese oxides); neutral; clear smooth boundary.

Bg2—25 to 32 inches; brown (10YR 4/3) silt loam; common medium faint yellowish brown (10YR 5/4), few fine faint grayish brown (10YR 5/2), and few medium faint dark brown (7.5YR 4/4) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; friable; common fine roots; dark grayish brown (10YR 4/2) silt and very fine sand coatings on faces of peds; neutral; clear smooth boundary.

BC—32 to 48 inches; brown (10YR 4/3) silt loam; common medium faint grayish brown (10YR 5/2), common fine faint dark brown (7.5YR 4/4), and common medium distinct yellowish brown (10YR 5/6) mottles; weak coarse and medium subangular blocky structure; friable; few fine roots; thin strata of loam; dark grayish brown (10YR 4/2) silt and very fine sand coatings on faces of peds; neutral; clear smooth boundary.

Cg—48 to 55 inches; grayish brown (10YR 5/2) stratified loam and fine sandy loam; common medium distinct yellowish brown (10YR 5/6) and few medium distinct dark brown (7.5YR 3/2) mottles; massive; friable; few fine roots; neutral; abrupt smooth boundary.

C—55 to 60 inches; brown (10YR 5/3) sandy loam; few medium distinct yellowish brown (10YR 5/6), common medium faint dark grayish brown (10YR 4/2), and few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; few fine roots; mildly alkaline.

Reaction is slightly acid to mildly alkaline to a depth of 40 inches and neutral to moderately alkaline below that depth. In some pedons free carbonates are at a depth of 20 to 40 inches.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2. It is typically silt loam but is loam in some pedons. The B horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. It is silt loam or loam. The C horizon has hue of 10YR, value of 5 or 6, and chroma of 1 to 3. It is loam, silt loam, or sandy loam.

Spinks Series

The Spinks series consists of deep, well drained soils on former beach ridges and offshore bars. These soils formed in sandy deposits. Permeability is moderately rapid. Slope ranges from 2 to 6 percent.

Spinks soils are commonly adjacent to Belmore, Dunbridge, Granby, Seward, and Tedrow soils. Belmore soils have more gravel and clay in the subsoil than the Spinks soils. They are in positions on the beach ridges similar to those of the Spinks soils. Dunbridge soils have limestone bedrock at a depth of 20 to 40 inches. The very poorly drained Granby soils are on flats and in depressions. The moderately well drained Seward soils are in the slightly lower landscape positions. The somewhat poorly drained Tedrow soils are on low beach ridges and along the edges of the higher ridges.

Typical pedon of Spinks fine sand, 2 to 6 percent slopes, in York Township; approximately 2,300 feet north and 410 feet east of the southwest corner of sec. 22, T. 4 N., R. 17 E.

A—0 to 4 inches; dark grayish brown (10YR 4/2) fine sand, light brownish gray (10YR 6/2) dry; weak fine granular structure; very friable; many fine roots; neutral; clear smooth boundary.

E1—4 to 10 inches; yellowish brown (10YR 5/4) loamy fine sand; weak medium and fine granular structure; very friable; many fine roots; few distinct dark grayish brown (10YR 4/2) organic stains in root channels; slightly acid; diffuse wavy boundary.

E2—10 to 20 inches; brownish yellow (10YR 6/6) loamy fine sand; weak medium and fine granular structure; very friable; many fine roots; dark grayish brown (10YR 4/2) fillings in old root channels; medium acid; diffuse wavy boundary.

E&Bt1—20 to 56 inches; yellowish brown (10YR 5/6) fine sand (E); many fine faint yellowish brown (10YR 5/8) mottles; single grained; loose; discontinuous dark brown (7.5YR 4/4) loamy sand lamellae (Bt) that are 0.125 to 1 inch thick, have weak fine granular structure, and are very friable; common fine roots; dark grayish brown (10YR 4/2) fillings in old root channels; medium acid; clear smooth boundary.

E&Bt2—56 to 60 inches; yellowish brown (10YR 5/6) sand (E); single grained; loose; discontinuous dark brown (7.5YR 4/4) loamy sand lamellae (Bt) that are 0.25 to 0.50 inch thick, have weak fine subangular blocky structure, and are very friable; medium acid.

The solum ranges from 36 to 60 inches in thickness. It is medium acid to neutral.

The A or Ap horizon has hue of 10YR, value of 3 to 5, and chroma of 2 to 4. It is typically fine sand but is sand or loamy sand in some pedons. The E horizon has hue of 10YR, value of 5 or 6, and chroma of 3 to 6. It is fine sand, loamy fine sand, or loamy sand. Individual lamellae in the Bt horizon have hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. They are typically loamy sand or loamy fine sand but are sandy loam in some pedons. Individually, they are 0.125 inch to 5 inches thick. The total thickness is more than 6 inches within a depth of 60 inches.

Tedrow Series

The Tedrow series consists of deep, somewhat poorly drained, rapidly permeable soils on low beach ridges, sand dunes, lake plains, and deltas. These soils formed in sandy sediments. Slope is 0 to 2 percent.

Tedrow soils are commonly adjacent to Dixboro, Gilford, Granby, Kibbie, Rimer, and Spinks soils. Dixboro, Gilford, Kibbie, and Rimer soils have more clay in the subsoil than the Tedrow soils. Dixboro, Kibbie, and Rimer soils are in landscape positions similar to those of the Tedrow soils. The very poorly drained Gilford and Granby soils are on flats and in depressions. The well drained Spinks soils are in the higher lying positions on former beach ridges and offshore bars.

Typical pedon of Tedrow loamy fine sand, 0 to 2 percent slopes, in Ballville Township; approximately 165 feet north and 165 feet west of the southeast corner of sec. 15, T. 4 N., R. 15 E.

Ap—0 to 8 inches; brown (10YR 4/3) loamy fine sand, pale brown (10YR 6/3) dry; weak fine granular structure; very friable; common fine roots; slightly acid; abrupt smooth boundary.

Bw1—8 to 14 inches; yellowish brown (10YR 5/6) loamy fine sand; many coarse distinct light yellowish brown (10YR 6/4) mottles; weak fine granular structure; very friable; common fine roots; slightly acid; clear smooth boundary.

Bw2—14 to 20 inches; yellowish brown (10YR 5/6) loamy fine sand; common medium distinct light brownish gray (10YR 6/2) mottles; weak fine granular structure; very friable; few fine roots; few fine dark brown (7.5YR 4/4) concretions (iron and manganese oxides); slightly acid; clear smooth boundary.

Bw3—20 to 27 inches; dark yellowish brown (10YR 4/4) loamy fine sand; common medium distinct light brownish gray (10YR 6/2) and common medium distinct strong brown (7.5YR 5/6) mottles; weak fine and medium subangular blocky structure; very friable; few fine roots; slightly acid; clear smooth boundary.

Bw4—27 to 32 inches; dark yellowish brown (10YR 4/4) loamy fine sand; common medium distinct light brownish gray (10YR 6/2), few fine distinct dark grayish brown (10YR 4/2), and common medium distinct yellowish brown (10YR 5/6) mottles; weak medium and coarse subangular blocky structure; very friable; slightly acid; clear smooth boundary.

BC—32 to 36 inches; dark yellowish brown (10YR 4/4) loamy fine sand; common fine distinct dark grayish brown (10YR 4/2) and common fine faint yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure; very friable; neutral; abrupt smooth boundary.

Cg1—36 to 46 inches; grayish brown (10YR 5/2) loamy fine sand; few fine faint brown (10YR 5/3) mottles; single grained; loose; slight effervescence; mildly alkaline; clear smooth boundary.

Cg2—46 to 60 inches; dark grayish brown (10YR 4/2) loamy fine sand; common coarse faint very dark grayish brown (10YR 3/2), many medium faint brown (10YR 5/3), and few fine faint grayish brown (10YR 5/2) mottles; single grained; loose; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 24 to 54 inches. The Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 1 to 3. It is typically loamy fine sand but is loamy sand or fine sand in some pedons. It is slightly acid or neutral. The Bw horizon has hue of 7.5YR to 2.5Y, value of 4 to 6, and chroma mainly of 3 to 6. Some individual subhorizons have chroma of 2 or less. This horizon is loamy sand, fine sand, or loamy fine sand. It is slightly acid or neutral in the upper part and slightly acid to mildly alkaline in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 4. It is loamy fine sand or fine sand and is mildly alkaline or moderately alkaline.

Toledo Series

The Toledo series consists of deep, very poorly drained, slowly permeable soils on broad flats and in long, narrow concave areas on lake plains. These soils formed in clayey lacustrine sediments. Slope is 0 to 2 percent.

Toledo soils are commonly adjacent to Bono, Fulton, and Sandusky soils and are similar to Bono soils. Bono soils have a dark surface layer that is thicker than that of the Toledo soils. Their landscape positions are similar to those of the Toledo soils. The somewhat poorly drained Fulton soils are on slight rises and on slopes along drainageways. Sandusky soils have tufa fragments in the upper part. They are near seeps of water that is charged with calcium carbonate.

Typical pedon of Toledo silty clay, in Riley Township; approximately 2,475 feet west and 1,650 feet south of the northeast corner of sec. 1, T. 5 N., R. 16 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay, grayish brown (10YR 5/2) dry; weak fine granular structure; firm; many fine roots; slightly acid; abrupt smooth boundary.

Bg1—7 to 12 inches; dark grayish brown (10YR 4/2) silty clay; common medium distinct strong brown (7.5YR 5/6) mottles; strong coarse prismatic structure; firm; few fine roots; common faint dark grayish brown (10YR 4/2) coatings on faces of peds; few distinct very dark gray (10YR 3/1) organic stains on faces of peds; neutral; clear smooth boundary.

Bg2—12 to 22 inches; gray (10YR 5/1) clay; many medium prominent yellowish brown (10YR 5/6), few medium distinct brown (10YR 5/3), and few medium distinct very dark grayish brown (10YR 3/2) mottles; strong coarse prismatic structure; firm; few fine roots; many faint gray (10YR 5/1) coatings on faces of peds; neutral; clear smooth boundary.

Bg3—22 to 44 inches; gray (10YR 5/1) clay; many medium distinct yellowish brown (10YR 5/4), few medium distinct dark grayish brown (10YR 4/2), and few fine prominent strong brown (7.5YR 5/6) mottles; strong coarse prismatic structure; firm; few fine roots; many faint gray (10YR 5/1) coatings on faces of peds; few fine white (10YR 8/1) calcium carbonate concretions; neutral in the upper part and mildly alkaline in the lower part; clear smooth boundary.

Cg1—44 to 55 inches; grayish brown (10YR 5/2) clay; many coarse faint brown (10YR 5/3) and common medium distinct strong brown (7.5YR 5/6) mottles; massive; firm; many faint grayish brown (10YR 5/2) coatings in vertical partings; few fine light gray (10YR 7/1) calcium carbonate concretions; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—55 to 60 inches; gray (10YR 5/1) silty clay; common fine prominent strong brown (7.5YR 5/6), few medium distinct dark grayish brown (10YR 4/2), and common medium distinct brown (7.5YR 5/4) mottles; massive; firm; strong effervescence; moderately alkaline.

The thickness of the solum ranges from about 30 to 55 inches. The depth to carbonates ranges from 30 to 50 inches.

The Ap horizon is neutral in hue or has hue of 10YR or 2.5Y. It has value of 2 or 3 and chroma of 0 to 2. It is typically silty clay or silty clay loam but is silt loam or clay in some pedons. It ranges from neutral to medium acid. The B horizon is neutral in hue or has hue of 10YR to 5Y. It has value of 4 to 6 and chroma of 0 to 2. It is silty clay or clay. It generally is slightly acid or neutral, but the lower part ranges to mildly alkaline. The C horizon is neutral in hue or has hue of 10YR to 5Y. It has value of 4 to 6 and chroma of 0 to 6. It is typically silty clay or clay. In some pedons, however, it is silty clay loam in which the content of clay is more than 35 percent. Thin strata of silt loam, loam, or fine sandy loam are in some pedons.

Weyers Series

The Weyers series consists of deep, very poorly drained soils on lake plains. These soils are near seeps of water that is charged with calcium carbonate. They formed in material weathered from tufa and marl. Permeability is moderately rapid in the upper part of the profile and moderate to slow in the lower part. Slope is 0 to 2 percent.

Weyers soils are commonly adjacent to Fulton, Toledo, and Sandusky soils and are similar to Sandusky soils. Fulton and Toledo soils formed in lacustrine sediments and do not have a mollic epipedon. They are in areas on the lake plains that do not receive seepage charged with calcium carbonate. Sandusky soils have lacustrine sediments at a depth of 20 to 40 inches. They are farther from the source of seepage than the Weyers soils and are in intermediate positions between the Weyers soils and soils that formed in lacustrine sediments.

Typical pedon of Weyers coarse sandy loam, in Townsend Township; at the center of sec. 9, T. 5 N., R. 17 E.

Ap—0 to 10 inches; very dark gray (10YR 3/1) coarse sandy loam, dark gray (10YR 4/1) dry; moderate fine granular structure; very friable; few fine roots; about 10 percent coarse fragments of tufa; violent effervescence; mildly alkaline; clear smooth boundary.

A—10 to 14 inches; very dark gray (10YR 3/1) coarse sandy loam, dark gray (10YR 4/1) dry; moderate medium granular structure; very friable; few fine roots; about 8 percent coarse fragments of tufa; common shell fragments; violent effervescence; moderately alkaline; clear smooth boundary.

Cg1—14 to 19 inches; grayish brown (2.5Y 5/2) gravelly coarse sandy loam; few fine distinct light yellowish brown (10YR 6/4) mottles; weak medium granular structure; very friable; about 15 percent coarse fragments of yellowish brown (10YR 5/4) tufa;

violent effervescence; moderately alkaline; clear smooth boundary.

Cg2—19 to 25 inches; dark gray (10YR 4/1) loam; few fine distinct light brownish gray (10YR 6/2) mottles; weak fine subangular blocky structure; friable; common dark grayish brown (10YR 4/2) organic coatings on faces of peds; about 8 percent coarse fragments of yellowish brown (10YR 5/4) tufa; violent effervescence; moderately alkaline; clear smooth boundary.

Cg3—25 to 33 inches; dark gray (10YR 4/1) coarse sandy loam; few fine faint dark grayish brown (10YR 4/2) mottles; weak fine and medium granular structure; very friable; thin strata of black (10YR 2/1) sandy loam in the lower part; about 12 percent coarse fragments of yellowish brown (10YR 5/4) and light brownish gray (10YR 6/2) tufa; violent effervescence; moderately alkaline; clear smooth boundary.

C—33 to 52 inches; pale brown (10YR 6/3) and very pale brown (10YR 7/3) gravelly coarse sandy loam; single grained; loose; about 15 percent coarse fragments of yellowish brown (10YR 5/4) tufa as much as 7 inches in diameter; 25 percent coarse fragments in a 6-inch zone in the middle part; violent effervescence; moderately alkaline; clear smooth boundary.

2Cg—52 to 72 inches; white (10YR 8/1) silt loam; massive; very friable; violent effervescence; moderately alkaline.

The content of coarse fragments of tufa ranges from 0 to 15 percent in the Ap and A horizons and from 0 to 60 percent in individual subhorizons of the C horizon. It averages 5 to 35 percent in the C horizon. Some pedons have subhorizons of continuous tufa several inches thick.

The Ap and A horizons have hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. The Ap horizon is commonly coarse sandy loam but is silt loam, loam, or sandy loam in some pedons. It is mildly alkaline or moderately alkaline.

The part of the C horizon immediately below the mollic epipedon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. The lower part of this horizon commonly has hue of 10YR or 2.5Y, value mainly of 4 to 8, and chroma of 1 to 4. Thin subhorizons have value of 2 or 3. The C horizon is commonly stratified loamy sand, loamy coarse sand, sandy loam, coarse sandy loam, loam, silt loam, or the gravelly or very gravelly analogs of these textures. The calcium carbonate equivalent in this horizon is more than 40 percent. Thin layers of sapric material are in some pedons. The 2C horizon is neutral in hue or has hue of 10YR to 5Y. It has value of 5 to 8 and chroma of 0 to 2. Moderately fine textured or fine textured lacustrine material is at a depth of 40 and 72 inches in some pedons.

Formation of the Soils

This section describes how the major factors of soil formation have affected the soils in Sandusky County and explains some of the processes of soil formation.

Factors of Soil Formation

Soils form through processes acting on deposited or accumulated geologic material. The major factors of soil formation are parent material, climate, relief, living organisms, and time (*12*).

Climate and living organisms, particularly vegetation, are the active forces in soil formation. Their effect on the parent material is modified by relief and by the length of time that the forces of soil formation have acted on the parent material. The relative importance of each factor differs from place to place. In some areas one factor dominates and determines most of the soil properties, but normally the interaction of all five factors determines what kind of soil forms in a given place.

Parent Material

The soils of Sandusky County formed in several kinds of parent material: glacial till, beach ridge deposits, lacustrine sediments, bedrock residuum, recent alluvium, material weathered from tufa, and marl. Parent material greatly affects the texture of the soil.

Glacial till, a general term applied to glacial deposits, is one of the extensive parent materials in the county. It is fairly homogenous and uniform in texture. Bennington, Blount, Glynwood, Hoytville, and Nappanee are examples of soils that formed in this material. They have a moderately fine textured or fine textured subsoil.

Beach ridges formed along the edges of glacial lakes. They are commonly parallel to each other and generally are oriented in an east-west direction across the county. Belmore, Granby, Tedrow, and Spinks are examples of soils that formed in these deposits.

Loamy to clayey lacustrine deposits are extensive in the county. Layers of silty and loamy material are moderately extensive. They are evident in the moderately coarse textured and medium textured subsoil of Dixboro, Kibbie, and Colwood soils. Silty and clayey lacustrine deposits are extensive. They are evident in the moderately fine textured and fine textured subsoil of Lenawee and Del Rey soils. Clayey lacustrine deposits are also extensive. They are evident in the fine textured subsoil of Toledo and Fulton soils.

Some of the soils in the county formed in material weathered from displaced limestone or dolomite bedrock. The bedrock is highly fractured. The dominant soils that formed in bedrock residuum are Castalia soils. These soils are in areas where the bedrock formerly extended above the glacial lakes.

Recent alluvium, or floodwater deposits, is the youngest parent material in the county. It is still accumulating as fresh sediment is added by the overflow of streams. The sediment is derived dominantly from the surface layer of the higher lying adjacent soils. Rossburg and Shoals soils formed in alluvium.

Tufa and marl are in areas near seeps of water that is charged with calcium carbonate. Sandusky and Weyers soils formed in these areas.

Climate

Because the climate in Sandusky County is uniform, it has not greatly contributed to differences among the soils. It determined the kind of native vegetation, which was dominantly hardwood trees. It has favored both physical change and chemical weathering of parent materials and the activity of living organisms.

The amount of rainfall has been high enough for carbonates to be leached to a moderate depth in Glynwood, Mentor, and other soils. Wet and dry cycles favored the translocation of clay minerals and the formation of soil structure, as is evident in Belmore and Kibbie soils.

The range of temperature variation has favored both physical change and chemical weathering of the parent materials. Freezing and thawing have aided the formation of soil structure. Warm temperatures in summer have favored chemical reactions in the weathering of primary minerals. The area close to Lake Erie has a longer frost-free period than other parts of the county. Also, differences in relief have resulted in variations in the microclimate in some areas.

Rainfall and temperature have been conducive to plant growth and the accumulation of organic matter in all the soils. More information about the climate is available under the heading "General Nature of the County."

Relief

Relief tends to modify the effects of climate within short distances. Soils on hillsides generally are drier than those in adjacent depressions because water runs off the hillsides and collects in the depressions. The presence or absence of a seasonal high water table is largely determined by relief.

Relief can account for the formation of different soils in the same kind of parent material. Glynwood, Nappanee, and Hoytville soils, for example, formed in glacial till. The moderately well drained Glynwood soils have a moderately thick solum. They generally formed where the slope was not steep enough to result in excessive erosion and not flat enough to prevent runoff. The somewhat poorly drained Nappanee soils formed in areas where runoff is slow. Nearby, the very poorly drained Hoytville soils formed on flats where some plant residue accumulated because the water table is near or above the surface during extended wet periods.

The steepest soils in the county are in areas on the beach ridges, along the major streams and their tributaries, and on bedrock ridges. The rest of the county is nearly level or gently sloping. Most of the more poorly drained soils are on flats or in depressions.

Living Organisms

At the time that Sandusky County was settled, the vegetation in most areas was hardwoods, dominantly beech, maple, oak, hickory, and ash. Swamps and other low lying areas supported swamp forest vegetation, mainly swamp white oak, pin oak, elm, and cottonwood. Grassy clearings were on the marshy openings in the poorly drained swales.

Soils that formed in forested areas are generally acid and are moderate or low in natural fertility. These soils include Glynwood, Mentor, Bennington, Blount, and Lucas soils. In the soils in swales and low lying areas, organic matter has accumulated where the water table is high for longer periods. Bono, Colwood, and Lenawee are examples of these dark, fertile soils.

Small animals, insects, worms, fungi, and bacteria mix the soil material and add organic matter. Their burrowing and mixing make the soil more permeable.

Human activities also affect soil formation. Examples of these activities are the installation of drainage systems, irrigation, and cutting and filling. Another example is the application of lime and fertilizer, which affects soil chemistry.

Time

Time is needed for the other factors of soil formation to produce their effects. The age of a soil is indicated, to some extent, by the degree of profile development. The length of time that the parent material has been in place and has been affected by vegetation and climate is an important factor of soil formation. The influence of time on soil formation is modified by the relief and the parent material.

In terms of geologic age, the soils in Sandusky County have been forming for a relatively short period. This limited amount of time accounts for the shallowness of leaching and the slightly acid or neutral reaction in many of the soils.

The older soils have more strongly developed profiles. Examples are Bennington, Blount, and Haskins soils. Soils that formed in recent alluvium, for example Rossburg and Shoals soils, do not have well expressed horizons. As it deposits fresh sediments, floodwater periodically interrupts the formation of these soils.

Processes of Soil Formation

Many soils in Sandusky County have a strongly expressed profile because the processes of soil formation have distinctly changed the parent material. These are the undulating soils that formed in glacial till on till plains and in glacial outwash on terraces along the major streams. In contrast, the parent material on flood plains has been only slightly modified.

All the factors of soil formation act in unison to control the processes that form different layers in the soil. These processes are additions, removals, transfers, and transformations (*16*). Some of these promote horizon differentiation, but others retard differentiation or obliterate existing differences.

In this county the most important addition to the soil is that of organic matter. Soils that formed where a high water table restricted decomposition of organic matter have a thick, dark surface layer. This surface layer has a high content of organic matter, has good structure, and has a base saturation that exceeds 50 percent. Colwood and Lenawee soils are examples. Some organic matter has accumulated in most of the soils in Sandusky County. Where the layer of accumulation was originally thin, however, plowing and cultivating generally have destroyed or incorporated it into other layers. Glynwood, Nappanee, and Mentor are examples of soils that have a limited content of organic matter.

Soils on flood plains, such as Rossburg and Shoals soils, periodically receive additions of soil material deposited by floodwater.

Leaching of carbonates from calcareous parent material is one of the most significant losses. It precedes many other chemical changes in the solum. In most of the glacial till in Sandusky County, the content of carbonates ranges from 15 to 25 percent. Most of the light colored soils that formed in glacial till have been leached to a depth of 20 to 36 inches. The upper 24 inches is now acid. Carbonates in the coarse textured soils, such as Spinks and Tedrow soils, generally have been leached to a depth of more than 36 inches. Other minerals in the soil are subject to the same chemical weathering that follows leaching, but their resistance is higher and their removal is slower.

Following the removal of carbonates, alterations of such minerals as biotite and feldspar result in changes of color within the profile. Free iron oxides may be segregated by a fluctuating high water table, which results in gray colors and in mottles, as is evident in Hoytville soils. If the water table is not seasonally high within the profile, brownish colors with higher chroma and redder hue than those in the C horizon are typical.

The main kind of transfer is the movement of clay from the A horizon to the B horizon during seasonal wetting and drying of the soil profile. The fine clay becomes suspended in percolating water moving through the A horizon. It is carried by the water to the B horizon. There, it is deposited on the faces of peds. The transfer of fine clay accounts for the patchy or nearly continuous clay films on faces of peds in the B horizon of Glynwood, Nappanee, and other soils. Various sesquioxides also have been transferred from the surface layer to lower layers through this weathering process.

Transformation of mineral compounds occurs in most soils. Gleying, or the reduction and solution of ferrous iron, has taken place in the very poorly drained and somewhat poorly drained soils. This reduction is evident in Toledo, Bono, and Fulton soils. It is caused by a recurring high water table. A gray soil color indicates conditions that favor the reduction process. Reduced iron is soluble, but it commonly has been moved only a short distance within the soils in Sandusky County. Some of the iron is reoxidized and resegregated, forming bright yellow and red mottles. The mottles in all but the well drained soils were formed through this alteration of iron. Accumulations of iron and manganese oxides are common in the somewhat poorly drained and very poorly drained soils. They occur as dark brown or black stains on the faces of peds or as small concretions.

References

(1) Allan, P.F., L.E. Garland, and R. Dugan. 1963. Rating northeastern soils for their suitability for wildlife habitat. 28th North Am. Wildl. Nat. Resour. Conf. Wildl. Manage. Inst., pp. 247-261, illus.

(2) Allen, E.R., and others. 1920. Soil survey of Sandusky County, Ohio. U.S. Dep. Agric., Bur. of Soils, 64 pp., illus.

(3) American Association of State Highway and Transportation Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vols., illus.

(4) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(5) Bownocker, J.A. Rev. ed., 1947, repr. in 1965. Geologic map of Ohio. Ohio Dep. of Nat. Resour., Div. of Geol. Surv., 1 sheet.

(6) Boyne, David H., Homer L. Carter, Mark A. Evans, and Theresa W. Johnson. 1982. 1981 Ohio farm income. Ohio Agric. Res. and Dev. Center, Dep. Ser. E.S.O. 950, 28 pp., illus.

(7) Carter, Homer L., and Mark A. Evans. 1982. Ohio agricultural statistics—1981. 56 pp., illus.

(8) Fenneman, Nevin M. 1938. Physiography of the Eastern United States. McGraw-Hill Book Company, Inc., 714 pp., ilus.

(9) Forsyth, Jane L. 1959. The beach ridges of northern Ohio. Ohio Dep. of Nat. Resour., Div. of Geol. Surv., Inf. Circ. 25, 10 pp., illus. (Rev. 1965)

(10) Gordon, Robert B. 1966. Natural vegetation in Ohio at the time of the earliest land surveys. Ohio Biol. Surv., Ohio State Univ., 1 map sheet.

(11) Janssens, Adriaan. 1977. Silurian rocks in the subsurface of northwestern Ohio. Ohio Dep. of Nat. Resour., Div. of Geol. Surv., Rep. of Invest. No. 100, 96 pp., illus.

(12) Jenny, Hans. 1941. Factors of soil formation. McGraw-Hill Book Company, Inc., 281 pp., illus.

(13) Johnson, William M. 1961. Transect methods for determination of composition of soil mapping units. Soil Conserv. Serv., Soil Surv. Tech. Notes, pp. 9-11, illus.

(14) Miller, Fred P., D.E. McCormack, and J.R. Talbot. 1979. Soil survey: Review of data-collection methodologies, confidence limits, and uses. Natl. Acad. Sci., Transp. Res. Board, Transp. Res. Rec. 733: 57-65, illus.

(15) Schmidt, James J. 1980. Ground water resource map of Sandusky County. Ohio Dep. of Nat. Resour., Div. of Water, 1 map sheet.

(16) Simonson, Roy W. 1959. Outline of a generalized theory of soil genesis. Soil Sci. Soc. Am. Proc. 23: 152-156, illus.

(17) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(18) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(19) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(20) United States Department of Commerce, Bureau of the Census. 1980. 1978 census of agriculture—Ohio state and county data. Vol. 1, Part 35.

Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Aspect. The direction in which a slope faces.

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

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.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography. A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Bottom land. The normal flood plain of a stream, subject to flooding.

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.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

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.

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.

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.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth, soil. The depth of the soil over bedrock. Deep soils are more than 40 inches deep over bedrock; moderately deep soils, 20 to 40 inches; and shallow soils, 10 to 20 inches.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of 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.

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.

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.

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.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

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.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (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.

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 rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Karst (topography). The relief of an area underlain by limestone that dissolves in differing degrees, thus forming numerous depressions or small basins.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low 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.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (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.)

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

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.

Perimeter drain. A drain installed around the perimeter of a septic tank absorption field to lower the water table. Also called a curtain drain.

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

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

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.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

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

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

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.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

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.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

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.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 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 multiplied 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.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

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.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

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 grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. 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.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt 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.

Toxicity (in tables). Excessive amount of toxic substances, such as sodium or sulfur, that severely hinder establishment of vegetation or severely restrict plant growth.

Tufa. A chemical, spongy, porous, sedimentary rock composed of calcium carbonate or silica. The chemical is carried by ground water and deposited from solution as a chemical precipitate in a spring or lake.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer of a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in glacial lake or other body of still water in front of a glacier.

Water bar. A shallow trench and a mound of earth constructed at an angle across a road or trail to intercept and divert surface runoff and control erosion.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.