Butler SWCD
1810 Princeton Road
Hamilton, OH 45011

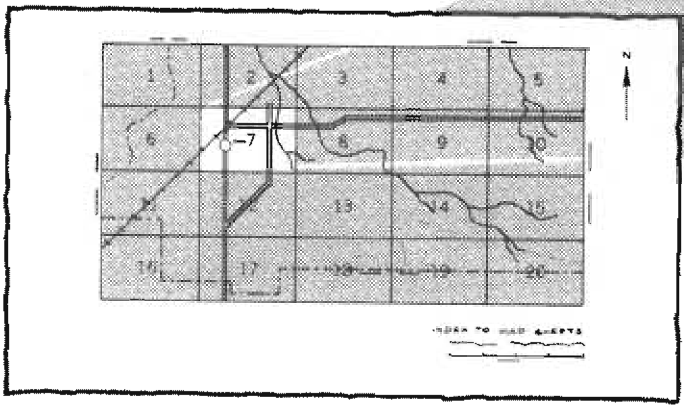
Soil Survey of

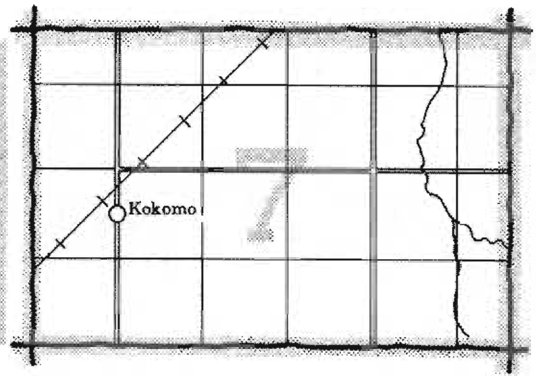
BUTLER COUNTY, OHIO

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

HOW TO USE

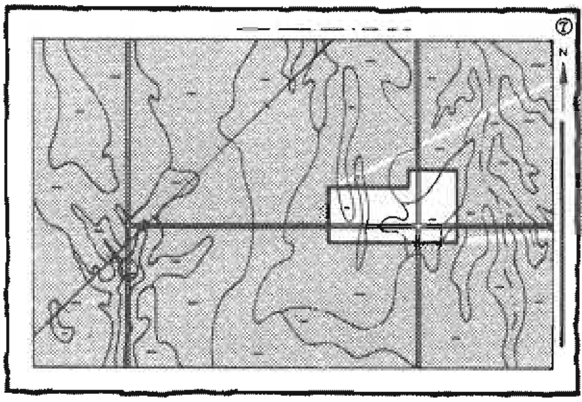
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

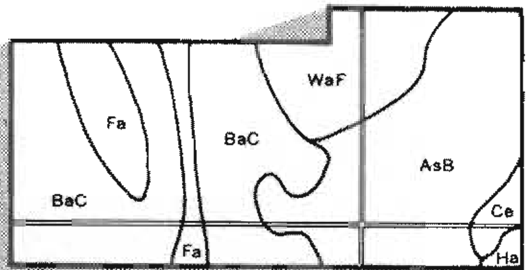




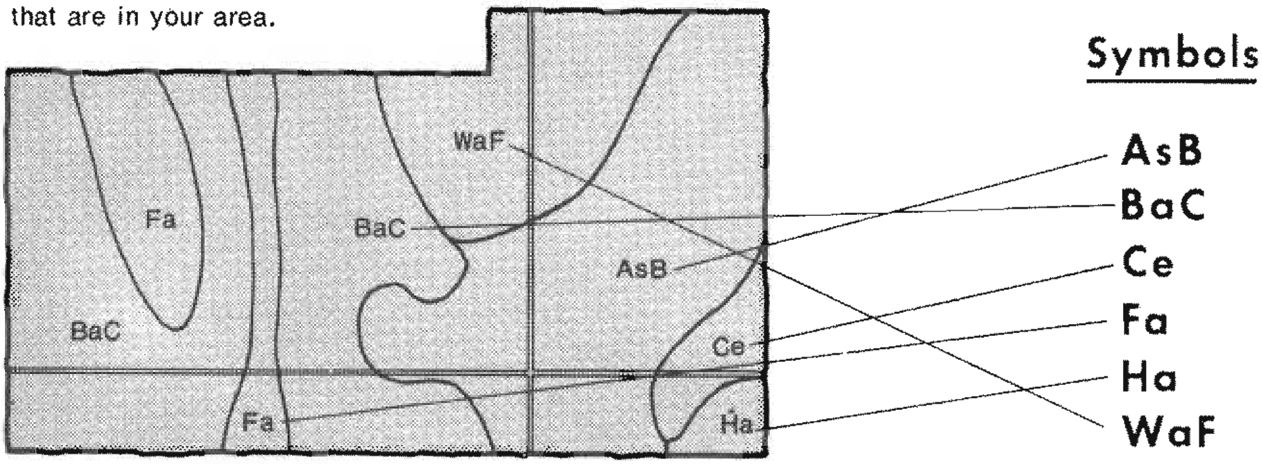
2. Note the number of the map sheet and turn to that sheet.

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



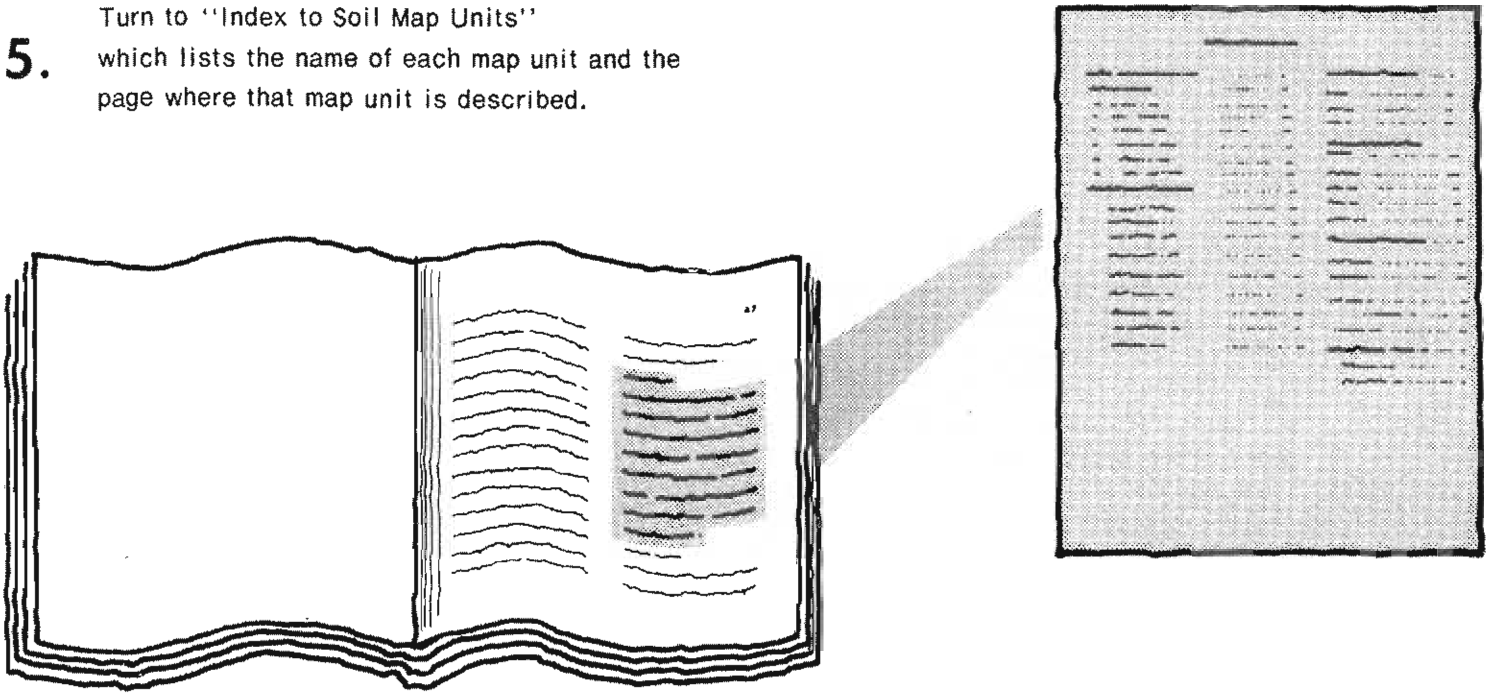


4. List the map unit symbols that are in your area.

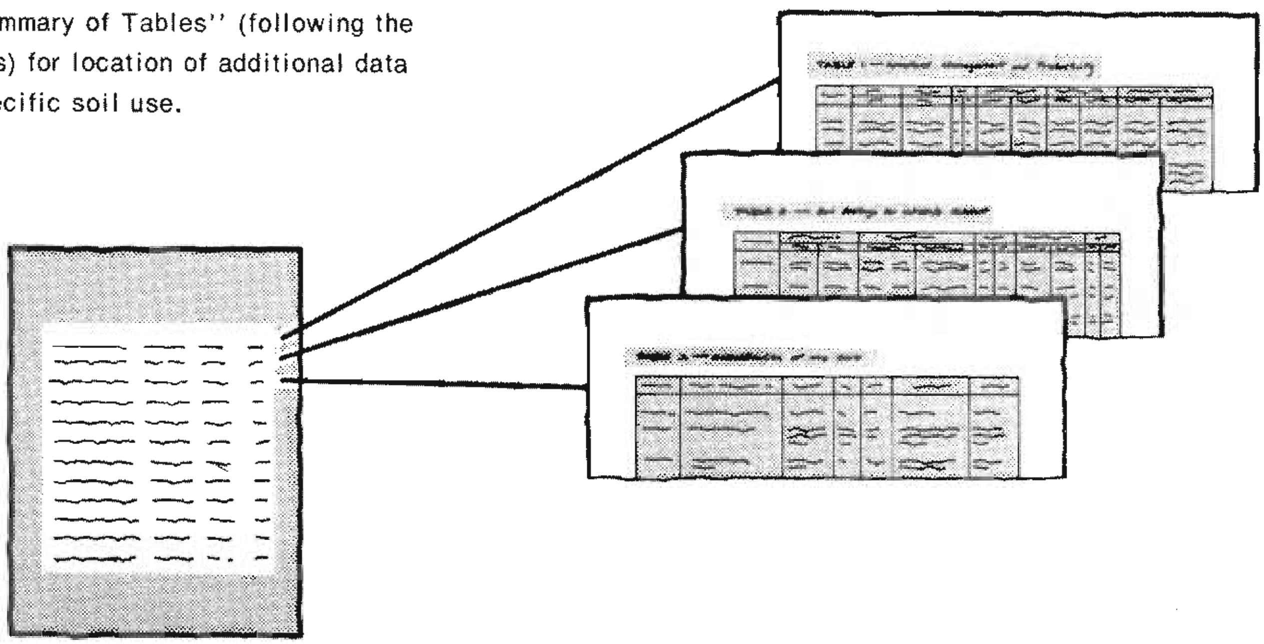


THIS SOIL SURVEY

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



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



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

This 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 performed in the period 1969-1975. Soil names and descriptions were approved in 1976. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1976. This survey was made cooperatively by the Soil Conservation Service and the Ohio Department of Natural Resources, Division of Lands and Soil, and the Ohio Agricultural Research and Development Center. It is part of the technical assistance furnished to the Butler County Soil and Water Conservation District. The survey was materially aided by funds provided by the Butler County Board of Commissioners.

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

Contents

Issued January 1980

Index to soil map units

Summary of tables

Foreword

We introduce the Soil Survey of Butler County, Ohio. You will find herein basic information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

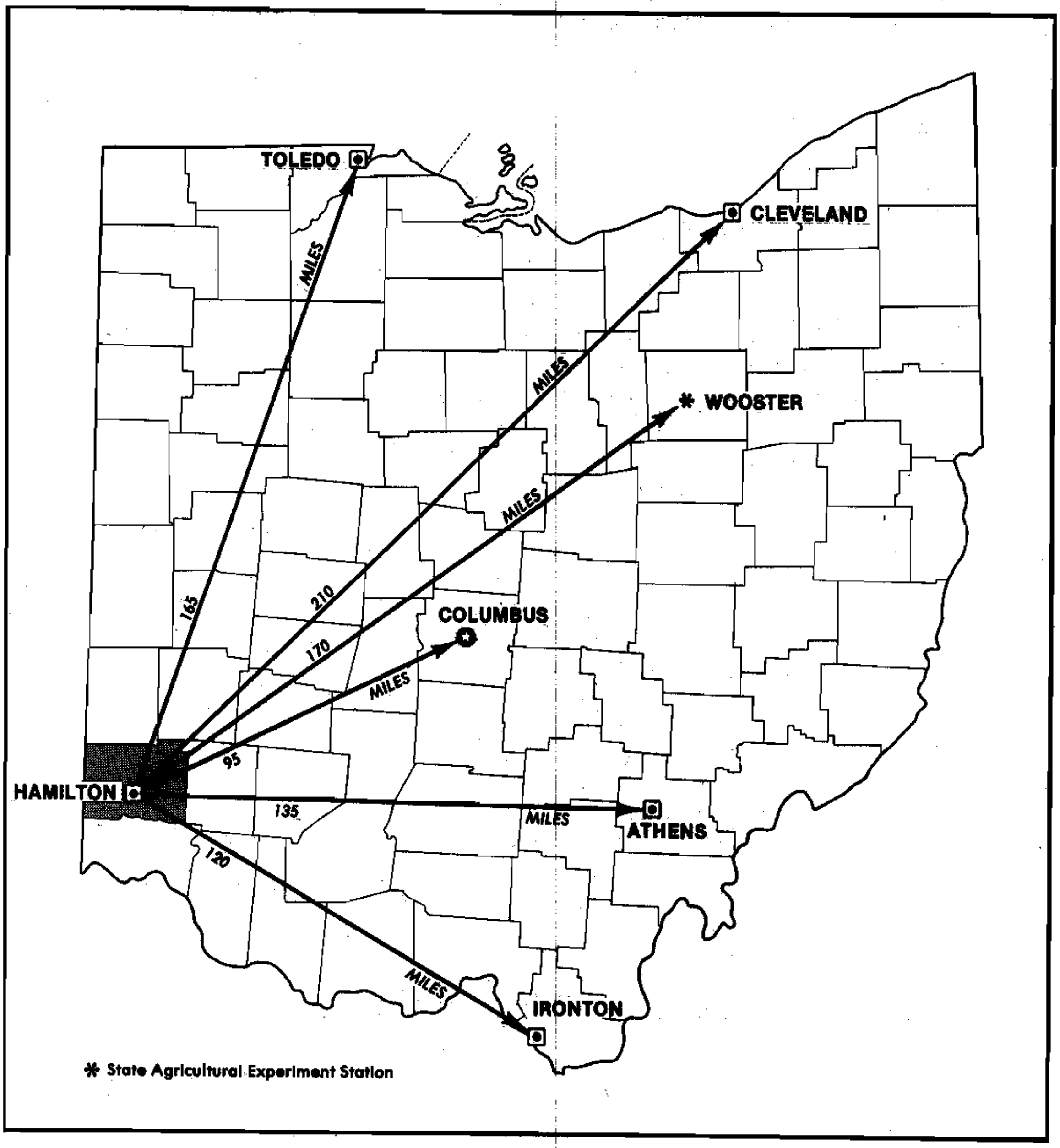
This soil survey has been prepared to meet the needs of different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders,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

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

These and many other soil properties that affect land use are described in this soil survey. This publication also shows, on the general soil map, the location of broad areas of soil and, on detailed soil maps, the location of each kind of soil. It provides descriptions of each kind of soil in the survey area and gives much information about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

We believe that this soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

Robert E. Quilliam
State Conservationist
Soil Conservation Service



Location of Butler County in Ohio.

SOIL SURVEY OF BUTLER COUNTY, OHIO

By Norbert K. Lerch, William F. Hale, and Danny D. Lemaster
Soil Conservation Service

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

Butler County, in southwestern Ohio, has a total of 301,184 acres, or about 471 square miles. Hamilton, the county seat and largest city, is near the center of the county and lies about 25 miles north of Cincinnati. In 1970 the population of the county was 226,207 and that of Hamilton was about 67,865.

General nature of the county

Approximately two-thirds of the land area is farmland, but since the county is in the expanding metropolitan and industrialized part of southwestern Ohio, an increasingly large acreage is being diverted to nonfarm uses. Industries related to steel and iron, paper, safes and bank vaults, machine tools, and auto body parts are dominant.

About one-half of the farm income in 1975 was derived from the sale of livestock and livestock products, mainly swine, dairy products, and cattle and calves. Corn, soybeans, wheat, oats, and hay are grown extensively on many farms and are a main source of income on some farms. Corn accounted for 23 percent of total cash receipts from farm marketing, followed by hogs with 20 percent and dairy with 19 percent.

Most of the soils are deep or moderately deep. Most formed in glacial till or glacial outwash of Wisconsin age, or in recent alluvium. On the steeper slopes and valley walls, the soils are mostly shallow to moderately deep and formed in material weathered from the underlying Ordovician-age shale and limestone bedrock.

History and development

The settlement of Butler County began in September 1791 when General Arthur St. Clair, first governor of the Northwest Territory, ordered the building of Fort Hamilton. This frontier log outpost on the east bank of the Miami River, about 30 miles north of Fort Washington (Cincinnati), was to link Fort Washington and other forts to the north. It was also a supply base for the army that St. Clair led against the Indians.

After General Anthony Wayne's victory and the signing of the Treaty of Greenville with the Indian tribes in 1795, Fort Hamilton was abandoned by the army and settlement began in earnest around the fort.

This territory was well populated before the county was organized in 1803, one of the original eight counties in Ohio. The present boundaries of the county were established in 1815.

The rural and urban populations were about equal in 1890, but since that time the urban population has gradually increased over the rural.

Hamilton, the county seat, is the largest city, and Middletown is the second largest city. These two cities are progressive industrial centers, producing a great variety of steel and paper products, and are good markets for agricultural products. Cincinnati to the south and Dayton to the north also provide excellent markets.

Butler County is well served by highways and railroads. Interstate, Federal, and State highways all enter the county. The county maintains a fine system of about 280 miles of smooth, black topped two-lane highways. Also the 454 miles of township roads are mostly hard surfaced and suitable for all-weather traffic.

There are a number of public and private water distribution systems in the county. There are also a number of wastewater treatment facilities scattered over the county. One large one, the LeSourdsville Regional Wastewater Treatment Plant, under construction in 1976-1977, will serve parts of four townships in the eastern part of the county.

Miami University, at Oxford, is one of the largest academic institutions in the State. It is one of the State supported universities, and maintains attractive branch campuses in Hamilton and Middletown. Miami University was founded in 1815 at Oxford. Recently, Western College for Women, also at Oxford, merged with Miami University providing a greater total educational facility.

Climate

Butler County is cold in winter but quite hot in summer. On most soils, winter precipitation, frequently snow, is sufficient to result in a good accumulation of soil moisture by spring and to minimize drought during summer. Normal annual precipitation is adequate for all crops that are adapted to the temperature and length of growing season in the area.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at the Hamilton-Fairfield weather station for the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 33 degrees F, and the average daily minimum temperature is 24 degrees. The lowest temperature on record, which occurred at Hamilton-Fairfield on January 1, 1963, is -21 degrees. In summer, the average temperature is 74 degrees, and the average daily maximum temperature is 86 degrees. The highest recorded temperature, which occurred on July 28, 1952, is 103 degrees.

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

Of the total annual precipitation, 21 inches, or 60 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 16 inches. The heaviest 1-day rainfall during the period of record was 4.90 inches at the Hamilton-Fairfield station on July 22, 1958. Thunderstorms occur on about 40 days each year, and most occur in summer.

The average seasonal snowfall is 15 inches. In the average year, 8 days have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year. The greatest snow depth at any one time during the period of record was 13 inches.

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 county receives 65 percent of the sunshine possible in summer and 45 percent of that possible in winter. The prevailing wind is from the southwest. Average windspeed is highest, 8 miles per hour, in winter.

Climatic data for this section were especially prepared for the Soil Conservation Service by the National Climatic Center at Asheville, North Carolina.

Physiography, drainage, and geology

Butler County lies in the Interior Low Plateau Province of the eastern part of the United States. This province is characterized by structural and sedimentary basins, domes, and arches which came into existence throughout Paleozoic time. Among these features, the Cincinnati geo-anticline or "Cincinnati Arch," is structurally significant in southwestern Ohio, and Butler County is almost on the crest of this arch. Outcrops of shale and fossiliferous limestone bedrock of Upper Ordovician age occur at numerous waterfalls in the tributary streams feeding into the Miami River. This Ordovician bedrock is the oldest in Ohio. It outcrops on the steep valley walls but is covered by Wisconsin-age glacial deposits ranging to more than 200 feet in thickness in the Miami River Valley.

The county has been greatly influenced by the Wisconsin Glaciation. A major part of the relief conforms to the bedrock topography. Landforms in the county include glacial uplands, extensive glacial river terraces and outwash plains, and recent alluvial flood plains. The upland topography still reflects the rolling shale and limestone bedrock hills that existed long before glaciation. Bedrock "highs" of that period are still bedrock hills, although the glaciers pushed over them. Because Butler County is near the southern edge of all the glaciers known to have covered Ohio, the glaciers exerted rather ragged pressures on it rather than the intense leveling efforts that they exerted in central and western Ohio.

During the Pleistocene Epoch, the bedrock topography of Butler County was modified several times by the erosional and depositional action of continental ice sheets. The occurrence of two prominent glaciations is manifested in places by two tills, one on top of the other. The younger of the two tills apparently was deposited during the Tazewell or Iowan substage of the Wisconsin stage, and the older is probably Illinoian in age. Evidence also indicates that the preglacial Great Miami River drained northward into the ancient Teays drainage system, whereas the present drainage of the Great Miami River is southwestward across the county into the Ohio River. All Butler County drains into the Great Miami River except for Mill Creek, which drains directly into the Ohio River, and Muddy and Little Muddy Creeks, which drain into the Little Miami River.

Butler County owes its rolling surface to Pleistocene ice sheet invasions preceded and followed by stream erosion. The dissection of the unconsolidated glacial deposits produced gently undulating surfaces and exposed, in places, alternating layers of gently dipping soft shales and limestones. Locally, no surface features are outstanding because of the almost horizontal attitude of the underlying bedrock. The Miami River Valley is exceptionally broad and level-bottomed considering the size of its stream. This valley floor is low enough to be subject to floods. It resulted principally from the deposition of glacial outwash in a valley widened by glaciation. The terrain here is flat and featureless. It is covered by a thin veneer of recent alluvium and underlain by glacial spillway sand and gravel.

The soils of Butler County mostly formed in the glacial materials that cover the bedrock shale and limestone. Because these glacial materials were transported for only short distances, the developed soils mostly reflect the influence of the underlying limestone bedrock. Till in the county consists mostly of limestone fragments that had their source within the county or in the counties immediately to the north or northeast. Only 10 to 15 percent of the till fragments are igneous rocks that travelled long distances, from either Canada or the northeastern United States, in the ice sheet.

The soils of Butler County formed in several kinds of parent material. These materials are glacial drift, weathered shale and limestone bedrock, loess, lacustrine deposits, and alluvium from all these materials.

Glacial drift, a general term applied to till and to outwash sand and gravel, is the most extensive of the parent materials in the county. The Miamian, Celina, and Crosby soils formed in till that was capped with loess (wind deposited silt) up to 18 inches thick. Because the till was fairly homogeneous, these soils have a rather uniform, moderately fine to fine textured subsoil. The Russell, Xenia, and Fincastle soils formed in till overlain by more than 18 inches of loess. In these soils, the upper part of the subsoil is more silty than that of the soils that formed where the loess cap was thin.

Outwash sand and gravel were deposited by glacial melt water that flowed in such streams as the Great Mimai River and its tributaries. After this coarse material was fairly well sorted, much of it was covered by finer textured material, mostly loamy outwash. The Ockley, Wea, Tippecanoe, and Sleeth soils formed in those materials. Ockley and Wea soils are strong brown and reddish in color, but Sleeth soils are dominantly gray as a result of slow drainage and poor aeration. Eldean, Rodman, and Casco soils also formed in water-sorted coarse sand and gravel, but were covered by only a thin layer of loamy outwash, or the loamy outwash was removed by geologic erosion. These soils are generally gravelly throughout and are relatively droughty.

Clay shale and limestone bedrock have markedly influenced some of the soils. Lower horizons of the Wynn soils formed in parent material that was mostly weathered from bedrock and retain the color of the bedrock. Olive brown and olive gray predominate in material weathered from Ordovician shale and limestone. The Eden soils formed entirely in this material.

Extensive areas of lacustrine material (lake-bottom sediments) are in the county. Lacustrine deposits of thinly layered or stratified silts and clays are the parent material of the Patton, Henshaw, and Uniontown soils. The large pre-glacial valleys now occupied by Mill Creek and Dick's Creek were partly filled with glacial drift which blocked their drainage. Thus the soils in the lower parts of the valleys formed in lacustrine sediments, but the soils in slightly higher parts of the valleys formed in glacial drift and are similar to the nearby upland soils that are about 300 feet higher.

Alluvial deposits left by floodwater are the youngest parent materials in the county. They accumulate when streams overflow and deposit sediment from the surface layer and subsoil of the higher-lying terrace and upland soils onto the flood plain. The soils that formed in alluvial deposits, such as the Ross soils, are dark colored and productive.

Water supply

Hamilton, Middletown, Fairfield, and Trenton all obtain their water from deep wells drilled in the glacial fill of the Miami River Valley. Oxford obtains its water from about 60 feet of glacial fill in the Four Mile Creek Valley.

The fill in the valley at Hamilton is about 180 to 217 feet or more thick and consists of sand, gravel, and silt. The water supply in this buried valley is large. The fill at Middletown is about 180 feet thick, and from it both Middletown and Trenton obtain large volumes of water.

The water pumped from these thick glacial deposits is quite hard, because the glacial material is predominantly of limestone origin.

Farming

In 1974, Butler County had 1,480 farms and 198,000 acres of farmland. The average farm size was 134 acres. Cash farm receipts for the county totaled 28,241,000 dollars. Receipts from livestock sales amounted to 14,535,000 dollars, and from crop sales, 13,706,000 dollars.

In 1975, the total cash receipts from farm marketing were distributed among eight major commodities as follows: Corn, 23 percent; hogs, 20 percent; dairy products, 19 percent; cattle, 12 percent; soybeans, 11 percent; wheat, 6 percent; all hay, 4 percent; and greenhouse and nursery products, 3 percent.

Land use

Butler County covers an area of 301,184 acres. According to the Conservation Needs Inventory of 1971 (*6*) 230,633 acres was classified as rural land. The remaining 70,551 acres was in urban use, in small water areas, and in other inextensive uses. A similar inventory in 1958 showed 240,650 acres of rural land in the county. Therefore, between 1958 and 1967, a total of 10,017 acres was removed from rural land use.

The 1967 inventory also showed 136,239 acres in crops, 37,721 acres in permanent pasture, 31,793 acres in forest, and 24,880 acres in other rural uses. Capabilities of the soils have been determined for all of these land uses. The local office of the Soil Conservation Service can provide detailed information about acreage, capabilities, farming practices, and treatment needed for all soils in the county.

How this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map for broad land use planning" and "Soil maps for detailed planning."

The names, descriptions, and delineations of soils in this soil survey do not always agree or join fully with soil maps of adjoining counties published at an earlier date. Differences are brought about by better knowledge about soils or modification and refinements in soil series concepts. In addition, the correlation of a recognized soil is based upon the acreage of that soil and the dissimilarity to adjacent soils within the survey area. Frequently, it is more practical to include soils that are small in extent with similar soils, if management and response are much the same, rather than to map them individually. The soil descriptions reflect these combinations. Other differences are brought about by the predominance of different soils in taxonomic units made up of two or three series or by the different range in slope allowed within the map unit for each survey.

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers and builders, home buyers, and others.

General soil map for broad land use planning

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

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

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Descriptions of map units

The map units in this survey have been grouped into three general kinds of areas for broad interpretive purposes. Each of the broad groups and the map units in each group are described in the following pages.

Well drained and moderately well drained soils on till plains

These are nearly level to sloping soils on broad hilltops and steep to very steep soils on hillsides. These soils have a fine to medium textured subsoil. In more than 50 percent of the acreage, the soils have a substratum of stony glacial till or are underlain by Ordovician shale and limestone bedrock at a depth of about 40 inches. Most hilltops are used for farming cash grain crops, and the hillsides are either in pasture or woodland. These map units make up about 67 percent of the county.

1. Russell-Miamian-Wynn

Deep and moderately deep, gently sloping to moderately steep, well drained soils that have a moderately fine or *fine textured subsoil; formed in loess, glacial till, and residuum from shale and limestone*

This map unit is in an area of till plains topographically shaped by the underlying bedrock. These areas are characterized by a gently rolling upland plain cut by steeper slopes along streams. Many areas have long, gentle slopes and shallow waterways.

This map unit makes up about 32 percent of the county. It is about 30 percent Russell soils, 25 percent Miamian soils, 20 percent Wynn soils, and 25 percent soils of minor extent (fig. 1).

Russell and Miamian soils are at slightly higher elevations than Wynn soils and are in very intricate patterns on the landscape. Russell and Miamian soils are deep and Wynn soils are moderately deep to Ordovician shale and limestone bedrock. Some areas of Russell and Miamian soils, however, have a substratum of stony glacial till or are 4 to 6 feet deep over bedrock. Wynn soils commonly are on the middle and lower parts of long gentle slopes adjacent to drainageways. Ordovician bedrock is exposed in the streambanks in many areas. Russell and Miamian soils are in more level areas near the top of the slopes, along ridgetops, and on low knolls. Russell and Miamian soils have moderately slow permeability, and Wynn soils have moderately slow to slow permeability. All are well drained.

Of minor extent in this map unit are Dana, Eden, Fincastle, Hennepin, Patton, Raub, and Xenia soils. Dana soils are moderately well drained, and Raub soils are somewhat poorly drained. Both soils are on toe slopes below Wynn soils. Eden soils are well drained and moderately deep to bedrock. Fincastle soils are somewhat poorly drained, and Xenia soils are moderately well drained. Both these gently sloping soils are on hilltops above Wynn, Russell, and Miamian soils. Hennepin soils are well drained, are on the hillsides, and are more than

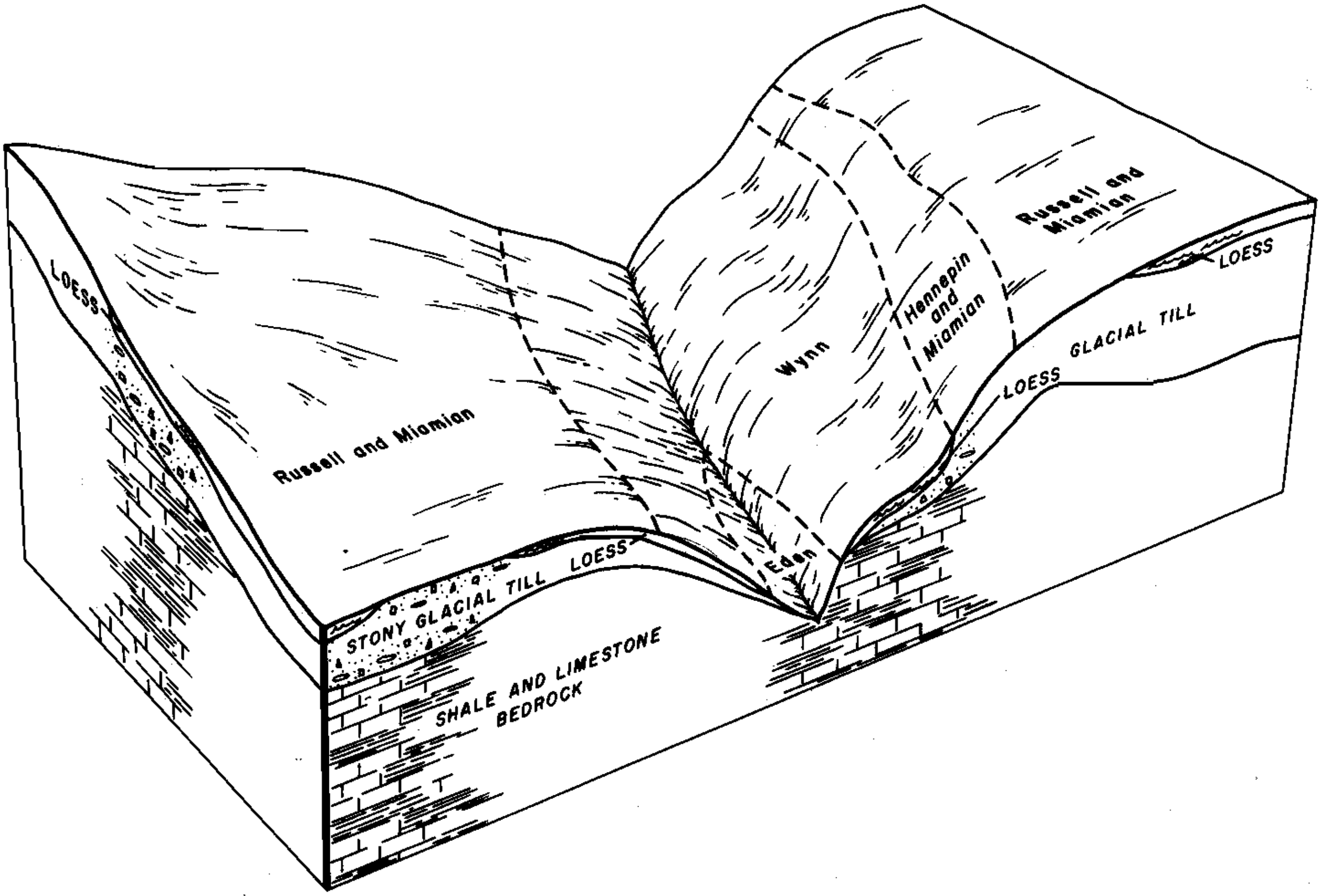


Figure 1.—Typical pattern of soils and underlying material in the Russell-Miamian-Wynn map unit.

40 inches deep to bedrock. Patton soils are poorly drained and are in depressional areas below the major soils.

This map unit is used mainly for cultivated crops. Steeper areas, however, are in woodland or pasture. Erosion is a serious hazard in farming most areas. Minimum tillage, contour farming, and grassed waterways are effective in reducing erosion.

The soils in this map unit have high potential for farming but only medium potential for community development. Low strength, shrinking and swelling, and the hazard of frost action must be overcome in designing structures. Moderately slow permeability in Russell and Miamian soils and moderate depth to bedrock in Wynn soils are severe limitations for septic tank absorption fields. The soils have high potential for woodland and woodland wildlife habitat as well as many kinds of recreational development.

2. Xenia-Wynn-Russell

Deep and moderately deep, nearly level and gently sloping, moderately well drained and well drained soils that have a moderately fine or fine textured subsoil; formed in loess, glacial till, and residuum from shale and limestone

Areas of this map unit are on glacial till plains. These till plains are topographically shaped by the underlying bedrock. The areas are characterized by gently undulating, broad upland plains with many shallow depressions and slight rises. Slopes are short, and variations in elevation commonly are less than 50 feet. Some areas are slow to drain.

This map unit occupies about 20 percent of the county. About 35 percent of the unit is Xenia soils, 30 percent is Wynn soils, and 15 percent is Russell soils (fig. 2). The remaining 20 percent is soils of minor extent.

The Xenia soils occupy the less sloping parts of the landscape. The Wynn and Russell soils are in the same

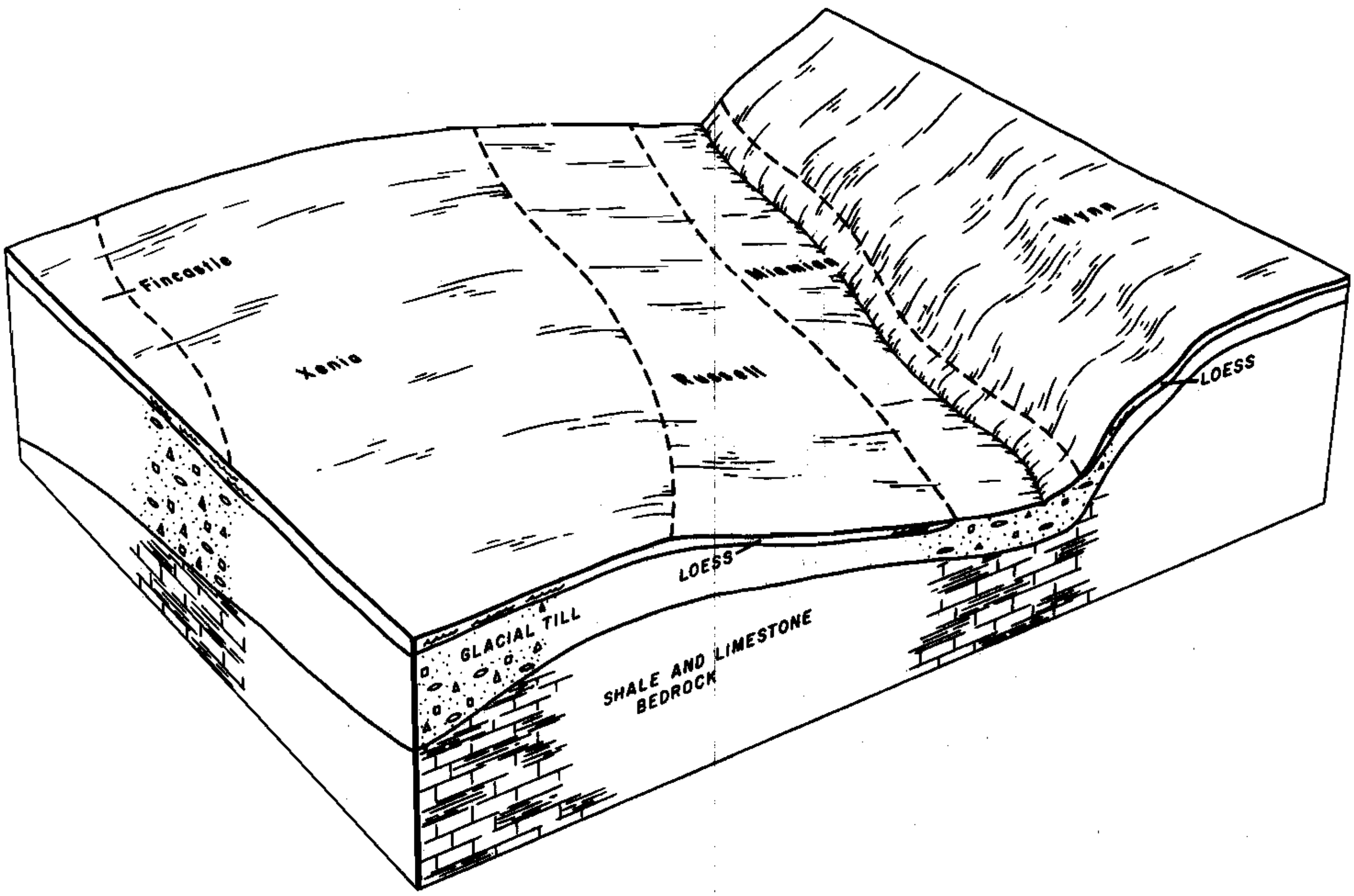


Figure 2.—Typical pattern of soils and underlying material in the Xenia-Wynn-Russell map unit.

gently sloping positions on the landscape. The Wynn soils are in gently sloping areas that have bedrock within a depth of 40 inches, but the Russell soils are in areas where bedrock is deeper than 40 inches. Xenia soils are moderately well drained, and the Wynn and Russell soils are well drained. The Xenia and Russell soils have a glacial till substratum that is up to 30 percent limestone flagstones. Xenia and Russell soils have moderately slow permeability, and Wynn soils have moderately slow to slow permeability.

Of minor extent in the map unit are Fincastle, Miamian, Patton, and Ragsdale soils. Fincastle soils are somewhat poorly drained and commonly are in the less sloping areas near Xenia soils. Miamian soils are well drained and are mixed with Russell soils in very intricate patterns. Patton soils are poorly drained, and Ragsdale soils are very poorly drained. Both these soils are in the shallow depressions that are common in this map unit.

This map unit is used mainly for cultivated crops, pasture, and woodland. Most shallow depressions have been artificially drained and are cultivated. Corn and soybeans are the most commonly grown crops. The pasture is a grass-legume mixture, and the woodland is oak-hickory and beech-maple forest types in the gently sloping areas and pin oak-red maple forest types in depressions. Erosion is a moderate hazard in gently sloping areas. Depressional areas must be artificially drained to be cultivated in a wet year. Many undrained depressions become ponded after half an inch of rainfall.

The soils in this map unit have high potential for farming and medium to low potential for building sites. The high water table, low strength, and shrinking and swelling must be considered in designing structures. Moderately slow permeability in Russell and Xenia soils and moderate depth to bedrock in the Wynn soils are severe limitations for septic tank absorption fields. Low soil strength in the Wynn soils and severe hazard of frost action in Xenia and Russell soils are severe limitations for local roads and streets. These soils have medium to high potential for most recreational development.

3. Miamian-Hennepin

Deep, gently sloping to very steep, well drained soils that have a moderately fine or medium textured subsoil; formed in loess and glacial till

This map unit is on the Camden end moraine. It is characteristically a gently rolling till plain dissected by steep or very steep slopes along waterways.

This map unit makes up 7 percent of the county. It is about 60 percent Miamian soils, 15 percent Hennepin soils, and 25 percent soils of minor extent.

Hennepin and Miamian soils are in very intricate patterns in the steep and very steep parts of the landscape. Hennepin soils do not have slopes of less than 18 percent. The less sloping Miamian soils are continuous over broad areas. These broad areas contain most of the minor soils. Miamian soils have moderately slow permeability, and Hennepin soils have moderately slow to slow permeability.

Of minor extent are Celina, Crosby, Genesee, Ragsdale, and Ross soils. Celina soils are moderately well drained and are in the gently sloping areas. Crosby soils are somewhat poorly drained and are at the heads of waterways and in many nearly level areas. Genesee and Ross soils are well drained and are on flood plains of the larger streams. Ragsdale soils are very poorly drained and are in the many nearly level depressions.

The less sloping areas are cultivated, and the steeper areas are in pasture or woodland. Erosion is a moderate to severe hazard in the less sloping areas and a very severe hazard on the steeper slopes. Minimum tillage, winter cover crops, and grassed waterways are effective in controlling erosion in the less sloping areas. The steeper areas should never be plowed but should be left in pasture or woodland. Adding organic matter to the less sloping areas benefits most crops.

The less sloping areas of Miamian soils have high potential for cultivated crops, and the steeper areas of Hennepin and Miamian soils have low potential for cultivated crops. Because of slope or restricted permeability, both major soils have low potential for community development and sanitary facilities. Both soils, however, have high potential for many recreation uses. The steeper areas of this map unit are very scenic, and retaining them for open space or recreational development will benefit nearby communities.

4. Rossmoyne-Cincinnati-Eden

Deep and moderately deep, gently sloping to very steep, moderately well drained and well drained soils that have a moderately fine or fine textured subsoil; formed in loess and glacial till, or in residuum from shale and limestone

Areas of this map unit are on the Illinoian till plain south of the Hartwell end moraine. This till plain is topographically shaped by the underlying bedrock. Areas are characteristically gently rolling upland till plains that have shallow, sluggish waterways and steep hillsides and valley walls along the larger streams.

This map unit makes up about 1 percent of the county. It is about 30 percent Rossmoyne soils, 25 percent Cincinnati soils, 15 percent Eden soils, and 30 percent soils of minor extent.

Rossmoyne soils are moderately well drained, and Cincinnati soils are well drained. Both soils are deep to bedrock but have a dense, brittle fragipan. The fragipan is slowly or moderately slowly permeable and restricts root penetration. Eden soils are well drained and are moderately deep to shale and limestone bedrock of Ordovician age. They are slowly permeable. Rossmoyne and Cincinnati soils are on the gently or moderately sloping areas of the upland till plain, and Eden soils are on the steep hillsides or valley walls topographically shaped by the underlying bedrock.

Of minor extent in this map unit are Avonburg and Wynn soils. Avonburg soils are somewhat poorly drained and are nearly level or depressional areas of the upland till plain. Wynn soils are well drained, are moderately sloping or moderately steep, are on side slopes shaped by bedrock, and are moderately deep to bedrock.

This map unit is used mainly for urban development. The upland till plain areas either have already been developed into housing subdivisions and small business centers or are idle and are becoming covered by weeds while awaiting development. The steep hillsides and valley walls, however, have been left in oak-hickory or beech-maple forest types and are being used as open space.

Rossmoyne and Cincinnati soils on the upland till plain have medium potential for urban development. The moderately slow to slow permeability of these soils is a severe limitation for septic tank absorption fields. Where possible, central sewage treatment facilities should be used. A high water table in the Rossmoyne soils is a severe limitation for houses with basements. The high hazard of frost action and the shrinking and swelling potential require that suitable base material be used where streets or building foundations are to be constructed. These soils are suited to most recreational development.

5. Wynn-Eden

Moderately deep, gently sloping to very steep, well drained soils that have a fine or moderately fine textured subsoil; formed in glacial till and residuum from shale and limestone

This map unit is on hillsides along the larger valleys. Topography is characterized by many small streams and very scenic, steep, wooded hillsides that have rock outcrops and escarpments in places. The streams generally flow over several small bedrock ledges or waterfalls before reaching the foot of the slope.

This map unit makes up about 7 percent of the county. It is about 60 percent Wynn soils, 25 percent Eden soils, and 15 percent soils of minor extent.

Wynn and Eden soils are well drained and moderately deep to shale and limestone bedrock. Wynn soils formed mainly in a thin layer of glacial till above the bedrock, and Eden soils formed in material weathered from the bedrock. Wynn soils have moderately slow or slow permeability, and Eden soils have slow permeability. Eden soils are on the steepest part of the side slopes.

Of minor extent are Dana soils that have a bedrock substratum, Hennepin soils, and Miamian soils. Dana soils that have bedrock substratum are well drained, are gently sloping, and are on benches. Hennepin and Miamian soils are also well drained but are in the few steep areas where the depth to bedrock is more than 60 inches.

This map unit is used mainly for woodland. A few areas are in pasture. Erosion is such a serious hazard that the soils should not be plowed. They are mostly so steep that they cannot be traversed safely by farm machinery. These soils are suited to pasture or woodland, which helps to control erosion. They are subject to slip if fill is put on top of them, if the bottom of the slope is undercut, or if they are saturated.

The soils in this map unit have low potential for farming, building sites, sanitary facilities, and some recreational development because of the generally steep slope. These soils can provide open space for hiking trails and similar recreation facilities and can serve as natural areas.

Very poorly drained to moderately well drained soils on till plains and lake plains

These are nearly level and gently sloping soils on till plains and lake plains and in till-filled valleys. They have a moderately fine textured subsoil. The lacustrine soils are in low, depressional areas, and the till soils are on gentle side slopes and low knolls. Most areas are used for farming cash-grain crops. These map units make up about 12 percent of the county.

6. Fincastle-Ragsdale-Xenia

Deep, nearly level and gently sloping, somewhat poorly drained, very poorly drained and moderately well drained soils that have a moderately fine textured subsoil; formed in loess and glacial till

This map unit is on the more nearly flat till plains of the county. Topography is characterized by broad flats, occasional knolls, and many swales. Runoff is slow, and many depressional areas are ponded after rain.

This map unit makes up about 6 percent of the county. It is about 45 percent Fincastle soils, 15 percent Ragsdale soils, 10 percent Xenia soils, and 30 percent soils of minor extent.

Fincastle soils are somewhat poorly drained and are on broad flats. Ragsdale soils are very poorly drained and are in swales and depressional areas. Xenia soils are moderately well drained and are on knolls and slight rises on the till plain. All these soils are deep to bedrock. Fincastle and Xenia soils have moderately slow or slow permeability, and Ragsdale soils have slow permeability and a high water table for most of the year.

Of minor extent in this map unit are Miamian, Patton, and Russell soils. Russell and Miamian soils are well drained and are in intricate patterns on knolls and rises above Fincastle soils. Patton soils are poorly drained and are in swales and depressions similar to Ragsdale soils.

Drained areas of this map unit are used mainly for cultivated crops. Wetness is the major limitation for farming. Subsurface drains and surface ditches are effective in draining most areas. Undrained areas are used for woodland.

All major soils have low potential for community development and fair potential for recreation development. Wetness, shrinking and swelling, and the hazard of frost action must be considered in design structures. Moderately slow or slow permeability in Fincastle and Xenia soils and slow permeability in Ragsdale soils and wetness in all the soils are severe limitations for septic tank absorption fields. Fincastle and Xenia soils have high potential and Ragsdale soils have low potential for openland and woodland wildlife habitat. The major soils have high or medium potential for woodland development.

7. Fincastle-Patton-Xenia

Deep, nearly level and gently sloping, somewhat poorly drained, poorly drained, and moderately well drained soils that have a moderately fine textured subsoil; formed in loess, glacial till, and lacustrine silts

This map unit is in till filled valleys. Topography is characterized by large flats underlain by glacial till interspersed with low lying areas filled with lacustrine silt. Glacial melt water formed the ponds and lakes in which the silts were laid down.

This map unit makes up about 6 percent of the county. It is about 40 percent Fincastle soils, 20 percent Patton soils, 15 percent Xenia soils, and 25 percent soils of minor extent.

Fincastle soils are somewhat poorly drained and are on broad flats underlain by glacial till. Patton soils are poorly drained and are in lacustrine silt filled basins that are characteristic of the area. Xenia soils are moderately well drained and are on knolls and rises above Fincastle soils. Fincastle and Xenia soils have moderately slow permeability or slow permeability, and Patton soils are moderately permeable.

Of minor extent in this map unit are Eel, Genesee, and Henshaw soils. Eel soils are moderately well drained, and Genesee soils are well drained. Both soils are on flood plains that cross the map unit. Henshaw soils are somewhat poorly drained and are in basins with Patton soils.

Most areas have been drained and are farmed. Corn and soybeans are the main crops. Undrained areas, however, remain as swampy woodland. Soil wetness is the major hazard for farming. Subsurface drains and surface drainage channels, however, are effective in reducing wetness.

Drained areas of this map unit have high potential for farming; wetness and the moderately slow permeability or slow permeability, however, are severe limitations for community development. Patton soils have low potential for recreation development and medium potential for woodland and wildlife habitat. Fincastle and Xenia soils have high or medium potential for woodland and wildlife habitat.

Well drained soils on flood plains and terraces

These are nearly level to moderately sloping soils. Most slopes are short and irregular. The soils have a medium to fine textured subsoil. The soils on terraces are underlain by stratified sand and gravel. About 25 percent of the soils in these map units are mapped in complexes with Urban land. Most areas are used for cash grain crops. These map units make up about 21 percent of the county.

8. Eldean-Ockley

Deep, nearly level to moderately sloping, well drained soils that mostly have a fine or moderately fine textured subsoil; formed mainly in glacial outwash

These nearly level to moderately sloping soils are on stream terraces and outwash plains. Several areas are more than a mile wide. The soils are between the flood plain and the upland and are underlain by stratified sand and gravel.

This map unit makes up about 11 percent of the county. It is about 55 percent Eldean soils, 10 percent Ockley soils (fig. 3), and 35 percent soils of minor extent.

Eldean soils are shallower to sand and gravel and are closer to the flood plain than Ockley soils. Both soils are deep to bedrock and are well drained. Eldean soils have moderate permeability or moderately slow permeability, and Ockley soils have moderate permeability.

Of minor extent in this map unit are the Casco, Genesee, Rodman, Thackery, Tippecanoe, Sleeth, Warsaw, and the Wea soils. Casco, Genesee, Rodman, Warsaw, and Wea soils are well drained, Thackery and Tippecanoe soils are moderately well drained, and Sleeth soils are somewhat poorly drained. Casco and Rodman soils are shallower to sand and gravel than either Eldean or Ockley soils, and they have short steep slopes. They are in a very intricate pattern on the landscape. Thackery soils are similar to Ockley soils and are in similar positions on the landscape. Tippecanoe, Warsaw, and Wea soils have a dark colored surface layer and are nearly level or gently sloping. Sleeth soils are in depressions and adjacent to some of the waterways. Genesee soils are on the flood plain.

This map unit is used mainly for farming, and corn and soybeans are the major crops. Some areas are used as pasture or for hay.

These soils have high potential for farming, but droughtiness is a hazard in dry years. The soils have high potential for community development, but pollution of ground water supplies by septic tank effluent is a hazard. This is the best map unit in the county for farming and community development. The soils are a good source of sand and gravel, and many gravel pits are

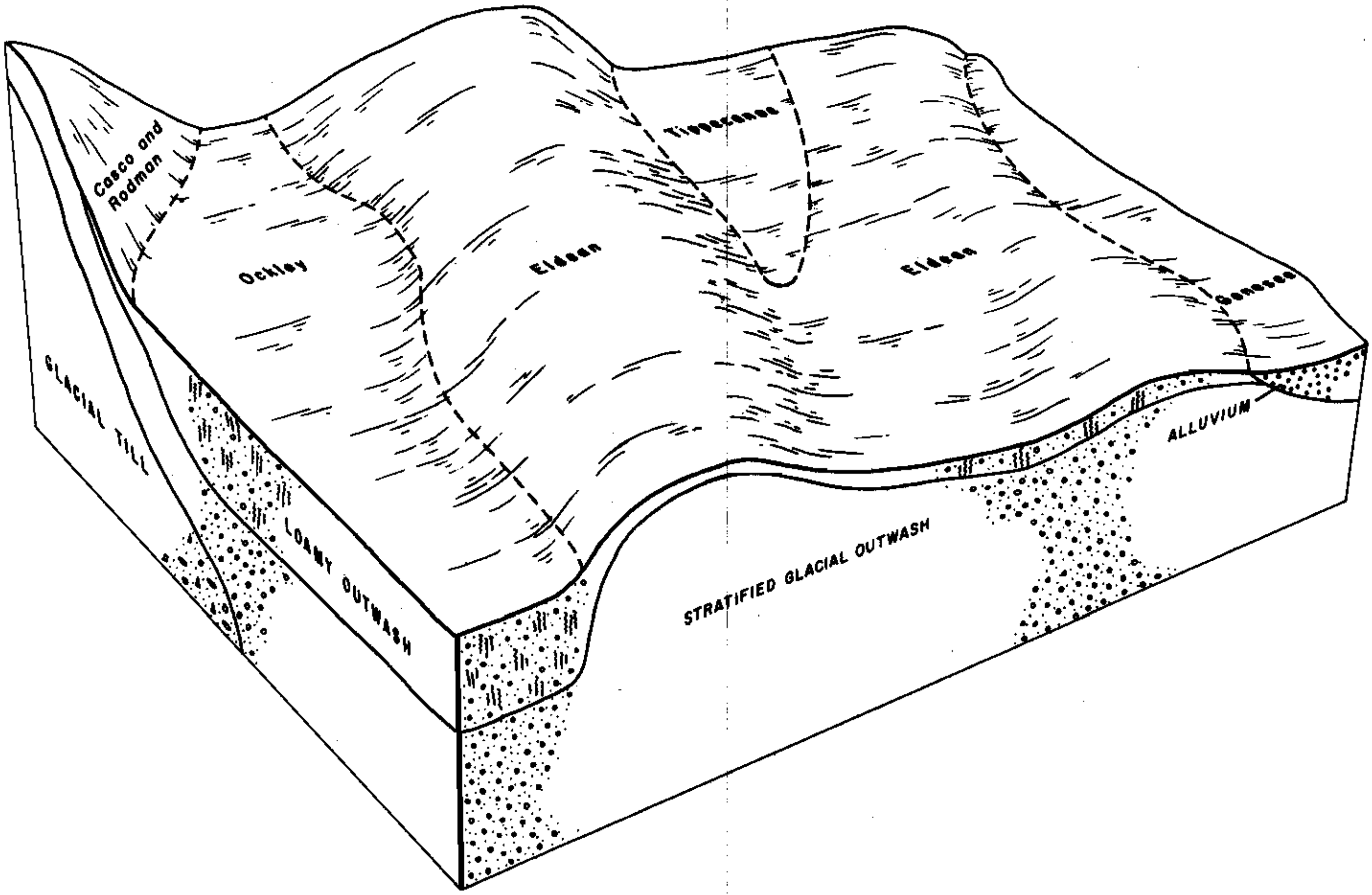


Figure 3.—Typical pattern of soils and underlying material in the Eldean-Ockley map unit.

within the unit. Most of the population of Butler County lives within this map unit. It has high potential for recreational development and wildlife habitat.

9. Genesee-Ross

Deep, nearly level, well drained soils that have a medium textured subsoil or upper substratum; formed in recent alluvium

These nearly level soils are on flood plains of streams. Most areas are on both sides of the stream and are 200 to 1,000 feet wide. These soils are in the lowest positions on the landscape.

This map unit makes up about 10 percent of the county. It is about 35 percent Genesee soil, 20 percent Ross soil, and 45 percent soils of minor extent.

Genesee soils are slightly lower in elevation and closer to the stream than Ross soils. Both soils have moderate permeability, a deep rooting zone, and high available water capacity. Ross soils have a darker colored surface layer and higher organic matter content than Genesee soils. Both soils, however, are well drained and highly fertile.

Of minor extent in the map unit are well drained Landes, Lanier, and Stonelick soils and somewhat poorly drained Shoals soils. Landes and Lanier soils are in the narrower valleys and on about the same position on the landscape as Ross soils. Stonelick soils are at the same elevation and occupy the same position on the landscape as Genesee soils, but they are confined to linear areas closer to the stream channel than Genesee soils. Shoals soils are in shallow depressions that commonly are adjacent to the base of steep hillsides on the outer edge of the flood plain.

This map unit is used mainly for farming, and corn and soybeans are the major crops. Some areas are used as pasture or for hay. Johnsongrass covers some areas.

This map unit has high potential for farming. Flooding is a slight hazard for farming but is a severe hazard for community development. Areas unprotected from flooding have low potential for both community and recreational development. All areas have high potential for woodland and wildlife habitat.

Soil maps for detailed planning

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. And they 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, a brief description of the soil profile, and a listing of the principal hazards and limitations to be considered in planning management.

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

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, 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, Eldean loam, 0 to 2 percent slopes, is one of several phases in the Eldean series.

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

A *soil complex* consists of two or more soils 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. Russell-Miamian silt loams, 2 to 6 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or is can be made up of all of them. Casco and Rodman gravelly loams, 6 to 18 percent slopes, moderately eroded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ 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, gravel, 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

AvA—Avonburg silt loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on the Illinoian glacial till plains. Many crayfish castles are on the surface of this soil in the summer and fall. Individual areas of this unit are irregular in shape. This soil is not extensive in the county. The largest area is about 70 acres.

Typically, this soil has a dark grayish brown, friable silt loam surface layer about 9 inches thick. The subsurface layer, about 5 inches thick, is brown, mottled, friable silt loam. The subsoil is about 50 inches thick. The upper part is grayish brown, mottled, firm silty clay loam. The middle part, a firm brittle fragipan, is light brownish gray and gray, mottled silty clay loam and clay loam. The lower part, to a depth of about 64 inches, is dark yellowish brown, mottled, firm clay loam.

Included with this soil in mapping are two nearly level areas of a predominantly light gray soil that is similar to this Avonburg soil but is wetter. These two areas occur adjacent to the Warren County line along the eastern boundary of Section 8 in Union Township and join similar areas, in Warren County, mapped Clermont silt loam. Because only two of these areas occur in Butler County and the acreage is small, they are treated as inclusions. Also included are small intermingled areas of moderately well drained Rossmoyne soils.

Permeability of this Avonburg soil is very slow, and surface runoff is slow. It has a high water table during the winter and spring seasons. Available water capacity is moderate. Reaction ranges from slightly acid to very strongly acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Organic matter content is low in the surface layer. The surface layer is friable and easily tilled through a wide range in moisture content. It does, however, have a tendency to crust or puddle after hard rains.

This soil is near urban areas and at present, most areas are not farmed. Some areas contain houses, and a few areas are in woods or pasture. If cultivated, this soil needs drainage, especially surface drainage.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. It has a seasonal high water table. Subsurface drainage lines or surface drains help to reduce excess wetness. Maintaining good soil structure is a concern. This soil generally is low in organic-matter content. It can be used for two crops year after year if management is optimum. It dries slowly in spring, and planting may be delayed if areas are not drained.

This soil is suitable for pasture. Grazing when wet will cause surface compaction and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to native hardwood trees. In existing stands, tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by spraying, cutting, or girdling. Wetness is a hazard when planting or harvesting trees during winter and spring.

This soil is poorly suited as building sites and for sanitary facilities because of wetness and very slow permeability. Some recreational uses are limited for the same reasons. Homesites should be located on the slightly higher included Rossmoyne soil if at all possible. Performance of septic systems can sometimes be improved by increasing the size of the leach field or providing an alternate leach field. Drainage ditches lower the seasonal high water table. Landscaping building sites helps keep surface water away from foundations. Local roads can be improved by artificial drainage and a suitable base material.

This soil is in capability subclass IIw; woodland suitability subclass 3o.

Bt—Brenton silt loam. This deep, nearly level, somewhat poorly drained soil is on terraces. Areas are irregular in shape and are commonly 3 to 50 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 12 inches thick. The subsoil is about 32 inches thick. The upper part is brown, mottled, friable silty clay loam, and the lower part is brown, mottled, friable silt loam. The substratum, to a depth of 60 inches, is a yellowish brown, mottled, friable silt loam and loam.

Included with this soil in mapping are small intermingled areas of poorly drained Patton soils that are in depressions and make up 5 to 15 percent of the unit. Also included are small intermingled spots of lighter colored Henshaw soils that are on slight rises and make up 5 percent of the unit.

This Brenton soil has moderate premeability and high available water capacity. Runoff is slow. The water table is high in winter and spring. The surface layer has high organic-matter content and good tilth. Shrinking and swelling is moderate in the subsoil and low in the substratum. The rooting zone ranges from slightly acid to neutral.

Most of the acreage is used for farming, and the soil has high potential for this use. It also has high potential for pasture, woodland, or wildlife habitat. It has low potential for most building site development and sanitary facilities and medium potential for most recreational development.

This soil has a moderate limitation of wetness. Subsurface drainage lines, with proper outlets or surface drains reduce excess wetness. Returning crop residue to the soil or regularly adding other organic matter helps to improve fertility and increase water infiltration. Maintenance of fertility and drainage are the main management concerns.

This soil is poorly suited as building sites and for sanitary facilities because of wetness. Dwellings without basements are better suited than dwellings with basements. Performance of septic systems can sometimes be improved by providing an alternate leach field or installing curtain drains around the field to lower the seasonal high water table. Landscaping building sites helps keep surface water away from foundations. Local roads can be improved by artificial drainage and by using a suitable base material.

This soil is in capability subclass IIw; woodland suitability subclass not assigned.

CdD2—Casco and Rodman gravelly loams, 6 to 18 percent slopes, moderately eroded. These deep, moderately sloping to moderately steep, well drained and excessively drained soils are on stream terraces. They commonly are on terraces adjacent to the upland or bottomland and in sloping areas between different terrace levels. They also are on terrace remnants along the valley walls. Areas range from 3 to 20 acres in size.

This map unit is about 65 percent Casco soil and 35 percent Rodman soil. Any individual area, however, may be all Casco soil, all Rodman soil, or both soils.

Typically, the Casco soil has a surface layer of dark grayish brown, friable gravelly loam about 8 inches thick. The subsoil is about 10 inches thick. The upper part is dark brown, firm clay loam, and the lower part is reddish brown, firm gravelly clay loam. The substratum, to a depth of 60 inches, is brown, stratified, loose, very gravelly loamy sand.

Typically, the Rodman soil has a surface layer of dark brown, friable gravelly loam about 7 inches thick. The subsoil is dark yellowish brown friable gravelly loam about 5 inches thick. The substratum, to a depth of 60 inches, is dark yellowish brown very gravelly loamy sand.

Included with these soils in mapping, and making up 5 to 15 percent of mapped areas, are Miamian and Russell soils that formed mostly in glacial till. These soils commonly are on the moderately steep terrace remnants along valley walls. Some areas of these remnants have only 2 to 3 feet of sandy and gravelly material over the glacial till.

The Casco soil has moderate permeability in the surface layer and subsoil and very rapid permeability in the substratum. The Rodman soil has moderately rapid permeability in the surface layer and subsoil and very rapid permeability in the substratum. Available water capacity is low and surface runoff is medium in the Casco soil. Available water capacity is very low and surface runoff is medium in the Rodman soil. Both soils are droughty and, in most places, have a shallow root zone because root growth is restricted by the very gravelly loamy sand substratum. These soils range from slightly acid to mildly alkaline.

These soils are not well suited to cultivated crops, because they are droughty and moderately sloping to moderately steep. They are used mainly for small grain, pasture, and hay. They have a medium to high potential for pasture, woodland, and wildlife. They have a low to medium potential as building sites and for sanitary facilities and medium to low potential for most recreational uses.

Erosion is a severe hazard if these soils are cultivated. Because they are droughty, the soils are better suited to spring crops than to crops that mature late in summer. Control of erosion, maintenance of fertility, and droughtiness are the main management concerns.

These soils are suited to hay and pasture. These crops are effective in controlling erosion.

Some areas of these soils are covered with trees, and the soils are best suited to woodland. Woodland can be improved for timber production by excluding undesirable species and poorly formed trees.

These soils have limitations when used as building sites and for sanitary facilities. The main limitations are slope and seepage. Trench sides may cave if not shored up. There is a possibility that seepage from sanitary facilities may pollute water supplies. The substratum is a good source of sand, gravel, and roadfill.

These soils are in capability subclass VIe and woodland suitability subclass 3s.

CdE—Casco and Rodman gravelly loams, 18 to 35 percent slopes. These deep, steep to very steep, well drained and excessively drained soils are on terrace escarpments and terrace remnants. Areas are linear in shape and range from 3 to 15 acres in size.

This map unit is about 65 percent Casco soil and 35 percent Rodman soil. Any individual area, however, may be all Casco soil, all Rodman soil, or both soils.

Typically, the Casco soil has a surface layer of dark grayish brown, friable gravelly loam about 6 inches thick. The subsoil is 10 inches thick. The upper part is dark brown, firm clay loam; the lower part is reddish brown firm gravelly clay loam. The substratum, to a depth of 60 inches, is brown, stratified, loose very gravelly loamy sand.

Typically, the Rodman soil has a dark brown, friable gravelly loam surface layer about 5 inches thick. The subsoil is dark yellowish brown, friable gravelly loam 5 inches thick. The substratum, to a depth of 60 inches, is stratified, loose very gravelly loamy sand.

Included with these soils in mapping, and making up 5 to 15 percent of mapped areas, are Miamian and Russell soils that formed mostly in glacial till. These soils commonly are on till deposits along the valley walls. Also included along the valley walls are intermingled areas that have only 2 or 3 feet of sandy and gravelly material over glacial till.

The Casco soil has moderate permeability in the surface layer and subsoil and very rapid permeability in the substratum. The Rodman soil has moderately rapid permeability in the surface layer and subsoil and very rapid permeability in the substratum. Available water capacity is low and surface runoff is rapid in the Casco soil. Available water capacity is very low and surface runoff is rapid in the Rodman soil. Both soils are droughty. The root zone is shallow in most places because root growth is restricted by the very gravelly loamy sand substratum. These soils range from slightly acid to mildly alkaline.

These soils are not suited to cultivated crops because they are too steep and too droughty. They are used mainly for woodland, and some areas are in pasture. The soils have medium to high potential for woodland and wildlife. They have low potential for building sites, sanitary facilities, and recreational uses.

Many areas of these soils are covered with trees, and they are suited to woodland. Woodland can be improved for timber production by excluding undesirable species and poorly formed trees.

These soils are poorly suited as building sites and for sanitary facilities because of the steep to very steep slopes. Most recreational uses are limited for the same reason. Seepage from sanitary facilities can pollute water supplies. Trench sides may cave if not shored up. Landslides can occur if the slope is undercut or the top is loaded. The substratum is a good source of sand, gravel, and roadfill.

These soils are in capability subclass VIIe; woodland suitability subclass 3s.

CeB—Celina silt loam, 2 to 6 percent slopes. This deep, gently sloping, moderately well drained soil is on low, undulating ridges and knolls between waterways on end moraines. Most areas are elongated and range from 2 to 30 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsoil is 20 inches thick. The upper part is yellowish brown silty clay loam, the middle part is dark yellowish brown light clay, and the lower part is yellowish brown clay loam. The substratum, to a depth of 60 inches, is yellowish brown loam.

Included with this soil in mapping are small areas of somewhat poorly drained Crosby soils and very poorly drained Ragsdale soils at the head of and along the small drainageways. These inclusions make up 5 to 15 percent of some of the larger mapped areas.

This Celina soil has moderately slow permeability and moderate available water capacity. Runoff is medium. Organic matter content is low in the surface layer, and tilth is good. The soil generally is medium acid to mildly alkaline in the rooting zone. The water table is high in winter and spring.

Most areas of this soil are used for crops. Corn, soybeans, small grain, and hay are the principal crops. The soil has high potential for these uses if properly managed. It also has high potential for pasture, woodland, and openland or woodland wildlife habitat. It has medium potential for building sites and sanitary facilities and high potential for most recreational uses.

The hazard of erosion is moderate. Minimum tillage, winter cover crops, and grassed waterways help to reduce excessive soil loss. Returning crop residue to the soil and regularly adding other organic material will improve fertility, reduce crusting, and increase water infiltration. Natural drainage generally is adequate for farming, but random subsurface drainage lines are beneficial in draining wet spots. Maintenance of fertility and organic-matter levels and control or erosion are the major management concerns.

This soil is well suited to a variety of pasture crops, but rarely is used for permanent pasture because of its suitability for more valuable crops. Grazing should be avoided when the soil is wet.

This soil is suited to woodland, but only a few acres are used for trees. There are few limitations for this use.

This soil is poorly suited as building sites and for sanitary facilities because of wetness and moderately slow permeability. It is better suited to dwellings without basements than to dwellings with basements. Homesites should be located on the crests of knolls if possible. Landscaping building sites helps keep surface water away from foundations. Performance of septic systems can sometimes be improved by installing curtain drains around the absorption field or by providing an alternate or larger leach field. Local roads can be improved by artificial drainage and using a suitable base material.

This soil is in capability subclass IIe; woodland suitability subclass 1o.

CnC2—Cincinnati silt loam, 6 to 12 percent slopes, moderately eroded. This moderately sloping, deep, well drained soil is on the Illinoian glacial till plain. It is on the sides of smaller waterways and in irregularly shaped and narrow areas near the heads of drainageways and adjacent to the steeper upland soils on valley walls. Most areas are 3 to 30 acres in size.

Typically, the surface layer is dark brown, friable silt loam about 6 inches thick. The subsoil is about 57 inches thick. The upper part is brown and yellowish brown silty clay loam. The middle part is a fragipan of dark yellowish brown and yellowish brown, firm, brittle clay loam. The lower part is dark yellowish brown, firm clay loam. The substratum, to a depth of 74 inches, is yellowish brown, firm light clay loam.

Included with this soil along the borders of mapped areas are a few small areas of moderately steep soils. Also included are small areas of severely eroded soils. Some small areas of Eden soils that are generally less than 2 acres in size are at the end of ridgetops and near the steeper drainageways.

This soil is moderately permeable above the fragipan and moderately slowly permeable or slowly permeable in and below the fragipan. The root zone is only moderately deep because it is limited by the fragipan. Available water capacity is moderate, and runoff is rapid. Organic matter content is low in the plow layer. The root zone commonly is medium acid to strongly acid.

This soil is suited to crops commonly grown in the county, but much of the acreage is in residential use. A few areas are in crops. Several areas are either idle or in pasture. Some rather large areas are in woodland. The soil has high potential for pasture, woodland, and wildlife habitat. It has low to medium potential for most building sites and sanitary facilities and medium to high potential for most recreational uses.

The hazard of erosion is severe if this soil is cultivated. In plowed or cultivated fields, there are areas of yellowish brown severely eroded soil that is sticky when wet and hard and cloddy when dry. Because the soil is mostly moderately eroded, crusting of the surface interferes with germination of seeds. Minimum tillage or contour stripcropping and winter cover crops help to prevent excessive soil loss. Minimum tillage and returning crop residue to the soil helps to improve fertility and increase water infiltration. Maintenance of fertility and organic-matter content and control of erosion are important management concerns.

Pasture and hay crops help to control erosion on this moderately sloping soil.

About 25 percent of this soil is covered with trees. Several varieties of oaks are common. Woodland can be improved for timber production by excluding undesirable species and poorly formed trees. Woodland productivity is good.

This soil is suitable for homesites. It is also suited to most recreational uses. The slow permeability in the fragipan limits use for septic tank absorption fields. This problem can be alleviated by providing an alternate leach field or increasing the size of the field. Homesites should be landscaped so that surface drainage is away from buildings. Suitable base material should be used under local roads.

This soil is in capability subclass IIIe; woodland suitability subclass 2o.

CrA—Crosby silt loam, 0 to 2 percent slopes. This nearly level soil is deep and somewhat poorly drained. It is on the till plain on broad, flat ridgetops and at the heads of shallow drainageways where surface water tends to pond. Areas generally are 2 to 20 acres in size and are irregular in shape.

Typically, the surface layer is grayish brown, friable silt loam about 7 inches thick. A brown, firm silt loam subsurface layer about 3 inches thick is between the surface layer and subsoil. The subsoil is about 16 inches thick and has grayish brown mottles. The upper part is yellowish brown silty clay loam, the middle part is yellowish brown heavy clay loam or silty clay, and the lower part is yellowish brown loam. The substratum, to a depth of 60 inches, is yellowish brown loam.

Included with this soil in mapping are small areas of moderately well drained Celina soils on slight rises and very poorly drained Ragsdale soils in low depressions and a few areas where slope is more than 2 percent. These inclusions make up 5 to 15 percent of some of the larger mapped areas.

This Crosby soil has slow permeability and high available water capacity. Runoff is slow. The surface layer is low in organic matter content, and the rooting zone is neutral. Natural lime occurs deep in the soil. The water table is high in winter and spring.

Most areas of this soil are used for crops. Corn, soybeans, wheat, and hay are the principal crops. The soil has high potential for crops if properly managed. It also has high potential for pasture, woodland, and openland or woodland wildlife habitat. It has low potential for building sites and sanitary facilities and medium potential for recreational uses.

This soil is nearly level and seasonal wetness is the major limitation for most uses. The soil normally remains wet for long periods because runoff and permeability are both slow. Subsurface drainage benefits most crops. Returning crop residue to the soil and regularly adding other organic matter will improve fertility and reduce soil crusting. Maintenance of soil drainage, fertility, and organic matter levels are important management concerns.

This soil is well suited to a variety of pasture crops but rarely is used as permanent pasture because of its suitability for row crops. Grazing should be avoided when the soil is wet.

Only a small acreage of this soil is wooded, but it is suited to trees. There are moderate limitations to use of equipment, and plant competition is moderate.

This soil is poorly suited as building sites and for sanitary facilities because of wetness. It is better suited to dwellings without basements than to dwellings with basements. Performance of septic systems can sometimes be improved by providing an alternate leach field or installing curtain drains around the absorption field. Surface and subsurface drainage lowers the seasonal high water table. Landscaping building sites keeps surface water away from foundations. Local roads can be improved by artificial drainage and using suitable base material.

This soil is in capability subclass IIw; woodland suitability subclass 3o.

DaA—Dana silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on till plains and moraines. Most areas are round or oblong and range from 3 to 30 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 10 inches thick. A very dark brown, friable silt loam subsurface layer about 5 inches thick is between the surface layer and the subsoil. The subsoil is about 32 inches thick. It is brown, dark yellowish brown, and yellowish brown, friable silty clay and clay loam. The substratum, to a depth of 60 inches, is brown loam.

Included in mapping are small areas of very poorly drained Ragsdale soils and somewhat poorly drained Raub soils in low spots and along waterways. These inclusions make up 5 to 15 percent of some of the larger mapped areas.

This Dana soil has moderate permeability in the subsoil and moderately slow permeability in the substratum. It has high available water capacity. Runoff is slow. The water table is high in winter and spring. Organic matter content is high in the surface layer, and tilth is good. The rooting zone is medium acid to neutral. The surface layer crusts after a hard rain.

Most areas of this soil are used for crops. Corn, soybeans, and small grain are the main crops, and the soil has high potential for these crops if properly managed. It also has high potential for pasture, woodland, and openland or woodland wildlife habitat. It has medium potential for building sites and sanitary facilities and high potential for recreational uses.

This soil is one of the best in the county for farming. Natural drainage generally is adequate for farming, but random and subsurface drainage lines are beneficial in draining wet spots. Returning crop residues to the soil and regularly adding other organic matter will maintain fertility, reduce crusting, and increase water infiltration. Maintenance of fertility and drainage of included wet soils are the main management concerns.

This soil is well suited to a variety of pasture crops. It rarely is used as permanent pasture, however, because of its suitability for row crops.

Very few areas are used for trees.

This soil is suitable for homesites and is well suited to recreational uses. Because it does not have sufficient strength and stability to support vehicular traffic, the base material needs to be replaced if the soil is used for roads. Homesites should be landscaped so that surface drainage is away from buildings.

This soil is in capability class I; woodland suitability subclass 1o.

DaB—Dana silt loam, 2 to 6 percent slopes. This deep, gently sloping, moderately well drained soil is on foot slopes or in gently sloping basins on till plains and moraines. Areas are rounded or oblong and are commonly 2 to 40 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 9 inches thick. The subsurface layer is very dark brown silt loam about 4 inches thick. The subsoil is about 31 inches thick. It is brown, dark yellowish brown, and yellowish brown, friable silty clay loam and clay loam. The substratum, to a depth of 60 inches, is brown loam.

Included with this soil in mapping are small areas of somewhat poorly drained Raub soils along waterways and in depressional areas. This inclusion makes up 5 to 15 percent of some of the larger mapped areas.

This Dana soil has moderate permeability in the subsoil and moderately slow permeability in the substratum. It has high available water capacity. Runoff is medium. Organic matter content is high in the surface layer, and tilth is good. The surface layer crusts after a hard rain. The rooting zone is medium acid to neutral. The water table is high in winter and spring.

Most areas of this soil are used for crops. Corn, soybeans, and small grain are the main crops, and the soil has high potential for these crops if properly managed. It also has high potential for pasture, woodland, and openland or woodland wildlife habitat. It has medium potential for building sites and sanitary facilities and high potential for most recreational uses.

The hazard of erosion is moderate. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil erosion. Natural drainage generally is adequate for farming, but random subsurface drainage lines are beneficial in draining wet spots. Returning crop residue to the soil and regularly adding other organic matter will maintain fertility, reduce soil crusting, increase water infiltration and reduce erosion. Maintaining soil fertility, erosion control, and the drainage of wet spots are the main management concerns.

This soil is suited to both pasture crops and woodland. It is rarely used for either permanent pasture or woodland, however, because of its suitability for crops.

This soil is suited to homesites and is well suited to recreational uses. Because it does not have sufficient strength and stability to support vehicular traffic, the base material needs to be replaced if the soil is used for roads. Homesites should be landscaped so that surface drainage is away from buildings.

This soil is in capability subclass IIe; woodland suitability subclass 1o.

DbB—Dana silt loam, bedrock substratum, 2 to 8 percent slopes. This deep, moderately well drained, gently sloping soil is in slightly concave areas on uplands. Areas are roughly fan or crescent shaped and range from 3 to 20 acres in size. Slopes are smooth, and a few shallow drainageways are in some areas.

Typically, the surface layer is dark grayish brown, friable silt loam about 9 inches thick. There is a subsurface layer of dark brown heavy silt loam about 5 inches thick. The subsoil is about 29 inches thick. The upper part is dark brown and dark yellowish brown silty clay loam; the middle part is dark yellowish brown and yellowish brown, firm clay loam; and the lower part is olive brown, very firm clay loam. The substratum is interbedded, olive brown, calcareous clay shale and dark gray, thin-bedded strata of fossiliferous limestone.

Included with this soil in mapping, and making up about 15 percent of some mapped areas, are small areas of Wynn soils on higher divides between drainageways. These Wynn soils differ from Dana soils in being shallower to bedrock. Also included are small areas of similar soils that have 8 to 12 percent slopes.

This Dana soil has moderate permeability and moderate available water capacity. Surface runoff is medium. Reaction ranges from neutral to moderately alkaline in the subsoil and varies in the surface layer as a result of liming practices. High organic-matter content gives this soil good tilth.

Most areas of this soil are used for crops. Corn, soybeans, and hay are the principal crops. This soil has high potential for these uses if properly managed. It also has high potential for pasture, woodland, and wildlife habitat. It has medium potential as building sites and for sanitary facilities but high potential for most recreational uses.

There is a moderate erosion hazard in cultivated areas. Minimum tillage, winter cover crops, and grassed waterways prevent excessive soil loss. Where areas are adjacent to steeper slopes, excess runoff needs to be diverted at the bottom of the steeper slope. Returning crop residues to the soil improves fertility and increases water infiltration. Natural drainage generally is adequate for farming, but random subsurface drainage lines are needed to drain wet spots in some areas. Maintenance of soil fertility and control of erosion are the main management concerns.

This soil is well suited to a variety of pasture crops, but it rarely is used for permanent pasture because of its suitability for row crops.

Only a small acreage of this soil is wooded. It is suitable for new plantings. Tree seedlings are planted by machine on this soil.

This soil is suited to homesites and is well suited to recreational uses. Because it does not have sufficient strength and stability to support vehicular traffic, the base material needs to be replaced if the soil is used for roads. Homesites should be landscaped for surface drainage away from buildings.

The interbedded shale and limestone bedrock underlying this soil between depths of 40 and 60 inches makes excavations for most uses difficult and expensive; however, the bedrock is rippable by heavy equipment and rarely requires blasting. The many flagstones are undesirable in pond embankments. Ground water flowing on the surface of the nearly impervious shale causes wet weather seeps on some slopes and in waterways. Water also seeps into excavations if not intercepted. This is common on the lower parts of slopes on the bedrock hills.

This soil is in capability subclass IIe; woodland suitability subclass 2o.

EcE2—Eden silty clay loam, 15 to 25 percent slopes, moderately eroded. This moderately deep, steep, well drained soil is on valley walls and hillsides. Most areas are dissected by shallow drainageways. Interbedded shale and limestone bedrock commonly outcrop in many of these waterways. Limestone flagstones are common on the surface in places (fig. 4), especially in and around waterways. Intermittent sidehill seeps commonly occur along the surface of the nearly impervious shale bedrock. Most areas are elongate or fan shaped and range from 5 to 200 acres in size.

Figure 4.—Interbedded clay shales and thin-bedded limestone on Eden silty clay loam, 15 to 25 percent slopes, moderately eroded.

Slopes are typically smooth, though steep, and the waterways are not deeply cut in V-shaped ravines as they are in till soils, such as Hennepin or Miamian soils. The shale and limestone bedrock has been very resistant to downcutting. Many waterways throughout this map unit are scenic, dropping over a whole series of hard limestone ledges. The soft shale layers between the hard rock layers have been undercut, resulting in a long series of waterfalls and pools.

Typically, the surface layer is very dark brown, friable silty clay loam about 6 inches thick. The subsoil is about 23 inches thick. The upper part is olive brown, firm silty clay that is 20 percent limestone flagstones. The lower part is light olive brown, firm silty clay that is about 10 percent limestone flagstones. The substratum is calcareous, interbedded clay shale and thin-bedded limestone. In some small areas the surface layer is very dark grayish brown, and in other areas the surface layer is silt loam.

Included with this soil in mapping are small areas where the soil is severely eroded. In these areas, the surface layer typically is calcareous, olive brown clay or silty clay, and depth to bedrock is commonly very shallow. Also included are small areas of well drained Wynn soils on the less steep, upper and lower parts of slopes. These inclusions make up 5 to 15 percent of some of the larger areas.

In this Eden soil, permeability is slow, and the available water capacity is low. Runoff is rapid. Reaction ranges from neutral to mildly alkaline in the root zone. Organic-matter content is low as a result of the loss of surface soil by erosion. Root development is restricted by shale and limestone bedrock.

This soil is too steep for farming. Most of the acreage is in pasture or woodland, and the potential for these uses is medium. The soil has low potential for building sites and sanitary facilities because of steep slopes and limited depth to bedrock.

This soil is commonly in pasture, but, if overgrazed, the hazard of erosion is severe. Control of erosion and maintenance of a maximum stand of forage species are management concerns. During seeding, using cover crops or companion crops, trash mulching, or no-till seeding helps control erosion. Certain legumes, such as crownvetch, grow well because they tolerate droughtiness. Proper stocking, pasture rotation, and timely application of fertilizer help to maintain a maximum stand of forage species. Some less steep areas that have been farmed in the past now are in brushy pasture, commonly Canadian bluegrass, thornapple, and redcedar. Potential pond reservoir sites are limited. Because of steep slopes, embankments must be high if there is to be adequate water area. The clay shale makes the pond bottom water-tight, but there is danger of seepage along the top of the rock layers.

Management is difficult if this soil is used for woodland. The soil is clayey. The hazard of erosion is severe and use of harvesting equipment is severely limited. Logging roads and skid trails should be constructed on the contour where practical. Mechanical tree planting and weed control can be accomplished if safety precautions are taken. Woodland improvement for timber production requires exclusion of undesirable species and poorly formed trees.

This soil is poorly suited to most nonfarm uses because of the steep slopes and limited depth to bedrock. It is subject to slip if fill is put on top of it, if the toe of the slope is undercut, or if surface water or ground water saturates the area. The interbedded shale and limestone bedrock underlying this soil at a depth of 20 to 40 inches makes excavation for most uses difficult and expensive; however, the bedrock is rippable by heavy equipment and rarely requires blasting. The many flagstones make the soil undesirable for construction. Ground water flowing on the surface of the nearly impervious shale can cause seeps on some slopes and in waterways. Water can seep into excavations if not intercepted, and seepage is common on the lower parts of slopes.

This soil is in capability subclass VIe; woodland suitability subclass 3c.

EcF2—Eden silty clay loam, 25 to 50 percent slopes, moderately eroded. This moderately deep, very steep, well drained soil is on valley walls and hillsides. Most areas are dissected by shallow drainageways. Interbedded shale and limestone bedrock commonly outcrop in many of these waterways. Limestone flagstones are common on the surface in places, especially in and around waterways. Intermittent sidehill seeps commonly occur along the surface of the nearly impervious shale bedrock. Most areas are elongated and range from 5 to 200 acres in size.

Slopes are typically smooth and very steep. The shale and limestone bedrock has been very resistant to downcutting, and the waterways are not deeply V-shaped as they are in the deep till Hennepin or Miamian soils. Many waterways throughout this map unit are scenic, dropping over a whole series of limestone ledges. The soft shale layers between the hard rock layers have been undercut, giving rise to a long series of waterfalls and pools.

Typically, the surface layer is very dark brown, friable silty clay loam about 5 thick. The subsoil is about 22 inches thick. The upper part is olive brown, firm silty clay that is 20 percent limestone flagstones. The lower part is light olive brown, firm silty clay that is about 10 percent limestone flagstones. The substratum is interbedded clay shale and thin-bedded limestone. A few areas of rock outcrops and rock ledges are indicated on the soil maps by the symbol for rock outcrop. In some small areas, the surface layer is very dark grayish brown.

Included with this soil in mapping are small areas of soils that are severely eroded. In these areas, the surface layer typically is calcareous, olive brown clay or silty clay, and depth to bedrock is commonly very shallow.

Also included are small areas of well drained Wynn soils on the less steep, upper and lower parts of slopes. These inclusions make up 5 to 15 percent of some larger areas.

In this Eden soil, permeability is slow, and available water capacity is low. Runoff is rapid. Reaction ranges from neutral to mildly alkaline in the root zone. Organic-matter content is low as a result of loss of surface soil by erosion. Root development is restricted by shale and limestone bedrock.

This soil is too steep for farming. Most of the acreage is in woodland or pasture. The soil is too steep for pasture, but it has medium potential for woodland. It has low potential for building site development and sanitary facilities because of very steep slopes and limited depth to bedrock. There are no good sites for pond reservoirs on this soil, because the fill would have to be excessively high to allow for a suitable water area.

There are several management concerns if this soil is used for woodland. There is a severe erosion hazard, and the use of harvesting equipment is severely limited by very steep slopes. Logging roads and skid trails are difficult to construct, even on the contour. Areas of this soil that are in woodland should be improved for timber production by excluding undesirable species and poorly formed trees.

This soil is poorly suited to most nonfarm uses because of the very steep slope and limited depth to bedrock. It is subject to slippage if fill is put on top of it, if the toe of the slope is undercut, or if surface water or ground water saturates the area. The interbedded shale and limestone bedrock underlying this soil at a depth of 20 to 40 inches makes excavation for most uses difficult and expensive; however, the bedrock is rippable by heavy equipment and rarely requires blasting. The many flagstones make the soil undesirable in pond embankments. Ground water flowing over the nearly impervious shale can cause seeps on some slopes and in waterways. Water can also seep into excavations if not intercepted, and seepage is common on the lower parts of slopes.

This soil is in capability subclass VIIe; woodland suitability subclass 3c.

Ee—Eel silt loam. This deep, nearly level, moderately well drained soil is on flood plains. Flooding is frequent. Most areas are long and narrow and 2 to 200 acres in size. Slope is 0 to 2 percent.

Typically, the surface layer is dark grayish brown, friable silt loam about 9 inches thick. The upper part of the substratum is dark brown and brown, friable light silty clay loam that has dark grayish brown mottles. The lower part of the substratum, to a depth of 60 inches, is friable, mottled, dark grayish brown, stratified loam and silt loam.

Included with this soil in mapping are small areas of well drained Genesee soils and somewhat poorly drained Shoals soils. In a few areas the soils have lacustrine silt and clay below a depth of about 2 feet, and in other areas the surface layer is loam.

This Eel soil is moderately permeable and has high available water capacity. Runoff is slow. The soil is subject to brief flooding from October through June. The water table is high in winter and spring. The rooting zone is deep and neutral. The surface layer has a moderate amount of organic matter.

This soil has high potential for crops, and most areas are used for corn, soybeans, wheat, or hay. It also has high potential for pasture, woodland, and wildlife habitat. It has low potential, however, for building site development and sanitary facilities and medium potential for many recreational uses, mainly as a result of flooding.

This soil is suited to most crops grown in the county. The winter and spring floods can damage winter wheat crops, but flooding during the growing season of corn and soybeans generally is rare, and those crops can be grown without flood damage. Natural drainage is adequate for farming, and artificial soil drainage is generally not required. The soil is highly fertile, but the addition of fertilizer is common. The surface layer of this soil crusts after rain, but the addition of crop residues and other forms of organic matter helps to reduce crusting and conserve soil moisture in dry years.

This soil is highly productive of pasture. Overgrazing or grazing when the soil is wet, however, can cause surface compaction, poor tilth, and lower yields. Proper stocking, pasture rotation, and restricted use during wet periods keep the pasture and the soil in good condition.

This soil is well suited to trees, but few areas are wooded because the soil is also suitable for more valuable crops. Flooding is of brief duration, and trees generally are not damaged. There are no limitations for growing most high value trees.

This soil is poorly suited as building sites and for sanitary facilities because of flooding. Some recreational development is also limited by flooding.

This map unit is a good source of topsoil. Protective levees have been built in some areas, and where protected from flooding, the soil is well suited to some nonfarm uses.

This soil is in capability class I; woodland suitability subclass 1o.

ElA—Eldean loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on stream terraces and outwash plains. Most areas are irregular and broad in shape and range from 5 to 100 acres in size. Several large areas are as much as 500 acres in size.

Typically, the surface layer is dark brown, friable loam about 6 inches thick. The subsoil is about 26 inches thick. The upper part is brown, friable silty clay loam; the middle part is brown and dark reddish brown, firm gravelly clay; and the lower part is dark reddish brown, friable gravelly clay loam. The substratum, to a depth of about

60 inches, is yellowish brown, loose very gravelly loamy sand. In some small areas, the surface layer is silt loam.

Included with this soil in mapping are small areas of soils that have a gravelly loam surface layer and a few areas of soils that have less clay in the subsoil. Also included are small intermingled areas of Ockley soils and dark colored Warsaw soils.

Permeability of the Eldean soil is moderate or moderately slow in the surface layer and subsoil and rapid in the substratum. This soil dries and warms early in spring and can be planted early. Available water capacity is low. Runoff is slow. The root zone is moderately deep and is medium acid to moderately alkaline. The surface layer is low in organic-matter content.

Most of the acreage of this soil is used for farming. The potential for farming is high, and the soil is well suited to vegetable crops, especially if irrigated. The soil has high potential for pasture, woodland, and wildlife. It has medium to high potential for most building site development and sanitary facilities and high potential for most recreational uses.

This soil is well suited to corn, soybeans, wheat, and hay. It is moderately susceptible to drought, especially during dry periods in summer and fall. It is well suited to continuous row cropping. Returning crop residues to the soil or the regular addition of other organic material help to maintain organic-matter content and increase water infiltration. Tillage and harvesting equipment can be used with little difficulty. Use of minimum tillage and cover crops is important. Maintenance of fertility and organic-matter levels and control of erosion are the main management concerns.

This soil is well suited as building sites and for recreational uses (fig. 5), but seepage is a limitation if it is used for sewage lagoons and trench type sanitary landfills. Effluent from sewage and solid waste material can move through the rapidly permeable sand and gravel substratum and pollute water supplies. Because the soil does not have sufficient strength to support vehicular traffic, the base material needs to be replaced if this soil is used for roads. Storm sewers are generally needed in urban areas to handle storm water runoff. The substratum is a good source of sand, gravel, and roadfill.

This soil is in capability subclass IIs; woodland suitability subclass 2o.

ElB2—Eldean loam, 2 to 6 percent slopes, moderately eroded. This deep, gently sloping, well drained soil is on stream terraces. Most areas are long and narrow or irregular in shape and range from 3 to 25 acres in size.

Typically, the surface layer is dark brown, friable loam about 6 inches thick. The subsoil is about 24 inches thick. The upper part is brown, firm gravelly clay; the middle part is dark reddish brown, firm gravelly clay; and the lower part is dark reddish brown, friable gravelly clay

Figure 5.—Eldean loam, 0 to 2 percent slopes, is well suited as building sites.

loam. The substratum, to a depth of about 60 inches, is yellowish brown, loose very gravelly loamy sand. In some small areas, the surface layer is silt loam.

Included with this soil in mapping are small areas of Ockley soils, small intermingled areas of soils that have a surface layer of sandy loam, and a few areas of soils that have less clay in the subsoil.

In this Eldean soil, permeability is moderate or moderately slow in the surface layer and subsoil and rapid in the substratum. The soil dries and warms early in spring and can be planted early. Available water capacity is low. Runoff is slow. The root zone is medium acid to moderately alkaline. The surface layer is low in organic-matter content.

Most of the acreage of this soil is used for farming. The soil has high potential for farming and is well suited to vegetable crops, especially if irrigated. It also has high potential for pasture, woodland, and wildlife. It has medium to high potential for most building site development and sanitary facilities and high potential for most recreational uses.

This soil is well suited to corn, soybeans, wheat, and hay. The surface layer is mixed with considerable material from the upper part of the subsoil. There is a greater tendency toward surface crusting and droughtiness in this soil than in uneroded Eldean soils. The moderate hazard of erosion limits farming. Minimum tillage or contour tillage and winter cover crops help to prevent excessive soil loss. Returning crop residues to the soil helps to improve fertility, increase water infiltration, and maintain organic-matter content. Maintenance of fertility and organic-matter content and control of erosion are the main management concerns.

This soil is moderately well suited as building sites and for recreational uses, but seepage is a limitation if it is used for sewage lagoons and trench type sanitary landfills. Effluent from sewage and solid waste material can move through the rapidly permeable sand and gravel substratum and pollute water supplies. Low strength is a limitation if this soil is used for local roads. Use of a suitable base material generally will improve this condition. Storm sewers are generally needed in urban areas to handle storm water runoff. The substratum is a good source of sand, gravel, and roadfill.

This soil is in capability subclass IIe; woodland suitability subclass 2o.

ElC2—Eldean loam, 6 to 12 percent slopes, moderately eroded. This deep, moderately sloping, well drained soil is on stream terraces. It is generally adjacent to the upland or the bottom land. Most areas are linear in shape and range from 5 to 20 acres in size.

Typically, the surface layer is dark brown, friable loam about 5 inches thick. The subsoil is about 19 inches thick. The upper part is brown, firm gravelly clay; the middle part is dark reddish brown, firm gravelly clay; and the lower part is dark reddish brown, friable gravelly clay loam. The substratum, to a depth of about 60 inches, is yellowish brown, loose very gravelly loamy sand.

Included with this soil in mapping are intermingled small areas of soils that have a gravelly loam surface layer and small areas of Casco soils. Also included are a few areas of severely eroded soils that have a brown or reddish brown color that contrasts noticeably with that of soils in surrounding areas when they are bare.

In this Eldean soil, permeability is moderate or moderately slow in the surface layer and subsoil and rapid in the substratum. The soil dries and warms early in spring and can be planted early. Available water capacity is low, and runoff is medium. The rooting zone is moderately deep and medium acid to mildly alkaline. The surface layer is low in organic-matter content.

Most of the acreage of this soil is used for farming. It has medium potential for farming. It has medium to high potential for pasture, woodland, and wildlife habitat. It has medium potential for most building site development, medium to low potential for sanitary facilities, and medium potential for most recreational uses.

The hazard of erosion is severe when this soil is cultivated. The amount of erosion is variable within short distances, and the brown subsoil is exposed in places. The soil also is droughty. It tends to be sticky when wet and hard and cloddy when dry. It is rather difficult to work except under conditions of optimum moisture content. Conservation tillage or contour stripcropping and winter cover crops reduce excessive soil loss. Minimum tillage and returning crop residues to the soil improve fertility and increase water infiltration. Maintenance of fertility and organic-matter content and control of erosion are the main management concerns.

Production of legumes and bluegrass for pasture and hay is good. Pasture and hay crops help to control erosion.

Only a few small areas of this soil are covered with trees. Oaks are common. Woodland improvement for timber production requires exclusion of undesirable species and poorly formed trees.

This soil is moderately well suited as building sites and for recreational uses, but it has limitations if used for sewage lagoons and trench type sanitary landfills. Seepage of effluent from sewage and solid waste material can move through the rapidly permeable sand and gravel substratum and pollute water supplies. Because the soil does not have sufficient strength to support vehicular traffic, the base material needs to be replaced if the soil is used for roads. Storm sewers are generally needed in urban areas to handle storm water runoff. The substratum is a good source of sand, gravel, and roadfill.

This soil is in capability subclass IIIe; woodland suitability subclass 2o.

EnA—Eldean gravelly loam, 0 to 2 percent slopes. This deep, nearly level, well drained gravelly soil is on stream terraces and outwash plains. Most areas are irregular in shape and range from 2 to 20 acres in size.

Typically, the surface layer is dark brown, friable gravelly loam about 6 inches thick. The subsoil is about 26 inches thick. The upper and middle parts are firm, brown and reddish brown gravelly clay, and the lower part is dark reddish brown, friable gravelly clay loam. The substratum, to a depth of 60 inches, is yellowish brown, loose very gravelly loamy sand.

Included with this soil in mapping are areas of soils that have a thinner subsoil and small areas of soils that have a less clayey subsoil.

In this Eldean soil, permeability is moderate or moderately slow in the surface layer and subsoil and rapid in the substratum. The surface layer has a high infiltration rate. The soil dries and warms early in spring and can be planted early. Available water capacity is low, and runoff is slow. The rooting zone is medium acid to mildly alkaline and moderately deep.

Most of the acreage of this soil is used for farming. The soil has high potential for farming and is well suited to vegetable crops if irrigated. It also has high potential for pasture, woodland, and wildlife habitat. It has medium to high potential for most building site development and sanitary facilities and high potential for most recreational uses.

This soil is well suited to corn, soybeans, wheat, and hay. It is moderately susceptible to drought, especially during dry periods in summer and fall. It is well suited to continuous row cropping. Returning crop residues to the soil or the regular addition of other organic material helps to maintain organic-matter content and increase water infiltration. Tillage and harvesting equipment can be used with little difficulty. Use of minimum tillage and cover crops is important. Maintenance of fertility and organic-matter levels is a major concern of management. Pebbles in the surface layer interfere somewhat with tillage, but not enough to make intertilled crops impractical.

This soil is moderately well suited as building sites and for recreational uses, but it has limitations if used for sewage lagoons and trench type sanitary landfills. Seepage of effluent from sewage and solid waste material can move through the rapidly permeable sand and gravel substratum and pollute water supplies. Storm sewers are generally needed in urban areas to handle storm water runoff. This soil has a gravelly surface layer, which can limit its use in lawns, gardens, and landscaping and also in most recreational development. The substratum is a good source of sand, gravel, and roadfill.

This soil is in capability subclass IIs; woodland suitability subclass 2o.

EnB2—Eldean gravelly loam, 2 to 6 percent slopes, moderately eroded. This deep, gently sloping, well drained gravelly soil is on stream terraces. It generally is adjacent to bottomland soils, and it also is in meander scours and drainageways that cross the terraces. Most areas are linear in shape and range from 5 to 20 acres in size.

Typically, the surface layer is dark brown, friable gravelly loam about 6 inches thick. The subsoil is about 24 inches thick. The upper part is brown, firm gravelly clay; the middle part is dark reddish brown, firm gravelly clay; and the lower part is dark reddish brown, friable gravelly clay loam. The substratum, to a depth of about 60 inches, is yellowish brown, loose very gravelly loamy sand.

Included with this soil in mapping are small areas where the soil is only slightly eroded and a few areas of soils in which the subsoil is less clayey. Also included are some areas of soils in which the subsoil is thinner. These soils are in the less sloping areas.

In this Eldean soil, permeability is moderate or moderately slow in the surface layer and subsoil and rapid in the substratum. The surface layer has a high infiltration rate. Because the surface layer is gravelly loam, the soil dries and warms early in spring and can be planted early. Available water capacity is low, and runoff is slow. The rooting zone is medium acid to moderately alkaline. The surface layer is low in organic-matter content.

Most of the acreage of this soil is used for farming. The soil has high potential for farming and is well suited to vegetable crops, especially if irrigated. It has high potential for pasture, woodland, and wildlife habitat. It has medium to high potential for building site development and sanitary facilities and high potential for most recreational uses.

This soil is well suited to corn, soybeans, wheat, and hay. There is a moderate hazard of erosion if this soil is cultivated. Minimum tillage, winter cover crops, and crop residues help to prevent soil losses and increase water infiltration. Maintenance of fertility and organic-matter level and control of erosion are the main management concerns. The pebbles in the surface layer interfere somewhat with tillage but not enough to make intertilled crops impractical.

This soil is moderately well suited as building sites and for recreational uses, but it has limitations if used for sewage lagoons and trench type sanitary landfills. Seepage of effluent from sewage and solid waste material can move through the rapidly permeable sand and gravel substratum and pollute water supplies. Storm sewers are generally needed in urban areas to handle storm water runoff. This soil has a gravelly surface layer, which limits its use for lawns, gardens, and landscaping and also for most recreational development. The substratum is a good source of sand, gravel, and roadfill.

This soil is in capability subclass IIe; woodland suitability subclass 2o.

EuA—Eldean-Urban land complex, nearly level. This map unit consists of deep, nearly level, well drained Eldean soils and Urban land. It is on stream terraces and outwash plains. Most of this map unit is in 2 areas that are more than 2,500 acres in size. One area is in the cities of Fairfield and Hamilton, and the other is in Middletown.

This map unit is 50 to 65 percent Eldean soils and 25 to 50 percent Urban land. Eldean soils and Urban land are so intricately mixed, or so small in extent, that it is not practical to map them separately.

Typically, the Eldean soil has a surface layer of dark brown, friable loam about 6 inches thick. The subsoil is about 26 inches thick. The upper part is brown, friable silty clay loam; the middle part is brown and dark reddish brown, firm gravelly clay; and the lower part is dark reddish brown, friable gravelly clay loam. The substratum, to a depth of about 60 inches, is yellowish brown, loose very gravelly loamy sand.

Urban land is covered by streets, parking lots, buildings, and other structures that obscure or alter the soil. The original soil has been disturbed or buried by earthmoving so that identification and classification are not feasible.

Included in mapping and making up to 25 percent of the unit are areas of deep, well drained Ockley and Wea soils. Wea soils have a darker colored surface layer than that of Eldean soils. Also included are Warsaw soils that differ from Eldean soils in having a darker colored surface layer and a coarser textured subsoil. Ockley and Wea soils commonly are on the part of the terrace nearest the upland, and Warsaw soils are on the part of the terrace adjacent to the bottom land.

In the Eldean soils, permeability is moderate or moderately slow in the surface layer and subsoil and rapid in the substratum. Available water capacity is low, and surface runoff is slow. Organic matter content is moderate.

The Eldean soils are used for parks, open space, building sites, lawns, and gardens. They have medium potential for lawns, vegetable and flower gardens, trees, and shrubs. Potential is medium to high for most engineering uses and high for most recreational uses.

The Eldean soils are well suited to grasses, flowers, vegetables, trees, and shrubs. Perennial plants selected for planting should have a fairly high tolerance for drought. Gravelly material is often exposed in disturbed areas that have been cut or filled. This limits use of the soil for lawns and gardens. Soil material that has been used for fill is so variable in characteristics that no prediction can be made about its properties. Onsite investigation is required to determine hazard, limitations, and suitability for use of individual areas.

These soils are moderately well suited as building sites and for recreational uses, but there are limitations to their use for sanitary facilities. Because filtration is inadequate, there is a possibility of ground water pollution if they are used for septic tank absorption fields. The many small stones limit the use of these soils for lawns and gardens and most recreational development. The use of these soils for local roads is limited by low strength, but use of a suitable base material will usually improve this condition. Storm sewers are generally needed in urban areas to handle storm water runoff. Onsite investigation is needed to determine the best use of a given area because the soils are variable and altered in many locations.

Eldean soils are in capability subclass IIs; woodland suitability subclass 2o; Urban land is not assigned to a capability subclass or a woodland suitability subclass.

EuB—Eldean-Urban land complex, gently sloping. This map unit consists of deep, gently sloping, well drained Eldean soils and Urban land. These soils are on stream terraces and outwash plains. Most areas are long and narrow or are irregular in shape. They range from 3 to 125 acres in size.

This map unit is 50 to 65 percent Eldean soils and 25 to 50 percent Urban land. The Eldean soils and Urban land are so intricately mixed, or so small in size, that it is not practical to map them separately.

Typically, the Eldean soil has a surface layer of dark brown, friable loam about 6 inches thick. The subsoil is about 24 inches thick. The upper part is brown, friable silty clay loam; the middle part is brown and dark reddish brown, firm gravelly clay; and the lower part is dark reddish brown, friable gravelly clay loam. The substratum, to a depth of about 60 inches, is yellowish brown, loose very gravelly loamy sand.

Urban land is covered by streets, parking lots, buildings and other structures that obscure or alter the original soil so that identification is not feasible. It has been disturbed or buried by earthmoving.

Included in mapping are small areas of Eldean-Urban land complex, nearly level. Also included are small areas of deep, well drained Ockley soils that make up as much as 20 percent of the map unit.

Eldean soils have moderate permeability or moderately slow permeability in the surface layer and subsoil and rapid permeability in the substratum. Available water capacity is low, and runoff is slow. The rooting zone is medium acid to mildly alkaline. The surface layer is low in organic-matter content.

The Eldean soils are used for parks, open space, building sites, lawns, and gardens. They have medium potential for lawns, vegetable and flower gardens, trees, and shrubs. They have medium to high potential for most building site development and sanitary facilities and high potential for most recreational uses.

The Eldean soils are well suited to grasses, flowers, vegetables, trees, and shrubs. Perennials selected for planting should have a fairly high tolerance for drought. Because of slope, erosion is a concern when the soil is disturbed and left bare for a considerable period. Gravelly materials are often exposed in disturbed areas that have been cut or filled. This limits use of the soil for lawns and gardens. Soil material that has been used for fill is so variable in characteristics that no prediction can be made about its properties. Onsite investigation is required to determine hazards, limitations, and suitability for use of individual areas.

These soils are moderately well suited to building site development and recreational uses but have limitations if used for sanitary facilities. Because filtration is inadequate, ground water pollution is possible if they are used for septic tank absorption fields. The many small stones can be a limitation if the soils are used for lawns and gardens and most recreational development. The soils do not have sufficient strength to support vehicular traffic, but roads can be built if suitable base material is used. Storm sewers are generally needed in urban areas to handle storm water runoff. Onsite investigations are needed to determine the best use of a given area because the soils are variable and altered in many locations.

Eldean soils are in capability subclass IIe; woodland suitability subclass 2o: Urban land is not assigned to a capability subclass or a woodland suitability subclass.

FcA—Fincastle silt loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on flats in high lying positions of the upland landscape. Most areas are oblong or irregular in shape and range from 3 to 150 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The next layer is about 5 inches thick. It is dark grayish brown, friable silt loam mixed with grayish brown silt loam that has a few yellowish brown mottles. The subsoil is about 28 inches thick. The upper part is dark yellowish brown, mottled, firm silty clay loam; the lower part is dark brown, mottled, firm clay loam. The substratum, to a depth of 62 inches, is brown light clay loam.

Included with this soil in mapping, and making up as much as 10 percent of the map unit, are small areas of nearly level Xenia and Ragsdale soils. The dark colored, wetter Ragsdale soils are in the lower lying areas of the landscape, and the better drained Xenia soils are on the slight rises.

In this Fincastle soil, permeability is moderately slow to slow in the subsoil and slow in the substratum. Available water capacity is high. Surface runoff from cultivated areas is slow, and the soil tends to dry slowly. Tilth is fair. The subsoil has a moderate shrink-swell potential. The root zone is normally deep, because the water table remains deep enough during the cropping season to allow crops common to the area to be grown. The soil commonly is medium acid except where limed. The water table is seasonally high for long periods in winter and spring.

Most of the acreage of this soil is farmed. It has high potential for cultivated crops, hay, pasture, and trees. It has low to medium potential for building site development and sanitary facilities. It has medium potential for recreational uses.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Although it has slow or moderately slow permeability, subsurface drainage lines or surface drains help to reduce excess wetness. Maintaining good soil structure is important. The soil is low in organic-matter content and is susceptible to surface crusting. It can be used for row crops year after year if management is optimum. It dries slowly in spring, and planting may be delayed in undrained areas.

This soil has high potential for pasture or hay. Overgrazing or grazing when the soil is too wet, however, can cause surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to hardwood trees. In existing stands, tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by spraying, cutting, or girdling. Wetness is a hazard when planting or harvesting trees.

The use of this soil for homesites and septic tank absorption fields is limited by wetness (fig. 6) and moderately slow permeability to slow permeability in the subsoil. Performance of septic systems can sometimes be improved by increasing the size of the leach field or providing an alternate leach field. The soil is better suited to dwellings without basements than to dwellings with basements. Surface and subsurface drainage lowers the seasonal high water table. Landscaping building sites helps to keep surface water away from foundations. Local roads can be improved by artificial drainage and using a suitable base material.

This soil is in capability subclass IIw; woodland suitability subclass 3o.

FcB—Fincastle silt loam, 2 to 6 percent slopes. This deep, gently sloping, somewhat poorly drained soil is on relatively high lying positions of the upland landscape. Most areas are irregular in shape and range from 5 to 50 acres in size, but a few areas are more than 100 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The next layer is about 5 inches thick. It is dark grayish brown, friable silt loam mixed with grayish brown silt loam that has a few yellowish brown mottles. The subsoil is about 27 inches thick. The upper part is dark yellowish brown, mottled, firm silty clay loam; the lower part is dark brown, mottled, firm clay loam. The substratum, to a depth of 60 inches, is brown light clay loam.

Included with this soil in mapping, and making up as much as 10 percent of the map unit, are small areas of nearly level Fincastle soils on the highest positions on the landscape. Also included are small areas of moderately well drained, gently sloping Xenia silt loam.

In this Fincastle soil, permeability is moderately slow to slow in the subsoil and slow in the substratum. Available

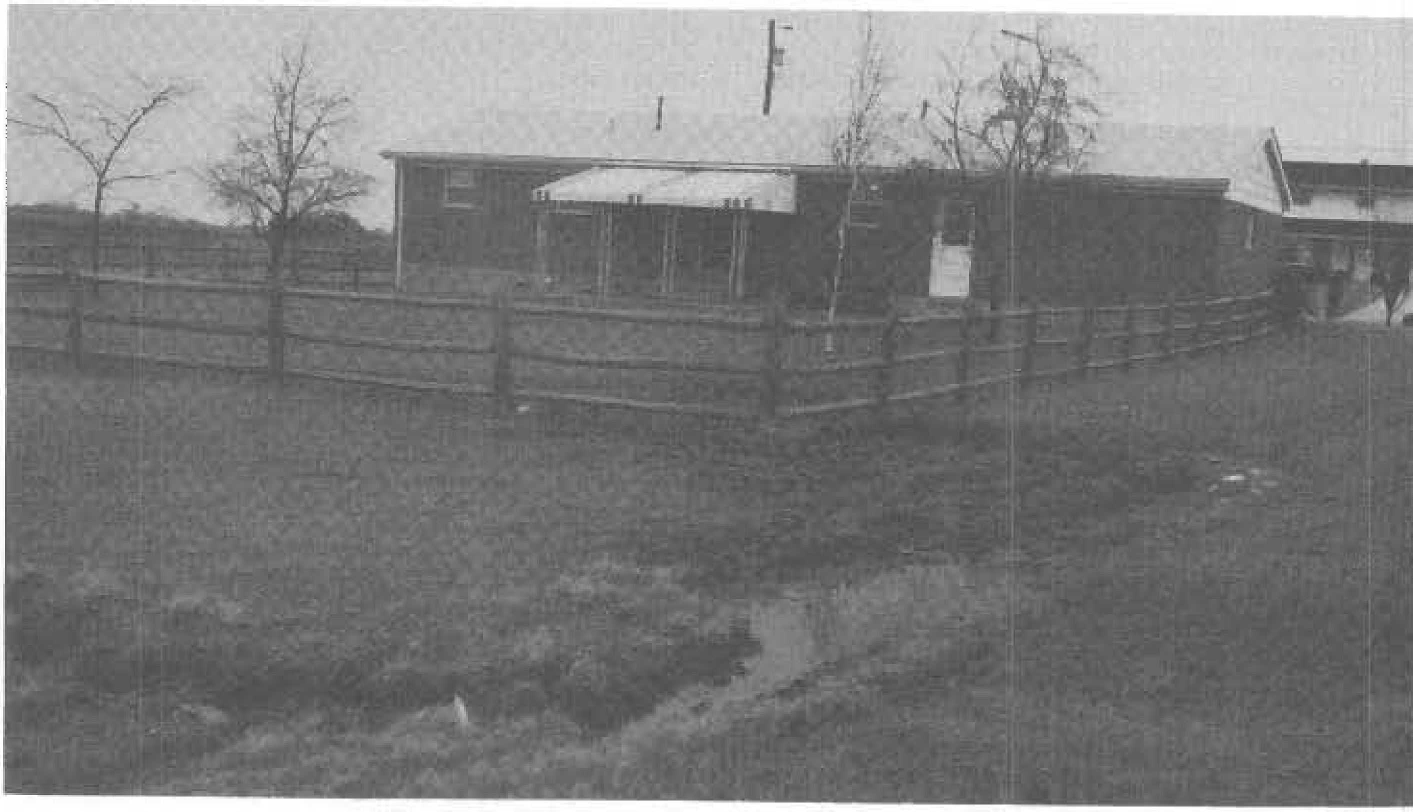


Figure 6.—Wetness and restricted permeability severely limit the use of Fincastle soils for septic tank absorption fields.

water capacity is high. Surface runoff from cultivated areas is medium, and in some places, this soil receives runoff from adjacent, higher areas. The soil tends to dry slowly. Tilth is fair. The subsoil has a moderate shrink-swell potential. The rooting zone is normally deep, because the water table remains deep enough during the cropping season to allow crops common to the area to be grown. The surface layer commonly is medium acid except where limed. The water table is seasonally high for long periods in winter and spring.

Most of the acreage of this soil is farmed. The soil has high potential for cultivated crops, hay, pasture, and trees if properly managed. It has low to medium potential for building site development and sanitary facilities. It has medium potential for recreational uses.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay. The hazard of erosion is moderate in cultivated areas. Minimum tillage and winter cover crops help to prevent excessive soil loss. Organic-matter content is low. Returning crop residue to the soil or the addition of other organic material helps to improve fertility and increase water infiltration. Maintenance of fertility and organic-matter levels and control of erosion are the main management concerns. There is a wetness hazard, especially in spring. Surface and subsurface drainage help to reduce wetness if the soil is cultivated.

This soil has high potential for pasture or hay. Overgrazing and grazing when the soil is too wet, however, will cause surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to such native hardwood trees as oak, ash, and maple. In existing stands, tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by spraying, cutting, or girdling.

The use of this soil for homesites and septic tank absorption fields is limited by wetness and moderately slow and slow permeability in the subsoil. It is better suited to dwellings without basements than to dwellings with basements. Any included areas of gently sloping Xenia soils should be used for homesites if feasible. Performance of septic systems can sometimes be improved by increasing the size of the leach field or providing an alternate leach field. Surface and subsurface drainage lowers the seasonal high water table. Landscaping building sites helps to keep surface water away from foundations. Local roads can be improved by artificial drainage and using a suitable base material.

This soil is in capability subclass IIe; woodland suitability subclass 3o.

FdA—Fincastle silt loam, bedrock substratum, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on uplands. It is on tops of hills, which have only a thin smear of stony till over the bedrock. These areas are shaped by the underlying bedrock. Most areas are oblong or irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The next layer is about 5 inches thick. It is dark grayish brown, friable silt loam mixed with grayish brown silt loam that has a few yellowish brown mottles. The subsoil is about 29 inches thick. The upper part is brown, mottled, friable light silty clay loam; the middle part is yellowish brown, mottled, firm silty clay loam; and the lower part is yellowish brown, mottled, firm clay loam. The substratum, to a depth of about 56 inches, is flaggy light clay loam till. It contains many angular till pebbles and many limestone flagstones averaging about 6 inches across and 2 inches in thickness. These flagstones make up 15 to 30 percent of the volume of the till. Commonly, a 6 to 18 inch layer of this stony till substratum rests directly on the underlying shale and limestone bedrock.

Included with this soil in mapping, and making up 5 to 10 percent of the map unit, are small areas of moderately well drained Xenia, bedrock substratum, soils on slight rises and as strips along the map unit boundary. Also included are small areas of nearly level, somewhat poorly drained soils that have shale and limestone bedrock at a depth of 20 to 40 inches and a few small areas of nearly level Fincastle soils.

In this Fincastle soil, permeability is moderately slow or slow in the subsoil and very slow in the substratum. Available water capacity is medium. Surface runoff from cultivated areas is slow, and the soil tends to dry slowly. Tilth is fair. The subsoil has moderate shrink-swell potential. The root zone is normally deep, because the water table remains deep enough during the cropping season to allow crops common to the area to be grown. The soil commonly is medium acid except where limed. The water table is seasonally high for long periods in winter and spring.

Most of the acreage of this soil is farmed. The soil has high potential for cultivated crops, hay, pasture, and trees. It has low to medium potential for building sites and sanitary facilities. It has medium potential for recreational uses.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Wetness is the main limitation to farming. The soil has a moderate capacity for storing and releasing plant nutrients. Subsurface drainage lines or surface drains help to reduce excess wetness. Maintaining good soil structure is important. The surface layer is low in organic-matter content and susceptible to surface crusting. The soil can be used for row crops year after year if management is optimum. It dries slowly in spring, and planting may be delayed in undrained areas. Rock interferes with excavation for subsurface drains and waterways in farm drainage. Crop yields are also influenced because seepy areas tend to occur where rock is at a minimum depth.

This soil has high potential for pasture. Overgrazing or grazing when the soil is too wet, however, will cause surface compaction and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to such native hardwood trees as oak, ash, and maple. In existing stands, tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by spraying, cutting, or girdling. Wetness is a hazard when planting or harvesting trees.

This soil has limited use for homesites and septic tank absorption fields because of wetness and moderately slow to slow permeability in the subsoil. It is better suited to dwellings without basements than to dwellings with basements. Any included areas of gently sloping Xenia soils should be used for homesites if feasible. Performance of septic systems can sometimes be improved by increasing the size of the leach field or providing an alternate leach field. Surface and subsurface drainage lowers the seasonal high water table. Landscaping building sites helps to keep surface water away from foundations. Local roads can be improved by artificial drainage and using a suitable base material.

The stony till and interbedded shale and limestone underlying this soil make excavation for most uses difficult and expensive; however, the stony till and bedrock is rippable by heavy equipment and rarely requires blasting. The many stones in the till make it undesirable to use in pond embankments.

FdB—Fincastle silt loam, bedrock substratum, 2 to 6 percent slopes. This deep, gently sloping, somewhat poorly drained soil is on high-lying positions of the upland landscape. Areas are as much as 1,200 feet wide, are irregular in shape, and are predominantly less than 50 acres in size, except for a few areas of more than 100 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The next layer is about 5 inches thick. It is dark grayish brown, friable silt loam mixed with grayish brown silt loam that has a few yellowish brown mottles. The subsoil is about 27 inches thick. The upper part is brown, mottled, friable light silty clay loam; the middle part is yellowish brown, mottled, firm silty clay loam; and the lower part is yellowish brown, mottled, firm clay loam. The substratum, to a depth of about 56 inches, is light clay loam till. It contains many angular till pebbles and many limestone flagstone averaging about 6 inches across and 2 inches thick. These flagstones make up 15 to 30 percent of the volume of the till. Commonly, a 6 to 18 inch layer of this stony till substratum rests directly on the underlying shale and limestone bedrock.

Included with this soil in mapping, and making up as much as 10 percent of the map unit, are small intermingled areas of nearly level Fincastle, bedrock substratum, soils on the highest positions on the landscape. Also included in a few places are areas of moderately well drained, gently sloping Xenia silt loam bedrock substratum, soils and areas of gently sloping, somewhat poorly drained soils that have shale and limestone bedrock at a depth of 20 to 40 inches.

In this Fincastle soil, permeability is moderately slow or slow in the subsoil and very slow in the substratum. Available water capacity is medium. Surface runoff from cultivated areas is slow. In some places, the soil also receives surface runoff from adjacent higher areas. It tends to dry slowly. Tilth is fair. The subsoil has moderate shrink-swell potential. The rooting zone is commonly deep because the water table remains deep enough during the cropping season to allow crops common to the area to be grown. The surface layer generally is medium acid except where limed. The water table is seasonally high for long periods in winter and spring.

Most of the acreage of this soil is farmed. The soil has high potential for cultivated crops, hay, pasture, and trees if properly managed. It has low to medium potential for building site development and sanitary facilities. It has medium potential for recreational uses.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. Wetness is a hazard, especially in spring. Surface drainage reduces wetness when the soil is cultivated. The hazard of erosion is moderate. Minimum tillage and winter cover crops help prevent excessive soil loss. The surface layer is low in organic-matter content. Returning crop residue to the soil or the addition of other organic material improves fertility and increases water infiltration. Maintenance of fertility and organic-matter levels and control of wetness are the main management concerns. Farm drainage is difficult because rock interferes with excavation for subsurface drainage lines and surface drains. Crop yields are also influenced by rock, because seeps tend to occur where rock is at minimum depth, especially in shallow waterways on slopes.

This soil has high potential for pasture. Overgrazing or grazing when the soil is too wet, however, will cause surface compaction and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to such native hardwood trees as oak, ash, and maple. In existing stands, tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by spraying, cutting, or girdling.

This soil has limited use for homesites and septic tank absorption fields because of wetness and moderately slow or slow permeability in the subsoil. Any included areas of gently sloping Xenia soils should be used as homesites if feasible. This soil is better suited to dwellings without basements than to dwellings with basements. Performance of septic systems can sometimes be improved by increasing the size of the leach field or by providing an alternate leach field. Surface and subsurface drainage lowers the seasonal high water table. Landscaping building sites helps to keep surface water away from foundations. Local roads can be improved by artificial drainage and using a suitable base material.

The stony till and interbedded shale and limestone underlying this map unit make excavation for most uses difficult and expensive; however, the stony till and bedrock is rippable by heavy equipment and rarely requires blasting. The many stones make the till undesirable for use in pond embankments.

This soil is in capability subclass IIw; woodland suitability subclass 3o.

Gn—Genesee loam. This deep, nearly level, well drained soil is on flood plains. Flooding is common. Most areas are either circular or long and narrow and are 2 to 400 acres in size. Slope is 0 to 2 percent.

Typically, the surface layer is dark grayish brown, friable loam about 8 inches thick. The upper part of the substratum is dark brown, friable loam and silt loam; the middle part is dark yellowish brown, friable loam; and the lower part, to a depth of 60 inches, is yellowish brown stratified loam, sandy loam, and silt loam.

Included with this soil in mapping are a few areas of the moderately well drained Eel soils in lower parts of the landscape and a few areas of dark colored Ross soils that are higher on the flood plains and further removed from the stream channel. In a few areas a dark colored soil is buried under about 2 to 3 feet of light colored alluvium.

This Genesee soil is moderately permeable. Available water capacity is high, and runoff is slow. The soil is subject to flooding from October to June. The rooting zone is deep and neutral to moderately alkaline. The surface layer contains a moderate amount of organic matter and is highly fertile.

This soil has high potential for crops, and most areas are used for corn, soybeans, wheat, or hay. The soil also has high potential for pasture, woodland, and wildlife habitat. It has low potential for building site development and sanitary facilities and medium potential for many recreational uses.

This soil is suited to most of the crops grown in the county. The spring floods, however, can damage winter wheat. Flooding during the growing season of corn and soybeans is rare, and these crops generally can be grown without flood damage. The natural drainage of the soil is adequate for farming. The soil is highly fertile, and the regular addition of fertilizer, as recommended by soil tests, can keep the soil highly productive.

This soil is highly productive for pasture. Overgrazing or grazing when the soil is wet, however, causes surface compaction and lower yields. Proper stocking, pasture rotation, and restricted use when the soil is wet will help to keep the pasture and the soil in good condition.

This soil is well suited to trees, but few areas are wooded because of the suitability of the soil for cultivated crops. Flooding is of brief duration, and trees generally are not damaged. Plant competition is a moderate limitation, but tree seeds and seedlings survive and grow well if the competing vegetation is controlled. Such high-value trees as black walnut grow well on this soil.

This soil is poorly suited as building sites and for sanitary facilities because of flooding. Some recreational development is limited for the same reason.

This soil is a good source of topsoil. Protective levees have been built in some areas, and where protected from flooding, the soil is suited for some construction.

This soil is in capability class I; woodland suitability subclass 1o.

Go—Genesee-Urban land complex. This map unit consists of deep, nearly level, well drained Genesee soils and Urban land. It is on flood plains. Areas range from 12 acres to more than 300 acres in size. This map unit is 50 to 65 percent Genesee soils and 20 to 35 percent Urban land. The Genesee soils and Urban land are so intricately mixed, or so small in extent, that it is not practical to map them separately.

Typically, the Genesee soil has a surface layer of dark grayish brown, friable loam about 8 inches thick. The upper part of the substratum is dark brown, friable loam and silt loam; the middle part is dark yellowish brown, friable loam; and the lower part, to a depth of 60 inches, is yellowish brown stratified loam, sandy loam, and silt loam.

Urban land is covered by streets, parking lots, buildings, and other structures that so obscure or alter the original soil that identification and classification is not feasible.

Included in mapping, and making up 5 to 15 percent of the unit, are small areas of moderately well drained Eel soils at low positions on the landscape and dark colored, well drained Ross soils at slightly higher elevation. Also included are a few areas of excessively well drained soils on knolls.

Most areas of this map unit are serviced by sewer systems and street gutters. Genesee soils have moderate permeability, high available water capacity, and slow runoff. Most areas are protected from floods by levees. The rooting zone is deep and neutral to moderately alkaline. The surface layer has a moderate amount of organic matter and is highly fertile.

The Genesee soils are used for parks, open space, building sites, lawns, and gardens. They have high potential for lawns, vegetable and flower gardens, trees and shrubs, building site development, and recreational facilities if protected from flooding. Where not protected from flooding, the potential for all nonfarm uses is low.

The Genesee soils are well suited to grasses, flowers, vegetables, trees, and shrubs. Erosion is generally a hazard only where the soil is disturbed and left bare for a long period. In areas that have been excavated or gullied, gravelly material is exposed and lawns and gardens are difficult to establish. Filled areas are so variable in characteristics that no predictions can be made about their properties. Onsite investigation is required for determining the hazards, limitations, and suitability of individual areas for a given use.

These soils are poorly suited as building sites and for sanitary facilities because of flooding. Some recreational development is limited for the same reason.

These soils are a good source of topsoil. Protective levees have been built in some areas, and if protected from flooding, the soils are suited for some nonfarm uses. Onsite investigations are needed to determine the best use of a given area, because the soils are altered and variable in many urban locations.

Genesee soils are in capability class I; woodland suitability subclass 1o; Urban land part is not assigned to a capability subclass or a woodland suitability subclass.

HeE2—Hennepin-Miamian silt loams, 18 to 25 percent slopes, moderately eroded. These deep, well drained soils are on short, steep side slopes bordering stream valleys. Many areas are dissected by small waterways and gullies. These soils are widespread in the county, and they generally are on the sharp, steep breaks from flood plains or terraces to uplands. Areas are elongated and range from 5 to 300 acres in size.

This map unit is about 60 percent Hennepin silt loam, 25 percent Miamian silt loam, and 15 percent included soils. The Miamian soil is on the upper and lower positions on side slopes; the Hennepin soil is on mid-slope positions. Especially along Four Mile Creek, this map unit extends for several miles in long, thin strips on both sides of the valley. It also extends up the valleys of many tributary streams to Four Mile Creek. These tributary streams are deeply cut in glacial till and form deep, V-shaped ravines and gullies.

The Hennepin and Miamian soils in this complex are so intricately mixed, or so small in extent, that it is not practical to separate them in mapping.

Typically, the Hennepin soil has a surface layer of dark brown, friable silt loam about 5 inches thick. The subsoil is about 12 inches thick and is dark yellowish brown, friable loam. The substratum, to a depth of 60 inches, is calcareous, brown loam glacial till that contains many till pebbles and rock fragments.

Typically, the Miamian soil has a surface layer of brown, friable silt loam about 4 inches thick. The subsoil is about 16 inches thick. It is dark yellowish brown, firm, heavy clay loam that contains some till pebbles and coarse fragments. The substratum, to a depth of 60 inches, is yellowish brown loam.

Included with these soils in mapping are small areas of soils where slope is more than 25 percent. These short, very steep sides of deep ravines cut down at right angles to the general direction of the map unit. Also included are a few small areas of severely eroded soils that have calcareous, pebbly glacial till exposed on the surface. These soils are commonly yellowish brown or olive brown and are devoid of vegetation. In a rather large area on the west side of Four Mile Creek Valley in and south of Hueston Woods State Park, the soil has a subsoil of reddish brown, and the glacial till is generally friable sandy loam. Also included are small areas of soils that have a moderately alkaline, or calcareous, very dark grayish brown surface layer.

Permeability is moderately slow or slow in the Hennepin soil and moderately slow in the Miamian soil. Available water capacity is moderate and runoff is rapid in both soils. The rooting zone ranges from slightly acid to moderately alkaline. Organic-matter content is low in the surface layer as a result of erosion. Root development is somewhat restricted by the underlying till, which is generally quite dense and firm. Depth to bedrock is generally more than 6 feet.

These soils are too steep for crops. Most of the acreage in the county is in pasture or woodland, and the soils have medium potential for these uses. The potential for building site development and sanitary facilities is low because the soils are steep.

These soils commonly are in pasture, but where they are overgrazed, the hazard of erosion is severe. Controlling erosion and maintaining a maximum stand of key forage species are concerns of management. During seeding, the use of cover crops or companion crops, trash mulching, or no-till seeding help to control erosion. Certain legumes, such as crownvetch, grow well on these soils. Proper stocking, pasture rotation, and timely application of fertilizer help to maintain a maximum stand of key forage species. Some areas of less steep soils that have been farmed and then abandoned, are in brushy pasture of Canadian bluegrass, thornapple, and redcedar. These areas need pasture renovation.

Pond reservoir sites are limited. Because the soils are steep, high embankments are required if there is to be adequate water area.

Steep slopes moderately restrict use of these soils for woodland. The use of equipment is moderately restricted on both soils, and the hazard of erosion is moderate in the Hennepin soil. Logging roads and skid trails should be constructed on the contour where practical. Mechanical tree planting and weed control can be accomplished if safety precautions are taken. Many areas of this soil are in hardwood forests. Hueston Woods State Park in north-central Oxford Township has a climax community of beech-hard maple forest. It is an outstanding example of the type of forest cover that once covered these and similar soils in this part of Ohio. Woodland improvement for timber production requires excluding undesirable species and poorly formed trees and killing grapevines and poison ivy.

These soils are poorly suited as building sites and for sanitary facilities and most recreational development because of steep slopes. Landslides can occur if the toe slope is undercut, if the top is loaded, or if too much surface water or ground water saturates the area.

These soils are in capability subclass VIe; the Hennepin soil is in woodland suitability subclass 1r and the Miamian soil is in woodland suitability subclass 2r.

HeF—Hennepin-Miamian silt loams, 25 to 50 percent slopes. These deep, very steep, well drained soils are on short side slopes bordering stream valleys. Some areas are moderately eroded and are dissected by waterways and a few gullies. These soils are widespread in the county, and they generally are on the sharp, very steep breaks from flood plains or terraces to uplands. Areas are elongated and range from 5 to 250 acres in size.

This unit is about 60 percent Hennepin silt loam and 25 percent Miamian silt loam. The Miamian soil is on the upper and lower positions on side slopes, and the Hennepin soil is on mid-slope positions. Especially along Brown's Run, this map unit extends for several miles in long, thin strips on both sides of the valley. It also extends well up the valleys of many tributary streams to Brown's Run. These tributary streams are typically deeply cut in glacial till and form deep V-shaped ravines and gullies.

The Hennepin and Miamian soils in this complex are so intricately mixed, or so small in extent, that it is not practical to separate them in mapping.

Typically, the Hennepin soil has a surface layer of dark brown, friable silt loam about 4 inches thick. The subsoil is about 9 inches thick and is dark yellowish brown, friable loam. The substratum, to a depth of 60 inches, is brown, calcareous loam that contains many till pebbles and rock fragments.

Typically, the Miamian soil has a brown, friable silt loam surface layer about 4 inches thick. The subsoil is about 16 inches thick. It is dark yellowish brown, firm heavy clay loam that contains some pebbles and coarse fragements. The substratum, to a depth of 60 inches, is yellowish brown loam.

Included with these soils in mapping are small areas where slopes are less than 25 percent. These are narrow waterway divides between deeply cut ravines that have very steep sides. Also included are a few small areas of severely eroded soils that have calcareous, pebbly glacial till exposed on the surface. These soils are commonly yellowish brown or olive brown and are devoid of vegetation. Small areas of soils that have a moderately alkaline or calcareous very dark grayish brown surface layer are included.

Permeability is moderately slow or slow in the Hennepin soil and moderately slow in the Miamian soil. Available water capacity is moderate, and runoff is rapid in both soils. The rooting zone ranges from slightly acid to moderately alkaline. Organic-matter content is low in the surface layer as a result of erosion. Root development is somewhat restricted by the underlying till, which is generally quite dense and firm. Depth to bedrock is generally more than 6 feet.

These soils are too steep for farming. Most of the acreage in the county is in woodland or pasture, and the soils have medium potential for these uses. The potential for building site development and sanitary facilities is low because the soils are very steep.

The hazard of erosion is severe if these soils are overgrazed. Controlling erosion and maintaining a maximum stand of key forage species are concerns of management. During seeding, the use of cover crops or companion crops, trash mulching, or no-till seeding helps to control erosion. Certain legumes, such as crownvetch, grow well in this soil. Proper stocking, pasture rotation, and timely application of fertilizer help to maintain a maximum stand of key forage species. Some areas are in brushy pasture of Canadian bluegrass, thornapple, and redcedar. They should be renovated to more productive pasture or converted to woodland.

Pond reservoir sites are limited. Because the soils are very steep a large amount of fill is required for a minimum water surface.

Management is difficult if these soils are used for woodland. The very steep slopes are a severe limitation. The hazard of erosion is moderate in the Miamian soil and severe in the Hennepin soil. The limitations to the use of equipment is severe in both soils. Logging roads and skid trails should be constructed on the contour where practical. Hand tree planting and weed control is common because of the steepness of the soils. There are many good stands of hardwoods. Woodland improvement for timber production requires excluding undesirable species and poorly formed trees and killing grapevines and poison ivy.

These soils are poorly suited as building sites and for sanitary facilities and most recreational use because of very steep slopes. Landslides can occur if the toe slope is undercut, if the top is loaded, or if too much surface water or ground water saturates the area.

These soils are in capability subclass VIIe; the Hennepin soil is in woodland suitability subclass 1r and the Miamian soil is in woodland suitability subclass 1o.

HoA—Henshaw silt loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on terraces. Most areas are irregular in shape and are less than 20 acres in size; a few are broad and are more than 100 acres in size.

Typically, this soil has a surface layer of dark grayish brown, friable silt loam about 9 inches thick. The subsoil is friable, mottled silty clay loam about 41 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum, to a depth of 60 inches, is light olive brown, massive, mottled heavy silt loam.

Included with this soil in mapping are a few small intermingled areas of dark colored, poorly drained Patton soils and dark colored, somewhat poorly drained Brenton soils in slight depressions. Also included are slightly higher areas of moderately well drained Uniontown soils. These included soils make up 5 to 20 percent of some of the larger mapped areas.

This Henshaw soil has a seasonal high water table and is naturally wet. If adequately drained, the root zone is deep enough for most annual crops commonly grown. Available water capacity is high and runoff is slow. Permeability is moderately slow. The root zone is neutral to medium acid. The surface layer is low in organic matter content. Shrink-swell potential is low.

Most of the acreage of this soil is used for farming, and the soil has high potential for this use. It has high potential for pasture, woodland, and wildlife. It has low potential for most building site development and sanitary facilities and a medium potential for most recreational uses.

This soil is seasonally wet. Subsurface drainage lines that have suitable outlets or surface drains reduce excess wetness. The soil can be used continuously for row crops if management is optimum. Returning crop residues to the soil or the regular addition of other organic matter helps to improve fertility and increase water infiltration. Maintenance of fertility and drainage is the main management concern.

This soil is poorly suited as building sites and for sanitary facilities because of wetness and moderately slow permeability. If possible, homesites should be located on the better drained, slightly higher lying included soils. Performance of septic systems can sometimes be improved by increasing the size of the leach field or providing an alternate leach field. Surface and subsurface drainage lowers the seasonal high water table. Landscaping building sites helps to keep surface water away from foundations. Local roads can be improved by artificial drainage and using a suitable base material.

This soil is in capability subclass IIw; woodland suitability subclass 1w.

La—Landes sandy loam. This deep, nearly level, well drained alluvial soil is on flood plains and is subject to rare flooding. It generally is nearer the stream channel than the other soils on flood plains. Areas are irregular in shape and range from 10 to more than 300 acres in size.

Typically, the surface layer is very dark grayish brown, friable sandy loam about 11 inches thick. The subsoil is dark brown, friable sandy loam about 15 inches thick. The substratum, to a depth of 60 inches, is loamy fine sand and coarse sand that has lenses of sandy loam or silt loam. The percentage of gravel increases with depth.

Included with this soil in mapping are small areas of Ross soils that are slightly higher in elevation and Stonelick soils that are lighter colored and on the same landscape position as the Landes soil. Also included are soils that have a loam surface layer and other soils on streambanks and natural levees that have slopes of more than 2 percent.

This soil has moderately rapid permeability in the surface layer and subsoil and rapid permeability in the substratum. It has moderate available water capacity. Surface runoff is slow. The soil is subject to rare flooding. The root zone is deep and mildly alkaline. Because the soil warms early in spring, most crops can be planted early.

Most areas of this soil are used for crops, even though it only has medium potential for that use. It has high potential for woodland, pasture, and openland and woodland wildlife habitat. It is a good source of topsoil and a fair source of roadfill material. This soil has low potential for building site development and sanitary facilities and high potential for some recreational facilities.

This soil is suited to most crops grown in the county, but the floods can damage winter wheat. Flooding seldom occurs during the growing season for corn and soybeans, and these crops can generally be grown without flood damage. If irrigated, this soil is suited to specialty vegetable crops.

A few areas of this soil are wooded, and plant competition is the only limitation to growing trees.

This soil is a good source of topsoil. It is poorly suited as building sites and for sanitary facilities because it floods. Where protected from flooding by levees, this soil is well suited to some nonfarm uses.

This soil is in capability subclass IIIs; woodland suitability subclass 1o.

Lg—Lanier fine sandy loam. This deep, nearly level, well drained soil is on flood plains and is subject to occasional flooding. Most areas are long and narrow and range from 2 to more than 100 acres in size. Slope ranges from 0 to 2 percent.

Typically, the upper part of the surface layer is dark brown, friable fine sandy loam about 8 inches thick, and the lower part is very dark grayish brown, friable sandy loam about 6 inches thick. The substratum, to a depth of 60 inches, is brown stratified very gravelly loamy sand.

Included with this soil in mapping are small areas of soils that have a light colored surface layer or a gravelly sandy loam surface layer. Also included are a few areas of soils in narrow valleys in which the fine sandy loam alluvium rests directly on shale and limestone bedrock or gravelly glacial till.

This Lanier soil is rapidly permeable to very rapidly permeable and has low available water capacity. Runoff is slow. The soil is subject to occasional flooding for very brief periods throughout the year. The content of organic matter in the surface layer is moderate. The rooting zone is shallow and mildly alkaline or moderately alkaline.

Most areas of this soil are either in woodland or pasture, although some areas are cultivated. The soil has high potential for crops, woodland, and pasture. It has low potential for building site development and sanitary facilities and medium potential for many recreational uses.

This soil is suited to crops common in the county, but it needs irrigation, particularly in dry years. The soil floods occasionally throughout the year, but crop damage can be expected more often from drought than from floods. Because the soil warms early in spring, most crops can be planted early. The addition of crop residues and other forms of organic matter conserves soil moisture. This soil is suited to many pasture grasses and legumes. The number of grazing days is reduced in dry years, however.

This soil is suited to trees. Flooding is of a very brief duration, and trees generally are not damaged. Plant competition is a moderate limitation, but tree seeds and seedlings survive and grow well if the competing vegetation is controlled.

This soil is a good source of roadfill, but a poor source of topsoil because of small stones. It is poorly suited as building sites and for sanitary facilities because it floods. Where protected from flooding by levees, the soil is well suited to some nonfarm uses.

This soil is in capability subclass IIw; woodland suitability subclass 2o.

MIB2—Miamian silt loam, 2 to 6 percent slopes, moderately eroded. This deep, gently sloping, well drained soil is on the Camden end moraine. Most areas are irregular in shape and 2 to 200 acres in size.

Typically, the surface layer is brown, friable silt loam about 6 inches thick. The subsoil is dark yellowish brown and is 16 inches thick. The upper part is friable silty clay loam, and the lower part is firm clay loam. The substratum, to a depth of 60 inches, is yellowish brown loam.

Included with this soil in mapping are small, low areas of moderately well drained Celina soils and many areas where the soil is only slightly eroded. Also included are areas of soils that have a substratum of stony till or that are underlain by shale and limestone bedrock at a depth of less than 40 inches.

This Miamian soil is moderately slowly permeable and has moderate available water capacity. Runoff is medium. The surface layer is low in organic-matter content. The soil has fair tilth and can be tilled properly in a narrow range of moisture content. The subsoil is slightly acid to mildly alkaline.

Most areas of this soil are used for crops. Corn, soybeans, small grain, and hay are the main crops, and the soil has high potential for those crops. It has high potential for pasture and openland wildlife habitat and medium potential for building site development and sanitary facilities. It has high potential for many recreational uses.

Erosion is a moderate hazard. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. The surface crusts after a hard rain, but the regular addition of crop residues and other forms of organic matter reduces the crusting and increases fertility. Natural drainage is adequate for farming, and generally no subsurface drains are required. Some slopes are long enough that contour plowing and stripcropping are beneficial. Control of erosion and maintenance of fertility and organic-matter content are the main management concerns.

The use of this soil for pasture or hay is effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, can cause surface compaction, excess runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use after soaking rain help to keep the pasture and the soil in good condition.

This soil is well suited to trees, and many areas remain in hardwoods. Plant competition is a moderate limitation, but tree seedlings survive and grow well if competing vegetation is controlled. Such deep-rooted trees as black walnut grow well.

This soil is suitable for homesites. It is moderately well suited for most recreational uses. Because it does not have sufficient strength and stability to support vehicular traffic, the base material needs to be replaced if this soil is used for roads. The moderately slow permeability limits its use for septic tank absorption fields. Using a larger leach field or an alternate leach field can help overcome this limitation. Homesites should be landscaped so that surface drainage is away from buildings.

This soil is in capability subclass IIe; woodland suitability subclass 1o.

MIC2—Miamian silt loam, 6 to 12 percent slopes, moderately eroded. This deep, moderately sloping, well drained soil is on the Camden end moraine. Most areas are irregular in shape and 2 to 130 acres in size.

Typically, the surface layer is brown, friable silt loam about 6 inches thick. The subsoil is firm clay loam about 15 inches thick. The upper part is dark brown, and the lower part is dark yellowish brown and has yellowish brown mottles. The substratum, to a depth of 60 inches, is dark yellowish brown loam.

Included with this soil in mapping are areas where the soil is only slightly eroded and a few areas where it is severely eroded and the surface layer and subsoil are as much as 8 inches thinner. Also included are areas of soils that have a substratum of stony glacial till or that are underlain by shale and limestone bedrock.

This Miamian soil has moderately slow permeability and moderate available water capacity. Runoff is rapid. The surface layer is low in organic matter. Tilth is fair. The soil can be tilled properly in a narrow range of moisture content. The subsoil is slightly acid to mildly alkaline.

Many areas of this soil are used for crops. Corn, soybeans, small grain, and hay are the main crops, and the soil has medium potential for these crops if erosion is controlled. It has high potential for pasture and openland or woodland wildlife habitat and medium potential for building site development and sanitary facilities. It has high potential for hiking trails and medium potential for camp and picnic areas and golf courses.

The hazard of erosion is severe. Minimum tillage, winter cover crops, grassed waterways, stripcropping, and contour farming, however, minimize soil loss. The surface crusts after a hard rain, but the regular addition of crop residues and other forms of organic matter reduces crusting and increases fertility. Internal drainage is adequate for farming. Because this soil is droughty during dry periods, measures to conserve moisture, such as minimum tillage and mulching, benefit most crops. Control of erosion and maintenance of fertility and organic-matter content are the main management concerns.

Using this soil for pasture or hay is effective in controlling erosion. Grazing when the soil is wet will cause surface compaction, excess runoff, and poor tilth. Proper stocking and pasture rotation help keep the pasture and the soil in good condition.

This soil is well suited to trees, and many areas remain in hardwoods. Plant competition is a moderate limitation. Black walnut and yellow poplar seedlings survive and grow well, however, if competing vegetation is controlled.

This soil is suitable for homesites. It is moderately well suited to most recreational uses. Because it does not have sufficient strength and stability to support vehicular traffic, the base material needs to be replaced if this soil is used for roads. The moderately slow permeability limits its use for septic tank absorption fields. Using a larger leach field or an alternate leach field can help overcome this limitation. Homesites should be landscaped so that surface drainage is away from the buildings.

This soil is in capability subclass IIIe; woodland suitability subclass 1o.

MlD2—Miamian silt loam, 12 to 18 percent slopes, moderately eroded. This deep, moderately steep, well drained soil is on the Camden end moraine. Most areas are irregular in shape and 2 to 20 acres in size.

Typically, the surface layer is brown, friable silt loam about 6 inches thick. The subsoil is firm clay loam about 14 inches thick. The upper part is dark brown, and the lower part is dark yellowish brown. The substratum, to a depth of 60 inches, is dark yellowish brown heavy loam.

Included with this soil in mapping are small areas of Hennepin soils that have slopes of more than 18 percent. Also included are a few areas where the soil is severely eroded and calcareous till is exposed.

This Miamian soil has moderately slow permeability and moderate available water capacity. Runoff is rapid. The surface layer is low in organic-matter content, and has fair tilth. The rooting zone is neutral to mildly alkaline.

Because this soil is moderately steep, it is used mainly for permanent pasture or woodland. It has low potential for cultivated crops and medium potential for small grain and hay crops. It has high potential for openland and woodland wildlife habitat and low potential for building site development and sanitary facilities.

Erosion is a severe hazard. Using minimum tillage, winter cover crops, and grassed waterways reduces soil loss. Conventional tillage by plowing and disking causes excessive erosion. This soil is droughty during dry periods, and measures that conserve soil moisture benefit crops. The regular addition of organic matter reduces crusting, increases water infiltration, and raises the fertility level of the soil. Control of erosion is the main management concern.

Using this soil for permanent pasture or hay is effective in controlling erosion. Grazing when the soil is wet can cause surface compaction, excessive runoff, and poor tilth. Proper stocking and pasture rotation help to keep the pasture and the soil in good condition. Most permanent pasture and hay are grass-legume mixtures. Bluegrass and either clover or alfalfa are commonly included in most mixtures. The trash-mulch method of pasture renovation minimizes erosion.

This soil is suited to trees, and many areas remain in hardwoods. Slope is a moderate limitation to the use of some tree harvesting equipment.

The use of this soil for building sites and sanitary facilities is mainly limited by slope. Because the soil does not have sufficient strength and stability to support vehicular traffic, the base material needs to be replaced if roads are built. The moderately slow permeability and slope limit use for septic tank absorption fields. Using a large leach field or an alternate leach field can help overcome this limitation.

This soil is in capability subclass IVe; woodland suitability subclass 1o.

MnC3—Miamian clay loam, 6 to 12 percent slopes, severely eroded. This deep, moderately sloping, well drained soil is on the Camden end moraine. Most areas are irregular in shape and 4 to 120 acres in size.

Typically, the surface layer is brown clay loam about 4 inches thick. The subsoil is about 11 inches thick. It is dark yellowish brown and yellowish brown clay loam and clay. The substratum, to a depth of 60 inches, is firm, yellowish brown calcareous loam.

Included with this soil in mapping are small areas where the soil is only moderately eroded and areas where calcareous till is exposed. Also included are a few areas of soils that have a substratum of stony glacial till or are underlain by shale and limestone bedrock at a depth of less than 40 inches.

This Miamian soil has moderately slow permeability and very low available water capacity. Runoff is rapid. The surface layer is very low in organic-matter content, and tilth is poor.

Most areas of this soil are idle and are growing weeds, grasses, and redcedar. The soil has high potential for woodland. It has low potential for cultivated crops and medium potential for pasture. It has high potential for openland and woodland wildlife habitat and medium potential for building site development. It has high potential for use as hiking trails and medium potential for camp and picnic areas. It has medium potential for golf fairways and landscaping.

The hazard of erosion is very severe. All the silty loess mantle on this soil has eroded away and the clay loam subsoil or substratum is exposed. The soil is not suited to cultivation. It is better suited to permanent pasture or woodland. Controlling further erosion is the major management concern.

Using this soil for pasture or hay is very effective in controlling erosion. Overgrazing or grazing when the soil is wet can cause surface compaction, excessive runoff, and poor yields. The trash-mulch method of pasture renovation minimizes erosion and also conserves soil moisture. The regular addition of phosphate to legumes and of nitrogen to grasses is very beneficial to both pasture and hay. The selection of drought-resistant varieties and the use of proper seed mixes can increase the number of grazing days on pasture and the yield from hayland. Proper stocking and pasture rotation keep the pasture in good condition.

This soil is suited to trees, and many areas are reverting back to trees through natural succession. Redcedar tolerates a high pH (alkaline soil) and low moisture content, and it generally is the dominant species in the succession. Plant competition is the only limitation for planting or harvesting trees. Tree seeds and seedlings survive and grow well if competing vegetation is controlled.

This soil is suitable for homesites. The soil is moderately well suited to most recreational uses. It does not have sufficient strength and stability to support vehicular traffic, but can be used for roads if the base material is replaced. The moderately slow permeability limits use for septic tank absorption fields. Using a large leach field or an alternate leach field can help overcome this limitation. Homesites should be landscaped so that surface drainage is away from buildings.

This soil is in capability subclass IVe; woodland suitability subclass 1o.

MnD3—Miamian clay loam, 12 to 18 percent slopes, severely eroded. This deep, moderately steep, well drained soil is on the Camden end moraine. Most areas are irregular in shape and 2 to 50 acres in size.

Typically, the surface layer is friable, brown clay loam about 5 inches thick. The subsoil is about 7 inches thick and is firm, brown and dark yellowish brown clay loam. The substratum, to a depth of 60 inches, is dark yellowish brown, firm clay loam.

Included with this soil in mapping are a few small areas where the soil is only moderately eroded and many areas where calcareous till is exposed. Also included are areas of soils where slope is more than 18 percent.

This Miamian soil has moderately slow permeability and very low available water capacity. Runoff is very rapid. The surface layer is very low in organic-matter content. Tilth is poor.

Most areas of this soil are idle and are growing weeds, grasses, and redcedar. The soil has high potential for woodland. It has low potential for cultivated crops and medium potential for pasture. It has high potential for openland and woodland wildlife habitat and low potential for building site development. It has medium potential for use as hiking trails and low potential for camp areas, playgrounds, and picnic areas. It has low potential for golf fairways and lawns.

The erosion hazard is very severe. All of the original silty loess mantle has eroded away, and the clay loam subsoil or substratum is exposed. The soil is not suited to cultivation. It is better suited to permanent pasture or woodland. Controlling further erosion is the main management concern.

The use of this soil for pasture or hay is very effective in controlling erosion. Grazing when the soil is wet can cause surface compaction, excessive runoff, and poor yields. The trash-mulch method of pasture renovation minimizes erosion and also conserves soil moisture. The regular addition of phosphate to legumes and of nitrogen to grasses is very beneficial to both the pasture and hay. The selection of drought-resistant varieties and the use of proper seed mixes can increase the number of grazing days on pasture and the yield from hayland. Proper stocking and pasture rotation keep the pasture in good condition.

This soil is suited to growing trees, and many areas are reverting back to trees through natural succession. Redcedar tolerates a high pH (alkaline soil) and low moisture content, and it generally is the dominant species in the succession. Plant competition, slopes steep enough to restrict use of equipment, and erosion are limitations for planting or harvesting trees. Tree seeds and seedlings survive and grow well, however, if the competing vegetation is controlled.

The main limitation to use of this soil as building sites and for sanitary facilities is slope. The soil does not have sufficient strength and stability to support vehicular traffic, but is can be used for roads if the base material is replaced. The moderately slow permeability and slope limit use for septic tank absorption fields. Using a large leach field or an alternate leach field can overcome this limitation.

This soil is in capability subclass VIe; woodland suitability subclass 1o.

MsC2—Miamian-Russell silt loams, 6 to 12 percent slopes, moderately eroded. These deep, moderately sloping, well drained soils are on hillsides and along waterways on rolling till plains. Areas are irregular or linear in shape and range from 3 to 50 acres in size.

This map unit is about 60 percent Miamian silt loam and 30 percent Russell silt loam. The irregular areas that surround waterways are more than 60 percent Miamian soil. In the linear areas, the Miamian soil commonly is adjacent to the steep or very steep slope breaks of hillsides, and the Russell soil is adjacent to the gently sloping, smooth, lower parts of hillsides. In the irregular areas, the Miamian soil is on the slope breaks and the Russell soil is in the smoother areas.

Typically, the Miamian soil has a surface layer of brown, friable silt loam about 8 inches thick. The subsoil is dark brown and dark yellowish brown, firm clay loam about 14 inches thick. The substratum, to a depth of 60 inches, is dark yellowish brown, firm loam.

Typically, the Russell soil has a dark brown, friable silt loam surface layer about 7 inches thick. The subsoil is about 27 inches thick. The upper part is brown, firm silt loam and silty clay loam, and the lower part is strong brown, brown, and yellowish brown, firm clay loam. The substratum, to a depth of 60 inches, is brown, firm loam.

Included with these soils in mapping are areas of soils, in similar or higher positions on the landscape, in which the substratum is more than 15 percent stone fragments. Also included are a few areas of severely eroded soils that have a pebbly or flaggy clay loam surface layer and areas of soils where slope is more than 12 percent.

Permeability is moderately slow in the Miamian soil. In the Russell soil, it is moderate in the upper part of the subsoil and moderately slow in the lower part of the subsoil and in the substratum. The available water capacity is moderate in the Miamian soil and high in the Russell soil. Surface runoff is medium. The surface layer varies in reaction because of local liming practices. The organic-matter level is low in both soils as a result of erosion of the surface layer. These soils are especially susceptible to gully and rill erosion.

These soils have medium potential for farming, and most areas are used for corn and soybeans. The soils have high potential for pasture, hay, and woodland. They have medium potential for building site development, medium to low potential for sanitary facilities, and medium potential for many recreational uses.

The hazard of erosion is severe. Minimum tillage, winter cover crops, grassed waterways, stripcropping, and contour farming, however, can minimize soil loss. These soils crust after rain, but the regular addition of crop residue and other forms of organic matter can reduce crusting and increase fertility. Internal drainage is adequate for farming. Measures to conserve soil moisture, such as minimum tillage and soil mulching, can benefit crops. The regular addition of fertilizer and other soil amendments, as recommended by soil tests, also benefits crops. Control of erosion and maintenance of fertility and organic-matter content are the main management concerns.

Using these soils for permanent pasture or hay is effective in controlling erosion. Pasture and hay commonly are grass-legume mixtures, generally bluegrass and clover. Grazing when this soil is wet will cause surface compaction, excessive runoff, and poor tilth. The trash-mulch method of pasture renovation can practically eliminate further erosion. Proper stocking and pasture rotation help to keep pasture and the soil in good condition.

These soils are well suited to trees. Plant competition is a concern, but tree seeds and seedlings survive and grow well if competing vegetation is controlled. Many wooded areas are in oak-hickory or beech-maple forest types. Plant competition is the only limitation to planting or harvesting trees.

These soils are suitable for homesites. They are moderately well suited to most recreational uses. They do not have sufficient strength and stability to support vehicular traffic, but roads can be built if a suitable base material is used. The moderately slow permeability limits use for septic tank absorption fields, but it can be overcome by increasing the size of the leach field or using an alternate leach field. Construction sites should be landscaped to drain surface water away from the buildings.

These soils are in capability subclass IIIe; woodland suitability subclass 1o.

MsD2—Miamian-Russell silt loams, 12 to 18 percent slopes, moderately eroded. These deep, moderately steep, well drained soils are on hillsides and along waterways on hilly till plains. Areas are irregular or elongated in shape and range from 3 to 25 acres in size.

This map unit is about 65 percent Miamian silt loam and 20 percent Russell silt loam. The Miamian soil commonly is on or near slope breaks of the hillsides and on streambanks. The Russell soil is on the broad, smooth hillsides.

Typically, the Miamian soil has a surface layer of brown, friable silt loam about 8 inches thick. The subsoil is dark brown and dark yellowish brown, firm clay loam about 13 inches thick. The substratum, to a depth of 60 inches, is dark yellowish brown, firm loam.

Typically, the Russell soil has a dark brown, friable silt loam surface layer about 7 inches thick. The subsoil is about 25 inches thick. The upper part is brown, firm silt loam and silty clay loam, and the lower part is strong brown, brown, and yellowish brown, firm clay loam. The substratum, to a depth of 60 inches, is brown, firm loam.

Included with these soils in mapping are small areas where slope is less than 12 percent, a few areas of the steep Hennepin-Miamian soil complex, and a few areas of Wynn soils that are moderately deep to bedrock. Also included are a few areas of severely eroded soils that have a calcareous gravelly clay loam surface layer, and a few areas of soils that formed in glacial till of Illinoian age.

Permeability is moderately slow in the Miamian soil. It is moderate in the upper part of the subsoil and moderately slow in the lower part of the subsoil and in the substratum in the Russell soil. The available water capacity is moderate in the Miamian soil and high in the Russell soil. Surface runoff is rapid on both soils. The surface layer varies in reaction as a result of local liming practices. The organic-matter content is low in both soils as a result of the erosion of the surface layer. These soils are very susceptible to gully and rill erosion.

These soils have low potential for cultivated crops, medium potential for pasture and hay, and high potential for woodland. Most areas are in pasture or woodland. These soils have low potential for building site development, sanitary facilities, and most recreational uses.

Erosion is a severe hazard on these soils. Using minimum tillage, winter cover crops, and grassed waterways reduces the amount of soil loss. Conventional tillage by plowing and disking is not suitable for these soils. The regular addition or organic matter reduces crusting, increases water infiltration, and raises the fertility level of the soils. Control of erosion is the main management concern.

Using these soils for permanent pasture or hay is effective in controlling erosion. Pasture and hay commonly are grass-legume mixtures, generally bluegrass and clover. Grazing when this soil is wet can cause surface compaction, excess runoff, and poor tilth. The trash-mulch method of pasture renovation can practically eliminate further erosion. Proper stocking and pasture rotation help to keep the pasture and the soil in good condition.

These soils are well suited to trees. Plant competition is a hazard, but tree seeds and seedlings survive and grow if the competing vegetation is controlled. Many of the woodlots are in oak-hickory or beech-maple forest types. Slope is a moderate limitation to the use of some tree harvesting equipment.

The main limitation to use of these soils for building sites and sanitary facilities is slope. The soils do not have sufficient strength and stability to support vehicular traffic, but roads can be built if a suitable base material is used. The moderately slow permeability and slope limit use for septic tank absorption fields. Increasing the leach field or using an alternate leach field can help overcome these limitations.

These soils are in capability subclass IVe; woodland suitability subclass 1o.

MtC2—Miamian-Russell silt loams, bedrock substratum, 6 to 12 percent slopes, moderately eroded. These deep, moderately sloping, well drained soils are on hillsides and along waterways on rolling till plains. Areas are irregular or linear in shape and range from 3 to 50 acres in size.

This map unit is about 60 percent Miamian soil and 30 percent Russell soil. Irregularly shaped areas that surround waterways are more than 60 percent included soils. In the linear areas, the Miamian soil commonly is adjacent to steeper soils on upper parts of hillsides, and the Russell soil is adjacent to gently sloping soils on the smooth, lower parts of hillsides. In the irregularly shaped areas, the Miamian soil is on the slope breaks and the Russell soil is in the smoother areas.

Typically, the Miamian soil has a brown, friable silt loam surface layer about 8 inches thick. The subsoil is about 17 inches thick. The upper part is dark yellowish brown, friable silty clay loam, and the lower part is dark yellowish brown, firm heavy clay loam that is 3 percent igneous pebbles and limestone fragments. The substratum, to a depth of about 57 inches, is calcareous till of yellowish brown stony clay loam and 15 to 30 percent limestone flagstones. Bedrock of Ordovician shale and limestone is at a depth of 57 inches.

Typically, the Russell soil has a surface layer of dark brown, friable silt loam about 6 inches thick. The subsoil is about 27 inches thick. The upper part is brown, firm silt loam and silty clay loam, and the lower part is strong brown, brown, and yellowish brown, firm stony clay loam that is about 3 percent igneous pebbles and limestone fragments. The substratum, to a depth of about 57 inches, is till of brown, firm, calcareous stony clay loam that is 15 to 30 percent limestone fragments. Bedrock of Ordovician shale and limestone is at a depth of 57 inches.

Included with these soils in mapping are small areas of gently sloping Russell-Miamian, bedrock substratum, soils on higher landscape positions. Also included on the same landscape positions, are small areas of Wynn soil and Miamian-Russell soils. Small areas of included soils are severely eroded and have a surface layer of calcareous pebbly or flaggy clay loam.

Permeability is moderately slow in the Miamian soil. It is moderate in the upper part of the subsoil and moderately slow in the lower part of the subsoil and in the substratum in the Russell soil. The available water capacity is low in the Miamian soil and moderate in the Russell soil. Surface runoff is medium for both soils. The surface layer varies in reaction as a result of local liming practices. The organic-matter content is low in both soils as a result of the erosion of the surface layer. These soils are very susceptible to gully and rill erosion.

These soils have medium potential for farming, and most areas are used for corn and soybeans. These soils have high potential for pasture, hay, and woodland. They have medium potential for building site development, medium to low potential for sanitary facilities, and medium potential for many recreational uses.

The hazard of erosion is severe. Using minimum tillage, winter cover crops, grassed waterways, stripcropping and contour farming, however, will reduce soil loss. These soils crust after rain, but the regular addition of crop residue and other forms of organic matter can reduce crusting and increase the fertility level. The internal drainage of these soils is adequate for farming. Measures to conserve soil moisture, such as minimum tillage and soil mulching, can benefit most crops. The regular addition of fertilizer and other soil amendments, as recommended by soil tests, can also benefit crops. Control of erosion and maintenance of fertility and organic-matter content are the main management concerns.

Using these soils for permanent pasture or hay is very effective in controlling erosion. Pasture and hay commonly are grass-legume mixtures, generally bluegrass and clover. Grazing when the soil is wet can cause surface compaction, excessive runoff, and poor tilth. The trash-mulch method of pasture renovation minimizes erosion. Proper stocking and pasture rotation help to keep pastures and soils in good condition.

These soils are well suited to trees. Plant competition is a limitation, but tree seeds and seedlings survive and grow well if competing vegetation is controlled. Many wooded areas are in oak-hickory or beech-maple types of forest. Plant competition is the only limitation to planting trees on these soils.

These soils are suitable for homesites. They are moderately well suited to most recreational uses. They do not have sufficient strength and stability to support vehicular traffic, but roads can be built if a suitable base material is used. The moderately slow permeability limits use of these soils for septic tank absorption fields. Increasing the leach field or using an alternate leach field can overcome this limitation. Construction sites should be landscaped for draining surface water away from buildings.

The stony glacial till substratum and the shale and limestone bedrock underlying these soils make excavation difficult and expensive. These materials are rippable by heavy equipment, however, and excavations rarely require blasting. The many flagstones in the till makes compaction of pond embankments difficult and may cause piping. Ground water flowing on the surface of the bedrock seeps into excavations if not intercepted and diverted.

These soils are in capability subclass IIIe; woodland suitability subclass 1o.

MuC—Miamian-Urban land complex, sloping. This map unit consists of moderately sloping to moderately steep, well drained, deep Miamian soils and Urban land. It is on upland hillsides and foot slopes in valleys partly filled with till. Areas range from 5 to 400 acres in size.

This map unit is 50 to 65 percent Miamian soils and 20 to 35 percent Urban land. The Miamian soils and Urban land are so intricately mixed, or so small in extent, that it is not practical to map them separately.

Typically, the Miamian soil has a surface layer of brown, friable silt loam about 6 inches thick. The subsoil is about 20 inches thick. The upper part is yellowish brown, friable silty clay loam, and the lower part is dark yellowish brown, firm clay loam. The substratum, to a depth of 60 inches, is glacial till of yellowish brown, firm, calcareous loam. The till is variable in thickness, but is generally at least 4 feet thick over bedrock. It is about 10 percent small limestone fragments.

Urban land is covered by streets, parking lots, buildings, and other structures that obscure or alter the original soil so that identification is not feasible.

Included in mapping, and making up about 30 percent of the unit, are small areas of well drained Russell soils that have a thicker loess mantle and less clay in the subsoil than the Miamian soil. Also included are small areas of Miamian-Russell silt loam, bedrock substratum, that has a layer of stony till over the bedrock, commonly at a depth of 55 to 72 inches.

Most areas of this map unit are artificially drained by sewer systems and gutters. Permeability is moderately slow in the Miamian soils. The available water capacity is moderate, and surface runoff is medium. The subsoil ranges from medium acid to mildly alkaline. The surface layer varies widely in reaction as a result of past liming practices. Organic-matter content is low as a result of the loss of surface soil by erosion. The surface layer has a tendency to become cloddy if worked when wet. Root development is restricted below a depth of about 24 inches by the dense, compact, glacial till. The silty surface layer and long slopes of the Miamian soils make them susceptible to rill and gully erosion, especially if left bare for long periods.

The Miamian soils are used for parks, open space, building sites, lawns, and gardens. They have medium potential for lawns, vegetable and flower gardens, trees, and shrubs. Potential is medium for recreational areas and building site development.

Perennials selected for planting should have a tolerance for high pH (alkaline soil). Because of the silty surface layer and upper part of the subsoil, erosion can be a hazard, especially where the soil is disturbed and left bare for a considerable period. The surface layer also has a tendency to puddle during rains and crust upon drying. Areas that have been cut or filled are not well suited to lawns and gardens. The clayey subsoil material that is exposed has poor tilth. It is sticky when wet and hard when dry.

This map unit is suitable for homesites. It is moderately well suited to most recreational uses. The Miamian soils do not have sufficient strength and stability to support vehicular traffic, but roads can be built if suitable base material is used. The moderately slow permeability limits use for septic tank absorption fields. A larger leach field or an alternate leach field can help overcome this limitation. Homesites should be landscaped so that surface drainage is away from buildings. Onsite investigation is needed to determine hazards, limitations, and suitability for use of individual areas.

Miamian soils in capability subclass IIIe; woodland suitability subclass 1o. Urban land is not assigned to a capability subclass or a woodland suitability subclass.

OcA—Ockley silt loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on stream terraces and outwash plains. Most areas are irregular and broad in shape and range from 3 to 100 acres in size.

Typically, the surface layer is dark brown, friable silt loam about 9 inches thick. The subsoil is about 41 inches thick. The upper part is dark brown, friable, light silty clay loam; the middle part is dark brown, firm silty clay loam; and the lower part is dark brown, friable clay loam, loam, or sandy clay loam. The substratum, to a depth of 60 inches, is brown stratified sand and gravel.

Included with this soil in mapping are a few low areas of moderately well drained Thackery soils and well drained, moderately deep Eldean soils on slight rises. Small intermingled areas of soils have a loam surface layer. Also included are areas of soils that have a silty mantle that is much thicker than normal, extending to a depth of 80 inches or more.

Permeability is moderate in the surface layer and subsoil and very rapid in the substratum. This soil warms early in spring, and can be planted early. Available water capacity is moderate. Runoff is slow. The root zone is deep for most of the annual crops commonly grown, but roots generally do not extend into the substratum. The surface layer is moderate in organic-matter content.

Most of the acreage of this soil is used for farming for which it has high potential. It also has high potential for pasture, woodland, and wildlife. It has medium to high potential for most building site development and sanitary facilities and high potential for recreational uses.

This soil has no features that limit its use for field crops or pasture. Where management is improved or optimum, there is little or no erosion hazard. This soil is well suited to irrigation. It is suited to minimum tillage. Maintenance of fertility and organic-matter levels is a major concern of management.

This soil is well suited to a variety of pasture crops, but it rarely is used as permanent pasture because of its suitability for more valuable corps.

This soil is well suited to trees, and a few small areas are in hardwoods. A wide variety of suited species are in most forests. Where new plantings are made, plant competition from grasses and shrubs is a concern.

This soil is well suited as building sites and for recreational uses, but it is limited for some sanitary facilities because of the very rapid permeability in the substratum. There is a hazard of pollution of underground water supplies by seepage from sanitary facilities. Storm sewers are needed in urban areas to handle storm water runoff. Numerous large gravel pits operate on this map unit, and it is a good source of gravel and sand.

This soil is in capability class I; woodland suitability subclass 1o.

OcB—Ockley silt loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on stream terraces. It is generally on toe slopes that are next to the upland. Areas commonly are irregular or linear in shape and range from 3 to 25 acres in size.

Typically, the surface layer is dark brown, friable silt loam about 7 inches thick. The subsoil is about 41 inches thick. The upper part is dark brown, friable light silty clay loam; the middle part is dark brown, firm silty clay loam; and the lower part is dark brown, friable clay loam, loam, or sandy clay loam. The substratum, to a depth of 60 inches, is stratified sand and gravel.

Included with this soil in mapping are small, intermingled areas of moderately eroded Ockley soils and small areas of gently sloping Thackery soils on lower slopes. Also included are a few small areas of gently sloping Eldean soils.

Permeability is moderate in the surface layer and subsoil and very rapid in the substratum. This soil warms early in spring and is well suited to crops that are important to local farming. Available water capacity is moderate. Runoff is medium. The surface layer is moderate in organic-matter content. The root zone is deep for most of the annual crops commonly grown, but roots generally do not extend into the substratum. Natural fertility is medium.

Most of the acreage of this soil is used for farming, for which it has high potential. It also has high potential for pasture, woodland, and wildlife. It has high potential for most building site development, sanitary facilities, and recreational uses.

This soil is well suited to corn, soybeans, wheat, and hay. There is a moderate hazard of erosion if this soil is cultivated. Minimum tillage or contour tillage and winter cover crops reduce soil loss. If erosion is controlled, the soil is well suited to irrigation. Returning crop residues to the soil or the regular addition of other organic material helps to improve fertility and increase water infiltration. Maintenance of fertility and organic-matter content and control of erosion are the main management concerns.

This soil is well suited to a variety of pasture crops, but it rarely is used as permanent pasture because of its suitability for more valuable crops.

This soil is well suited to trees, and a few small areas remain in native hardwoods. Most forests have a wide variety of adapted species. Where new plantings are made, plant competition from grasses and shrubs is a concern.

This soil is well suited as building sites and for recreational uses, but it is limited for some sanitary facilities because of the very rapid permeability in the substratum. There is a hazard of pollution of underground water supplies by seepage from sanitary facilities. Storm sewers are needed in urban areas to handle storm water runoff.

This soil is in capability subclass IIe; woodland suitability subclass 1o.

Pa—Patton silty clay loam. This soil is in low, nearly level or depressional areas throughout the county. It is subject to ponding as a result of runoff from higher, adjacent soils. The largest areas are in long, wide valleys that were glacial lakes. Smaller areas are associated with upland, terrace, or alluvial deposits throughout the county. In the uplands, the soil typically is in low, oblong basins 3 to 15 acres in size. These depressions are surrounded by till or bedrock slopes, and there is no well established outlet for surface runoff.

Typically, the surface layer is very dark gray, friable silty clay loam about 7 inches thick. The subsurface layer, about 6 inches thick, is friable, black silty clay loam mottled with yellowish brown. The subsoil is about 23 inches thick. The upper part is dark gray, mottled, firm, silty clay loam, and the lower part is dark grayish brown, mottled, firm silty clay loam. The substratum, to a depth of 65 inches, is dark grayish brown and grayish brown, stratified, mottled light silty clay loam and silt loam.

Included with this soil in mapping are small areas of Eel and Shoals soils that are along small waterways and are subject to flooding. Both soils have a lighter colored surface layer than the Patton soil. Small areas of lighter colored, better drained Henshaw and Uniontown soils on slight rises are included. This pattern of soils is mainly in the two large valleys. Also included are areas of soils in which the subsoil ranges from 35 to 40 percent clay.

This Patton soil has high organic-matter content in the surface layer. Permeability is moderate, and available water capacity is very high. Surface runoff is slow. Unless artificially drained, the water table is seasonally high for extended periods. The root zone is neutral. In drained areas, it is deep enough for such commonly grown annual crops as corn and soybeans.

If adequately drained, this soil is suited to crops commonly grown in the county and is important locally for farming. It is used mainly for corn and soybeans. Some areas have been developed for industrial, commercial, and residential uses. Most undrained areas are used for pasture or woodland. The soil has low potential for most building site development, sanitary facilities, and recreational uses.

Wetness is a hazard. This soil dries slowly in spring because of the seasonal high water table. Because the surface layer and subsoil are moderately fine textured, the soil has a tendency to shrink and swell, which is a hazard to seedlings. It is highly susceptible to compaction if worked when wet. Subsurface drainage lines and surface ditches are effective if adquate outlets can be established. Returning crop residue to the soil improves fertility, reduces crusting, and increases water infiltration. Maintenance of fertility and control of wetness are the main management concerns.

This soil is poorly suited as building sites and for sanitary facilities because of wetness and the seasonal high water table. Homesites should be located on any slightly higher included soils if possible. Subsurface drains are commonly used to lower the water table in areas where suitable outlets are available. Landscaping building sites helps to keep surface water away from foundations. Local roads can be improved by artificial drainage and using a suitable base material.

This soil is in capability subclass IIw; woodland suitability subclass 2w.

Pg—Pits, gravel. These consist of open excavations from which gravel was taken or is now being taken for use in construction and road building. This miscellaneous area generally is on terraces and flood plains underlain by glacial outwash. It is associated with Eldean, Genesee, Ross, Ockley, and other soils underlain by gravelly and sandy outwash. Areas range from 3 to 50 acres in size. Some actively mined pits are being enlarged.

The soil material in Pits, gravel, consists of layers of gravel and sand that are variable in thickness and in orientation. The kinds of aggregate and the sizes of grains are fairly uniform within a layer, but they are likely to differ considerably from the material in an adjacent layer. Some layers contain an appreciable amount of silt and sand. These areas are selectively mined so that the desirable kinds of aggregate can be obtained. Many gravel pits contain large piles of sand or other sorted materials being held for future sale.

Nearly all the large aggregates are rounded. Quartz, granite, and other siliceous materials are common, but limestone pebbles are dominant. Most areas also contain dolomite, but the amount is variable. In some places, a weakly bonded conglomerate has formed through cementation of calcareous material. Limestone and shale are generally of local origin.

Where the gravel has been removed, the exposed soil material is low in content of organic matter and available moisture capacity, and it is poorly suited to plants. The exposed soil material is so unstable that most areas are subject to erosion and are a potential source of sediment.

If areas that are no longer being mined are treated, plants can be established to reduce erosion. Grasses and trees that can tolerate low moisture and unfavorable soil properties should be selected for seeding and planting.

The large pits are outlined on the soil map. Small pits less than 2 acres in size are indicated on the map by special spot symbols.

Ponded areas are potentially suitable for wildlife habitat and recreational facilities.

Pits, gravel, is not assigned to a capability subclass or a woodland suitability subclass.

PrB—Princeton sandy loam, 2 to 8 percent slopes. This deep, gently sloping, well drained soil is on slight rises and knolls on terraces and in lacustrine, or former lake-bed, areas. Some areas are on foot slopes of till-filled valleys. A few areas on upland till plains are dune-like knolls that rise above the surrounding landscape. Most areas have rather short, irregular slopes and range from 2 to 20 acres in size.

Typically, the surface layer is brown, friable sandy loam about 9 inches thick. The subsoil is about 36 inches thick. The upper part is dark brown, firm heavy loam; the middle part is dark brown, firm sandy clay loam; and the lower part is mixed dark brown and reddish brown, friable heavy sandy loam. The substratum, to a depth of about 72 inches, is brown, very friable loamy sand that has thin layers of lighter or heavier textured material.

Included with this soil in mapping are small areas of soils that have a loam or silt loam surface layer. Princeton soils are commonly adjacent to areas of Ockley, Eldean, Uniontown, and Patton soils, and small areas of those soils are included in mapping. Included in the preglacial Little Miami River Valley, north of Monroe, between the Warren County line and Excello, are a few islandlike knolls of nearly level Patton soils. These soils are similar to Princeton soils to a depth of about 45 inches, but are underlain by mottled silty clay loam to silty clay lacustrine material instead of loamy sand.

Permeability of the Princeton soil is moderate in the surface layer and subsoil and moderately rapid in the substratum. Available water capacity is moderate and runoff is medium. The soil has moderate organic-matter content in the surface layer and good tilth. It is medium acid to slightly acid in the rooting zone of most crops.

Most areas of this soil are used for crops. Corn, soybeans, small grain, and hay are the main crops, and the soil has high potential for these crops if properly managed. It also has high potential for pasture, woodland, and openland or woodland wildlife habitat. It has high potential for building site development and sanitary facilities.

Erosion is a moderate hazard if this soil is cultivated. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some slopes are too irregular to be suited to stripcropping. Returning crop residues to the soil or the regular addition of other organic material helps to improve fertility and increase water infiltration. Maintenance of lime, fertility, and organic-matter levels and control of erosion are the main management concerns.

This soil is well suited to a variety of pasture crops, but it rarely is used as permanent pasture because of its suitability for more valuable crops.

This soil is well suited to trees, and a few small areas remain in hardwoods. Most forests have a wide variety of adapted species. Woodland improvement for timber production requires exclusion of undesirable species and poorly formed trees. Where new plantings are made, plant competition from grasses and shrubs is a concern.

This soil is well suited to septic tank absorption fields, but it is too permeable for sewage lagoons or landfills. Pond embankments constructed on this soil have low strength and need additional clay. Sloughing limits the excavation of trenches; therefore, trench sides need to be shored up. The included wet, darker colored soils should be avoided as building sites. Because the soil is moderately affected by frost action, a suitable base material must be used if roads and streets are constructed. This soil is a poor source of sand, because it has excess fines.

This soil is in capability subclass IIe; woodland suitability subclass 1o.

Ra—Ragsdale silty clay loam. This nearly level, deep, very poorly drained soil is on the Wisconsin glacial till plain. It is in long, narrow, and depressional areas or in shallow basins. This soil is subject to ponding as a result of runoff from higher, adjacent soils. Areas commonly range from 3 to 200 acres in size.

Typically, the surface layer is very dark gray, friable light silty clay loam about 12 inches thick. The subsoil is about 38 inches thick. The upper part is dark gray and gray, mottled, firm silty clay loam, and the lower part is yellowish brown, mottled light silty clay loam. The substratum, to a depth of 72 inches, is yellowish brown, mottled, friable silt loam.

Included with this soil in mapping are small intermingled areas of Raub soils in which the lower part of the subsoil formed in glacial till and soils that have a silt loam surface layer. Also included are small linear areas of Fincastle or Xenia soils along the boundaries of this soil and small areas of Patton soils, generally in the lowest part of the depression.

This Ragsdale soil has slow permeability and high available water capacity. Runoff is slow. The soil has a seasonal high water table but if adequately drained, it provides a deep rooting zone for most commonly grown annual crops. The surface layer is high in organic-matter content and in ability to store and release plant nutrients.

If adequately drained, this soil is well suited to crops commonly grown in the county, such as corn and soybeans. It has high potential for pasture, woodland, and wildlife habitat. It has low potential for building site development, sanitary facilities, and recreational uses.

Wetness is a hazard. The soil dries slowly in spring because of the seasonal high water table. It can be drained by subsurface drainage lines and surface ditches if adequate outlets are established. It is highly susceptible to compaction if worked when wet. Returning crop residues to the soil improves fertility, reduces crusting, and increases water infiltration. Maintenance of fertility and control of wetness are the main management concerns.

If drained, this soil is well suited to pasture or hay. Overgrazing or grazing when the soil is too wet, however, can cause surface compaction and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to hardwood trees. In existing stands, tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by spraying, cutting, or girdling. Wetness is a hazard when planting or harvesting trees.

This soil is poorly suited as building sites and for sanitary facilities because of wetness and the seasonal high water table. Subsurface drains are commonly used to lower the water table if suitable outlets are available. Landscaping building sites helps to keep surface water away from foundations. Local roads can be improved by artificial drainage and using a suitable base material.

This soil is in capability subclass IIw; woodland suitability subclass 2w.

RdA—Raub silt loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained, dark colored soil is on glacial till plains. It is in areas adjacent to and surrounding depressions and drainageways. Areas are rounded and oblong and range from 3 to 20 acres in size.

Typically, the surface layer is black, friable silt loam about 10 inches thick. The subsurface layer is very dark gray silt loam 5 inches thick. The subsoil is about 28 inches thick. The upper part is dark grayish brown, mottled, friable silty clay loam; the middle part is brown, mottled, firm silty clay loam; and the lower part is brown mottled, friable clay loam. The substratum, to a depth of 60 inches, is yellowish brown mottled loam.

Included with this soil in mapping are a few small areas of very poorly drained, dark colored Ragsdale soils in which the lower part of the subsoil formed in silty material rather than in weathered glacial till. Also included are a few small areas of moderately well drained Dana soils in the more sloping areas.

This Raub soil has slow permeability and high available water capacity. Surface runoff is slow. The surface layer is high in organic-matter content, and tilth is good. The rooting zone ranges from medium acid to slightly acid unless limed. The water table is high in winter and spring.

If drained, Raub soil is well suited to crops commonly grown in the county. Most of the acreage is in corn, soybeans, wheat, and hay, and the soil has high potential for these uses if properly managed. It also has high potential for pasture, woodland, and wildlife habitat. It has medium to low potential for most building site development and sanitary facilities and medium potential for most recreational uses.

Drainage is the main management concern if this soil is used for farming. Maintaining good soil structure is also a concern. Soil compaction is a concern when heavy machinery is used. The soil can be used for continuous row crops if management is optimum. It dries slowly in spring, and planting may be delayed in areas not drained.

This soil is suited to both pasture and trees, but rarely is used for either because of its suitability for more valuable crops.

This soil is poorly suited as building sites and for sanitary facilities because of wetness. Performance of septic systems can sometimes be improved by providing an alternate leach field or installing curtain drains around the absorption field to lower the water table. Landscaping building sites helps to keep surface water away from foundations. This soil is better suited to dwellings without basements than to dwellings with basements. Local roads can be improved by artificial drainage and using a suitable base material.

This soil is in capability subclass IIw; woodland suitability subclass not assigned.

RdB—Raub silt loam, 2 to 6 percent slopes. This deep, gently sloping, somewhat poorly drained, dark colored soil is on glacial till plains. It is on foot slopes adjoining the more sloping Russell-Miamian soil complex on higher positions on the landscape and Ragsdale and Raub soils in the lower areas. Areas are oblong or irregular in shape and range from 2 to 30 acres in size.

Typically, the surface layer is black, friable silt loam about 10 inches thick. The subsurface layer is very dark gray silt loam 5 inches thick. The subsoil is about 24 inches thick. The upper part is dark grayish brown, mottled, friable silty clay loam; the middle part is brown mottled, firm silty clay loam; and the lower part is brown mottled, friable clay loam. The substratum, to a depth of 60 inches, is yellowish brown, mottled loam.

Included with this soil in mapping are a few small areas of very poorly drained Ragsdale soils along waterways and in depressions. Also included are intermingled small areas of Dana soils that are better drained than this Raub soil.

This Raub soil has slow permeability and high available water capacity. Surface runoff is medium. The surface layer is high in organic-matter content, and tilth is good. The rooting zone ranges from medium acid to slightly acid unless limed. The water table is high in winter and spring.

If drained, this soil is well suited to crops commonly grown in the county. Most of the acreage is in corn, soybeans, wheat, and hay, and the soil has high potential for these uses if properly managed. It also has high potential for pasture, woodland, and wildlife habitat. It has medium to low potential for most building site development and sanitary facilities and medium potential for most recreational uses.

Drainage and erosion control are the main management concerns if this soil is used for farming. Random subsurface drainage lines are beneficial in draining wet spots. Minimum tillage, contour tillage, and winter cover crops minimize soil loss. Returning crop residues to the soil helps to maintain fertility and increase water infiltration. Maintaining soil fertility, controlling erosion, and drainage are the main management concerns.

This soil is suited to both pasture and trees, but rarely is used for either because of its suitability for more valuable crops.

This soil is poorly suited as building sites and for sanitary facilities as a result of wetness. Performance of septic systems can sometimes be improved by providing an alternate leach field or installing curtain drains around the absorption field to lower the water table. Landscaping building sites helps to keep surface water away from foundations. This soil is better suited to dwellings without basements. Local roads can be improved by artificial drainage and using a suitable base material.

This soil is in capability subclass IIw; woodland suitability subclass not assigned.

Rh—Riverwash. This is a miscellaneous area that consists of nearly level, unstabilized gravelly, sandy, silty, or clayey sediments in or along perennial and intermittent streams. These sediments are subject to flooding and shifting during high water periods. They are flooded and washed or reworked by streams so frequently that they support little or no vegetation. Some areas that are protected from fast flowing water support a scanty growth of willow, cottonwood, elm, sycamore, and low shrubs.

Accessible areas of Riverwash are sources of material for roadbuilding and other kinds of construction. Some areas are a good local source of gravel and sand. This miscellaneous area, however, is used mainly as wildlife habitat.

Riverwash is not assigned to a capability subclass or a woodland suitability subclass.

Rn—Ross loam. This soil is deep, dark colored, nearly level and well drained. It is on flood plains and is commonly flooded. Areas are irregular in shape and range from 5 acres to more than 200 acres in size. Slope ranges from 0 to 2 percent.

Typically, the surface layer is very dark brown, friable loam in the upper 11 inches, and it is black, friable silt loam in the lower 6 inches. The subsoil is 21 inches thick. The upper part is very dark grayish brown, friable silt loam, and the lower part is dark yellowish brown loam. The substratum, to a depth of 60 inches, is dark brown or dark yellowish brown sandy loam or sandy clay loam. In many areas, less than 24 inches of dark colored material is in the upper part of the soil.

Included with this soil in mapping are small areas of moderately well drained Eel soils and well drained Genesee and Landes soils. All of these are slightly lower on the landscape than this Ross soil.

This Ross soil has moderate permeability and high available water capacity. Runoff is slow. The soil is subject to occasional very brief flooding from November through June. The rooting zone is deep. The surface layer is high in organic matter, and the soil is highly fertile.

This soil has high potential for crops, and most areas are used for corn, soybeans, wheat, or hay. This soil also has high potential for pasture, woodland, and wildlife habitat. It has low potential for building site development and sanitary facilities and medium potential for many recreational uses.

This soil is one of the most fertile and highly productive soils in the county. Flooding generally does not occur during the growing season of corn and soybeans, and these crops commonly can be grown without flood damage. The natural drainage of the soil is adequate for farming. The addition of soil amendments and fertilizer, as recommended by soil tests, keeps the soil highly productive. Measures to conserve soil moisture will benefit crops during dry years.

This soil is well suited to pasture. Because the flooding is of brief duration, most pastures are not damaged. Grazing when the soil is wet can cause surface compaction and lower yields. Proper stocking, pasture rotation, and restricted use during droughty periods keep the pasture and soil in good condition.

This soil is well suited to trees, but few areas are wooded because it is also suitable for more valuable crops. Flooding generally does not damage trees. There are no limitations for growing or harvesting such trees as black walnut.

This soil is poorly suited as building sites and for sanitary facilities because it floods. Some recreational uses are limited for the same reason.

This soil is a good source of topsoil. Protective levees have been built in some areas, and where protected from flooding, the soil is suited to some nonfarm uses.

This soil is in capability class 1; woodland suitability subclass 1o.

RpB—Rossmoyne silt loam, 2 to 6 percent slopes. This deep, gently sloping, moderately well drained soil is on the Illinoian glacial till plain. This soil is in long, irregularly shaped areas in the extreme southeast or south of the county adjacent to or near the Hamilton County line. These areas are on relatively narrow, convex ridgetops, as much as 1,300 feet wide, between deeply entrenched streams.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is brown silt loam 5 inches thick. The subsoil is about 62 inches thick. The upper part is yellowish brown, friable heavy silt loam and yellowish brown mottled, firm silty clay loam. The middle part is a fragipan of yellowish brown mottled, light clay loam. The lower part is dark yellowish brown, mottled, firm clay loam. The substratum, to a depth of 90 inches, is yellowish brown, firm light clay loam.

Included with this soil in mapping are small, nearly level areas of the wetter Avonburg soils. Also included are some moderately eroded soils on ridgetops and around shallow waterways. In these soils the plow layer is a mixture of the original surface and subsurface layers and material from the subsoil. The subsoil material makes this soil stickier and not so easy to till as the uneroded Rossmoyne soil. In a few areas the fragipan is weakly developed or there is no fragipan.

Permeability in this Rossmoyne soil is moderate above the fragipan and moderately slow or slow in and below the fragipan. The fragipan restricts the movement of water through the soil. Surface runoff is medium. The root zone is limited above the fragipan and is moderately deep. It is strongly acid unless limed. The root zone has moderate available water capacity. This soil generally is saturated above the fragipan during wet periods in winter and spring. It has a low level of organic matter.

This soil is suited to crops commonly grown in the county, but because it is near Cincinnati and interstate roads, much of the limited acreage is in residential use. A few areas are in crops or large gardens. Several areas are either idle or in pasture or woodland. One area is used for recreation. The soil has high potential for pasture, woodland, and wildlife habitat. It has low potential for building site development and sanitary facilities and a high to medium potential for most recreational uses.

The hazard of erosion is moderate if this soil is cultivated. Minimum tillage or contour tillage and winter cover crops help prevent excessive soil loss. Returning crop residues to the soil or the addition of other organic material improves fertility, reduces crusting, and increases water infiltration. Natural drainage is generally adequate for farming, but random subsurface drainage lines are beneficial in draining wet spots in some areas. Maintenance of fertility and organic-matter levels and control of erosion are the main management concerns.

This soil is suited to pasture crops, but it rarely is used for permanent pasture because of its suitability for more valuable crops.

The use of this soil as building sites is limited by wetness. Subsurface or surface drainage is required to reduce wetness. The moderately slow or slow permeability limits the use of the soil for septic tank absorption fields, but increasing the size of the absorption area or providing an alternate leach field can help overcome this limitation. Because the soil is highly susceptible to frost action, the surface layer must be removed and replaced with proper base material before local roads are constructed, and footings and foundations for homes without basements must be constructed below the frost line. This soil is better suited to dwellings without basements than to dwellings with basements. The moderately slow or slow permeability is a limitation for camp areas and playgrounds. The included areas of wetter Avonburg soil should be avoided as building sites.

This soil is in capability subclass IIe; woodland suitability subclass 2o.

RtB—Russell silt loam, 2 to 6 percent slopes. This gently sloping, deep, well drained soil is on slight rises and low rounded knolls of till plains, where some of the till has been water worked and sorted. Most areas range from 3 to 30 acres in size and are mostly rounded or crescent in shape.

Typically, the surface layer is dark grayish brown silt loam about 8 inches thick. The subsoil is about 30 inches thick. The upper part is brown, firm silty clay loam; the lower part is strong brown, brown, and yellowish brown, firm clay loam. The substratum, to a depth of about 60 inches, is brown loam.

Included with this soil in mapping are small areas of soils which are similar to the Ockley soils but have a till substratum. These soils are on the lower parts of side slopes. They make up 10 to 15 percent of some of the larger mapped areas.

This Russell soil has moderate permeability in the upper part of the subsoil and moderately slow permeability in the lower part of the subsoil and in the substratum. Available water capacity is high. Surface runoff is medium. Reaction in the root zone is medium acid to mildly alkaline and becomes more alkaline with increasing depth. Organic matter content is low. The silty surface layer is friable and easily tilled throughout a fairly wide range of moisture content. It has a tendency to crust or puddle after hard rain.

Most of the acreage of this soil is used for the field crops commonly grown in the county. The soil has high potential for farming, hay, pasture, and trees and medium to high potential as building sites and for sanitary facilities.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If it is used for cultivated crops, there is a moderate hazard of erosion, especially on the longer slopes. Minimum tillage, winter cover crops, and grassed waterways reduce excessive soil loss. In a few areas, slopes are long and smooth enough to be farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material improves fertility, increases water infiltration, and reduces crusting.

Use of this soil for pasture or hay is also effective in controlling erosion. Grazing when this soil is too wet will cause surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees, and a few small areas remain in hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation and by spraying, cutting, or girdling. There are no hazards or limitations when planting or harvesting trees.

This soil is moderately well suited as building sites and for septic tank absorption fields if proper design and installation procedures are used. Because it does not have sufficient strength and stability to support vehicular traffic when wet, the base material needs to be strengthened or replaced if this soil is used for roads. The moderately slow permeability limits its use for septic tank absorption fields; but increasing the size of the absorption area or providing an alternate leach field can help overcome this limitation. Excessive seepage from sewage lagoons can be reduced by special clay treatment that seals the bottom of the lagoon.

This soil is in capability subclass IIe; woodland suitability subclass 1o.

RvB—Russell-Miamian silt loams, 2 to 6 percent slopes. These deep, gently sloping, well drained soils are on upland ridges and long smooth hillsides. They are also on large convex rises and foot slopes in valleys that have been partly filled with till by glacial action. Individual areas are irregular in shape and range from 3 to 100 acres in size.

This map unit is about 50 percent Russell silt loam and 30 percent Miamian silt loam. Russell soil is generally on the mid and lower parts of smooth or concave side slopes and on the broader ridgetops. Miamian soil is generally on narrow convex ridges, slope breaks, and sides of drainageways, especially where the topography is somewhat hummocky. The two soils are so intricately mixed, or so small that it is not practical to separate them in mapping.

Typically, Russell soil has a dark brown friable silt loam surface layer about 8 inches thick. The subsoil is about 30 inches thick. The upper part is brown, friable silt loam and firm silty clay loam, and the lower part is strong brown, brown, and yellowish brown, firm clay loam. The substratum, to a depth of about 60 inches, is brown, firm loam. The till substratum is variable in thickness but is generally at least 4 feet thick over bedrock.

Typically, the Miamian soil has a brown friable silt loam surface layer about 6 inches thick. The subsoil is about 20 inches thick. The upper part is yellowish brown, friable silty clay loam, and the lower part is dark yellowish brown, firm clay loam. The substratum, to a depth of 60 inches, is yellowish brown, firm calcareous loam that is variable in thickness. It is generally at least 4 feet thick over bedrock and is about 10 percent small limestone fragments.

Included with these soils in mapping, and making up about 10 percent of the unit, are small areas of Russell-Miamian, bedrock substratum, soils on higher landscape positions. These soils are more than 15 percent stone fragments in the lower part of the subsoil and in the substratum. Also included are small areas of moderately well drained Xenia soils on the lower part of side slopes. Many areas have small yellowish brown eroded spots.

Permeability is moderate in the upper part of the subsoil and moderately slow in the lower part of the subsoil and in the substratum in the Russell soil. It is moderately slow in the Miamian soil. Available water capacity is high in the Russell soil and moderate in the Miamian soil. Surface runoff is medium from both soils. Reaction ranges from medium acid to mildly alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices. The organic-matter content of these soils is low. The surface layer is friable and easily tilled throughout a fairly wide range of moisture content. It has a tendency to puddle during rain and crust upon drying. Root development is restricted below a depth of about 38 inches in the Russell soil and below a depth of about 26 inches in the Miamian soil by compact, loamy glacial till. The silty surface layer and long slopes make these soils especially susceptible to further sheet and rill erosion.

Most of the acreage of these soils is used for farming. They have high potential for cultivated crops, hay, pasture, and trees. They have medium to high potential as building sites and for sanitary facilities.

These soils are suited to corn, soybeans, small grains, and grasses and legumes for hay and pasture. Where used for cultivated crops, there is a moderate hazard of erosion. Maintenance of tilth is a major management concern. Tillage, cover crops, contour farming, and grassed waterways help prevent further erosion. In many areas slopes are long enough and smooth enough to be strip-cropped or terraced and farmed on the contour. Returning crop residues to the soil and adding barnyard manure increase organic-matter content, improve ferility, reduce crusting, and increase water infiltration.

Use of these soils for pasture or hay is also effective in reducing erosion. Grazing when the soil is too wet can cause surface compaction, excessive runoff, and poor tilth. Pasture rotation and restricted use during wet periods are important.

These soils are well suited to trees, and some small areas remain in native hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation or by spraying, cutting, or girdling. There are few soil limitations to planting or harvesting trees.

Many of these soils are good homesites. They are well suited to recreational uses. Because they do not have sufficient strength and stability to support vehicular traffic, the base material needs to be strengthened or replaced if these soils are used for roads. The moderately slow permeability limits use of the soils for septic tank absorption fields, but can be overcome by increasing the absorption area or by providing an alternate leach field. Construction sites should be landscaped to drain surface water away from the buildings.

These soils are in capability subclass IIe; woodland suitability subclass 1o.

RvB2—Russell-Miamian silt loams, 2 to 6 percent slopes, moderately eroded. These deep, gently sloping, well drained soils are on long smooth side slopes and upland ridges. Many larger areas have shallow waterways. Areas are irregular in shape and range from 3 to 100 acres in size.

This map unit is about 50 percent Russell silt loam and 30 percent Miamian silt loam. Included soils make up the other 20 percent. The Russell soil is generally on the mid and lower parts of smooth or concave side slopes. The Miamian soil is generally on slope breaks and narrow convex ridges and is adjacent to waterways. It is dominant where the landscape is hummocky and where erosion has removed some of the loess mantle. The two soils are so intricately mixed, or so small in extent, that it is not practical to separate them in mapping.

Typically, the Russell soil has a surface layer of dark brown, friable silt loam about 7 inches thick. The subsoil is about 29 inches thick. The upper part is brown, friable silt loam and firm silty clay loam, and the lower part is strong brown, brown, and yellowish brown, firm clay loam. The substratum, to a depth of about 60 inches, is brown, firm loam. The till substratum is variable in thickness, but is generally at least 4 feet thick over bedrock.

Typically, the Miamian soil has a brown, friable silt loam surface layer about 5 inches thick. The subsoil is about 19 inches thick. The upper part is yellowish brown, friable silty clay loam; and the lower part is dark yellowish brown, firm clay loam. The substratum, to a depth of 60 inches, is yellowish brown, firm, calcareous loam till that is about 10 percent small limestone fragments.

Included with these soils in mapping are small areas of Russell-Miamian, bedrock substratum, soils on higher landscape positions. These soils are more than 15 percent stone fragments in the lower part of the subsoil and in the substratum. Also included are small areas of Xenia soils on the lower parts of slopes and spots of severely eroded soils that have a calcareous pebbly or flaggy clay loam surface layer. These spots are designated on the soil map by the severely eroded symbol.

Permeability is moderate in the upper part of the subsoil and moderately slow in the lower part of the subsoil and in the substratum in the Russell soil, and it is moderately slow in the Miamian soil. Rooting is restricted by the compact till. Available water capacity is high in the Russell soil and moderate in the Miamian soil. Reaction ranges from neutral to medium acid in the surface layer and from medium acid to mildly alkaline in the subsoil. Organic-matter content is low as a result of the loss of surface soil by erosion. The surface layer has a higher clay content than that of uneroded soils. It has a tendency to puddle during rain and crust upon drying. Runoff is medium. The silty nature of the surface layer and long slopes make these soils especially susceptible to further sheet and rill erosion.

Most of the acreage of these soils is used for farming. They have high potential for farming and medium to high potential for building site development and sanitary facilities.

These soils are suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. When used for cultivated crops, there is a moderate erosion hazard. Maintenance of tilth is a major management concern. Minimum tillage, cover crops, contour farming, and grassed waterways help prevent further erosion. Many areas have long, smooth slopes that can be stripcropped or terraced. Returning crop residue to the soil and adding barnyard manure increase the organic-matter content, reduce crusting, and increase water infiltration.

Using these soils for pasture or hay is also effective in reducing erosion. Grazing when the soil is too wet can cause compaction, excessive runoff, and poor tilth. Pasture rotation and restricted use during wet periods are important.

These soils are well suited to trees, and some small areas remain in native hardwoods. Plant competition is moderate. There are few limitations to planting or harvesting trees.

These soils are suited to homesites and are well suited to recreational uses. The moderately slow permeability limits use of the soils for septic tank absorption fields, but this limitation can be overcome by increasing the size of the absorption area or providing an alternate leach field. Homesites should be landscaped so that surface drainage is away from buildings.

These soils are in capability subclass IIe; woodland suitability subclass 1o.

RwB—Russell-Miamian silt loams, bedrock substratum, 2 to 6 percent slopes. These deep, gently sloping, well drained soils are on high upland ridges and on crests and long smooth sides of glaciated bedrock hills. Individual areas are irregular in shape and range from 3 to 75 acres in size.

This map unit is about 50 percent Russell soil and 30 percent Miamian soil. The Russell soil is on the mid and lower parts of smooth or concave side slopes and on the broader ridgetops. The Miamian soil is on narrow, convex ridges, slope breaks, and sides of drainageways, especially where the topography is somewhat hummocky. The two soils are so intricately mixed, or so small, that it is not practical to separate them in mapping.

Typically, the Russell soil has a dark brown friable silt loam surface layer about 7 inches thick. The subsoil is about 31 inches thick. The upper part is yellowish brown and dark yellowish brown, friable silty clay loam; the middle part is firm, brown clay loam; and the lower part is strong brown clay loam. The substratum, to a depth of about 60 inches, is brown, firm, loam glacial till. This till is calcareous and contains many angular till pebbles and many limestone flagstones that average about 6 inches across and 2 inches thick. These flagstones make up 15 to 30 percent of the volume of the till. Shale and limestone bedrock is at a depth of about 60 inches.

Typically, the Miamian soil has a surface layer of brown, friable silt loam about 6 inches thick. The subsoil is about 20 inches thick. The upper part is yellowish brown, friable silty clay loam; and the lower part is dark yellowish brown, firm clay loam. The substratum, to a depth of about 60 inches, is yellowish brown, firm, calcareous loam glacial till that is about 20 percent small limestone flagstones. Shale and limestone bedrock is at a depth of about 60 inches.

Included with these soils in mapping, and comprising about 15 percent of the map unit, are small areas of

Wynn soils that have interbedded shale and limestone bedrock at a depth of less than 40 inches. Also included in many mapped areas are small areas of yellowish brown, eroded soils; small areas of Russell-Miamian soils underlain by less stony, deeper glacial till; and small areas of moderately well drained Xenia, bedrock substratum, soils on the lower parts of side slopes.

Permeability is moderate in the upper part of the subsoil and moderately slow in the lower part of the subsoil and in the substratum of the Russell soil. It is moderately slow in the Miamian soil. The available water capacity is moderate for Russell soil and slow for Miamian soil. Surface runoff is medium from both soils. Reaction ranges from medium acid to mildly alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices. Organic-matter content is low. The surface layer is friable and easily tilled throughout a fairly wide range of moisture content. It has a tendency to puddle during rain and crust upon drying. Root development is restricted below a depth of about 39 inches in the Russell soil and below a depth of about 25 inches in the Miamian soil by a compact, dense stony glacial till. The silty nature of the surface layer and long slopes make these soils especially susceptible to sheet and rill erosion.

Most of the acreage of these soils is used for farming. They have high potential for growing cultivated crops, hay, pasture, and trees. They have low to medium potential for building site development and sanitary facilities.

These soils are suited to corn, soybeans, small grain and grasses and legumes for hay and pasture. Where they are used for cultivated crops, there is a serious erosion hazard. Maintenance of tilth is a major management concern. Minimum tillage, cover crops, contour farming, and grassed waterways help prevent further erosion. In many areas, slopes are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residues to the soil and adding barnyard manure increase the organic-matter content, improve fertility, reduce crusting, and increase water infiltration.

Using these soils for pasture or hay is also effective in reducing erosion. Grazing when the soil is wet causes compaction, excessive runoff, and poor tilth. Pasture rotation and restricted use during wet periods are important.

These soils are well suited to trees, and some small areas remain in native hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation or by spraying, cutting, or girdling. There are few soil limitations to planting or harvesting trees.

These soils are suited to homesites and are well suited to recreational uses. Because it does not have sufficient strength and stability to support vehicular traffic, the base material needs to be strengthened or replaced if this soil is used for roads. The moderately slow permeability limits its use for septic tank absorption fields; but this can generally be offset by increasing the size of the absorption area or by providing an alternate leach field. Homesites should be landscaped so that surface drainage is away from buildings.

The stony till and interbedded shale and limestone underlying this map unit makes excavation difficult and expensive; however, the stony till and bedrock is rippable by heavy equipment and rarely requires blasting. The many stones in the till are undesirable in pond embankments. Ground water flowing on the surface of the nearly impervious shale in some areas can seep into excavations if not intercepted and diverted.

These soils are in capability subclass IIe; woodland suitability subclass 1o.

RwB2—Russell-Miamian silt loams, bedrock substratum, 2 to 6 percent slopes, moderately eroded. These deep, gently sloping, well drained soils are on the edges of high upland ridges, crests, and long, smooth side slopes of glaciated bedrock hills. Many of the larger areas are dissected by shallow drainageways. Individual areas are irregular in shape and range from 8 to 90 acres in size. Areas are about 50 percent Russell soil and about 30 percent Miamian soil. Most areas are moderately eroded. Many areas have a few flat limestone flags and igneous pebbles lying on the surface. The Russell soil is on plane or concave, midslope positions and on the broader ridgetops. The Miamian soil is on narrow, convex ridges, slope breaks, and surrounding waterways, especially where the topography is somewhat hummocky and erosion has removed come of the loess mantle. The two soils are so intricately mixed, or so small in extent that it is not practical to separate them in mapping.

Typically, the Russell soil has a dark brown, friable silt loam surface layer about 7 inches thick. The subsoil is about 29 inches thick. The upper part is dark yellowish brown, friable silty clay loam, the middle part is firm, brown clay loam; and the lower part is strong brown clay loam. The substratum, to a depth of about 60 inches, is brown, firm, flaggy loam glacial till. Shale and limestone bedrock is at a depth of about 60 inches.

Typically, the Miamian soil has a surface layer of brown, friable silt loam about 5 inches thick. The subsoil is about 18 inches thick. The upper part is yellowish brown, friable silty clay loam and the lower part is dark yellowish brown, firm clay loam. The subsoil commonly contains some crystalline glacial pebbles and fragments of limestone. The substratum, to a depth of about 60 inches, is yellowish brown, firm, calcareous, flaggy till. Shale and limestone bedrock is at a depth of about 60 inches.

Included with these soils in mapping, and making up about 15 percent of the map unit, are small areas of Wynn soils that have interbedded shale and limestone bedrock at a depth of less than 40 inches. Also included are small areas of Russell-Miamian soils underlain by less stony, deeper glacial till and small areas of moderately well drained Xenia soils on the lower parts of the slopes. In some areas the soils are so severely eroded that the surface layer is mostly pebbly or flaggy glacial till mixed with a remnant of clay loam subsoil. These areas are calcareous on the surface and designated on the soil map by the severely eroded symbol.

Permeability is moderate in the upper part of the subsoil and moderately slow in the lower part of the subsoil and in the substratum of the Russell soil, and it is moderately slow in the Miamian soil. The available water capacity is moderate for Russell soil and low for Miamian soil. Surface runoff is medium from both soils. Reaction ranges from medium acid to mildly alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices. The organic-matter content is low as a result of the loss of surface soil by erosion. The surface layer has a definite tendency to puddle during rain and crust upon drying because it has been mixed with more clayey material from the subsoil. Root development is restricted to the upper 36 inches of the Russell soil and the upper 23 inches of the Miamian soil by a compact, dense, stony glacial till. The silty surface layer and long slopes make these soils especially susceptible to further sheet and rill erosion.

Most of the acreage of these soils is farmed. They have high potential for cultivated crops, hay, pasture, and trees. They have medium potential for building site development and sanitary facilities.

These soils are suited to corn, soybeans, small grains, and grasses and legumes for hay and pasture. When used for cultivated crops, there is a serious erosion hazard. Maintenance of tilth is a major management concern. Minimum tillage, winter cover crops, and grassed waterways help prevent further erosion. In many areas, slopes are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residues to the soil and adding barnyard manure increase the organic-matter content of the soil, improve fertility, reduce crusting, and increase water infiltration.

Using these soils for pasture or hay is also effective in reducing erosion. Grazing when the soil is too wet can cause surface compaction, excessive runoff, and poor tilth. Pasture rotation and restricted use during wet periods are important.

These soils are well suited to trees, and some small areas remain in native hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation or by spraying, cutting, or girdling. There are few soil limitations for planting or harvesting trees.

These soils are suited to homesites and are well suited to recreational uses. Because they do not have sufficient strength and stability to support vehicular traffic, the base material needs to be strengthened or replaced if these soils are used for roads. The moderately slow permeability limits the use of the soils for septic tank absorption fields, but increasing the absorption area or providing an alternate leach field can help overcome this limitation. Homesites should be landscaped so that surface drainage is away from buildings.

The stony till and interbedded shale and limestone underlying this map unit make excavation difficult and expensive; however, the stony till and bedrock is rippable by heavy equipment and rarely requires blasting. The many stones in the till are undesirable in a pond embankment. Ground water flowing over the nearly impervious shale in some areas will seep into excavations if not intercepted and diverted.

These soils are in capability subclass IIe; woodland suitability subclass 1o.

RxB—Russell-Urban land complex, gently sloping. This map unit consists of well drained, deep Russell soils on long, smooth, upland slopes and broad ridgetops between drainageways and areas of urban land. Individual areas are 50 to 65 percent Russell soils and 20 to 35 percent Urban land. They range from 5 to 1,700 acres in size. Large areas of this map unit are in residential Hamilton, Middletown, and Oxford. The largest contiguous area of about 1,700 acres is in the Two Mile Creek Valley on the west side of the city of Hamilton. Another 600 acres is on the east side of Middletown. The Russell soils and Urban land are so intricately mixed or so small in extent that it is not practical to separate them in mapping.

Typically, the Russell soil has a surface layer of dark brown, friable silt loam about 8 inches thick. The subsoil is about 30 inches thick. The upper part is brown, friable silt loam and firm silty clay loam. The lower part is strong brown, brown, and yellowish brown, firm clay loam. The substratum, to a depth of about 60 inches, is brown, firm loam. The substratum is variable in thickness, but is generally at least 4 feet thick over bedrock. Also, the substratum is calcareous and has many angular glacial pebbles and about 10 percent small limestone flagstones.

Urban land is covered by streets, parking lots, buildings, and other structures that obscure or alter the soils so that the original soil cannot be identified.

Included in mapping, and making up 15 to 25 percent of the unit, are small areas of Miamian and Xenia soils. The well drained Miamian soils do not have as thick a loess mantle as the Russell soils, have a higher content of clay in the subsoil, and generally are in higher, convex areas on the landscape. Moderately well drained Xenia soils have gray mottles in the subsoil and are in the lower, less sloping areas. The disturbed soils around buildings and other structures make up about 25 percent of the unit.

Most areas of this map unit are artificially drained by sewer systems and gutters.

The Russell soils have moderate or moderately slow permeability, high available water capacity, and medium surface runoff. The content of organic matter is low. Reaction varies widely in the surface layer and ranges from medium acid to mildly alkaline in the subsoil. The surface layer is friable and easily tilled.

The Russell soils are used for parks, open space, building sites, lawns, and gardens. They have high potential for lawns, vegetable and flower gardens, trees, and shrubs. They have medium potential for recreational areas and for building site development.

The Russell soils are well suited to grasses, flowers, vegetables, trees, and shrubs. Perennial plants selected for disturbed areas where till is at the surface should have a tolerance for high pH (highly alkaline soil). Because of the silty surface layer and upper part of the subsoil, erosion can be a problem (fig. 7), especially where the soils are disturbed and left bare for a considerable period. The surface layer also has a tendency to puddle during rain and crust upon drying. The included spots of cut and fill land are not well suited to lawns and gardens. Clayey subsoil material which is exposed on the surface has poor tilth. It is sticky when wet and hard when dry.

The Russell soils have some limitations for building site development and are well suited to recreational development. Foundations and footings should be designed to prevent structural damage caused by frost action. All sanitary facilities should be connected to municipal sewers and treatment facilities. The silty upper part of the Russell soils will need to be replaced or covered with a suitable base material if local roads and streets are to function properly. Onsite investigation is needed to determine hazards, limitations, and suitability for most intensive nonfarm uses.

The Russell soils are in capability subclass IIe and woodland suitability subclass 1o. Urban land is not assigned to a capability or woodland subclass.

Sh—Shoals silt loam. This deep, nearly level, somewhat poorly drained soil is on flood plains of streams throughout the county, especially where small waterways

Figure 7.—Erosion and sedimentation on a road ditch on Russell-Urban land complex, gently sloping.

from upland areas do not have a well defined channel. It is subject to common flooding. Slope ranges from 0 to 2 percent. Most areas are long and narrow and range from 2 to 25 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The substratum extends to a depth of 60 inches or more. The upper part is dark grayish brown, friable silt loam mottled with yellowish brown; the middle part is dark brown, friable silt loam mottled with brown and yellowish brown and dark grayish brown, friable silt loam mottled with yellowish brown; and the lower part is grayish brown, stratified loam and silt loam mottled with gray and yellowish brown.

Included with this soil in mapping are small areas of very poorly drained, darker colored soils in depressions and along former stream channels. Near the present stream channel and on the slightly higher parts of the flood plain are small areas of the better drained, less mottled Eel and Genesee soils.

This Shoals soil has moderate permeability and very high available water capacity. Runoff is very slow. This soil is subject to flooding, from October to June, and some areas are ponded for brief periods after floodwaters recede. Surface deposits of fresh alluvium and an accumulation of logs, branches, stalks, and other organic debris indicate frequent flooding in most areas. This soil is saturated to near the surface during the wet season, especially in winter and spring. It dries out slowly in spring. It has low organic-matter content. The rooting zone is deep and is commonly mildly alkaline.

The use of this soil depends on the degree of protection from flooding and the extent to which adequate drainage is provided. Some areas in the wider valleys are used for crops. Most areas in the narrower valleys are used as permanent pasture or woodland because of their inaccessibility and the difficulty of providing adequate drainage. This soil has medium potential for crops, pasture, and woodland. It has low potential for building site development and sanitary facilities because of the flood hazard, high frost action, and wetness.

If suitable outlets are available, subsurface drainage is effective in lowering the water table for crop production. This soil is suited to most crops, but winter and spring floods are especially damaging to small grains. Flooding seldom occurs during the growing season, and such crops as corn and soybeans can often be grown without flood damage. This soil is suited to grass and legume pasture, but grazing should be avoided when the soil is wet. Seasonal wetness that restricts the use of equipment is the main limitation to woodland use. Wetness also affects the species of trees to plant.

This soil is poorly suited as building sites and for sanitary facilities because it floods. Some areas are protected by flood control measures, such as levees. The water table can be lowered by surface or subsurface drainage in some areas, making possible some less intensive nonfarm uses of the soil. Streambank stabilization is needed in some areas to control bank cutting. This soil is a good source of topsoil.

This soil is in capability subclass IIw; woodland suitability subclass 2o.

SlA—Sleeth silt loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on glacial outwash terraces and plains. Most areas are long and narrow and are 4 to 50 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 9 inches thick. The subsurface layer is grayish brown, friable silt loam about 3 inches thick. The subsoil is about 33 inches thick. The upper part is brown, mottled silty clay loam; the next part is grayish brown and dark grayish brown, mottled clay loam; and the lower part is dark grayish brown, grayish brown, and mottled sandy clay loam and gravelly sandy clay loam. The substratum, to a depth of 60 inches, is brown, stratified, calcareous sand and gravel.

Included with this soil in mapping are small areas of moderately well drained Thackery soils on the rises; darker colored, moderately well drained Tippecanoe soils at the foot on some steep slopes; and a few areas of dark colored and somewhat poorly drained soils. There are also a few areas of soils that have a loam or sandy loam substratum.

This Sleeth soil has moderate available water capacity and slow runoff. Permeability is moderate in the subsoil and very rapid in the substratum. There is a high water table from January to April. The organic-matter content of the surface layer is low. The root zone is medium acid to moderately alkaline.

This soil has high potential for crops where artificially drained. Most areas are used to raise corn and soybeans. The potential is high for pasture and wildlife habitat development and medium for woodland. It is low for building site development and sanitary facilities and medium for most recreational uses.

A high water table is the major limitation to farming. The soil commonly remains wet for long periods. Subsurface drainage will benefit most crops. The regular addition of organic matter improves soil fertility and reduces crusting after rain. The addition of soil amendments and fertilizer as recommended by soil tests benefits crops. Artificial soil drainage and control of the soil's organic-matter content level are the main management problems.

This soil has fair potential for pasture. Because the water table is high, grazing is restricted when the soil is saturated. Water-tolerant plants should be used where the soil is not artificially drained. Grazing when the soil is wet will cause surface compaction, poor tilth, and lower yields. Proper stocking, pasture rotation, and restricted use when the soil is wet will help keep the pasture and the soil in good condition.

This soil is suited to woodland. Plant competition is a moderate limitation. Tree seeds and seedlings survive and grow, however, if the competing vegetation is controlled. Most hardwoods grow well.

This soil is poorly suited as building sites and for sanitary facilities because of wetness. Homesites should be located on any slightly higher, better drained areas if at all possible. Performance of septic systems can sometimes be improved by increasing the absorption area, installing curtain drains, or providing an alternate leach field. Surface and subsurface drainage lower the seasonal high water table. Landscaping building sites helps to keep surface water away from foundations. Local roads can be improved by artificial drainage and using a suitable base material.

This soil is in capability subclass IIw; woodland suitability subclass 3o.

St—Stonelick fine sandy loam. This deep, nearly level, well drained soil is on flood plains and is occasionally flooded. Areas are irregular in shape, but are generally elongated. They range from 5 to 150 acres in size. Slope ranges from 0 to 2 percent.

Typically, the surface layer is dark grayish brown, friable fine sandy loam about 9 inches thick. The substratum, to a depth of 60 inches, is stratified, friable, brown loam, loamy sand, sandy loam, and light silt loam.

Included with this soil in mapping are areas of Genesee soils that are on the same landscape position, areas of soils that have layers of fine gravel in the substratum, and areas of soils that have a calcareous surface layer. In a few areas the soil is more than 15 percent gravel in the surface layer, and in many areas of natural levees slope is more than 2 percent.

This Stonelick soil has moderately rapid permeability, low available water capacity, and slow runoff. It is subject to flooding from November to June. Some areas are protected by levees. The rooting zone is deep and generally mildly alkaline. Organic-matter content is low. The soil is droughty, and crop yields are lowered in dry years unless the soil is irrigated.

Stonelick soils have medium potential for crops and most areas are used for farming. The soil has high potential for pasture, woodland, and wildlife habitat. It has low potential for development of building sites and sanitary facilities and medium potential for most recreational development.

This soil is suited to most crops grown in the county; however, droughtiness will lower yields in dry years. Conserving soil moisture benefits most crops. Spring floods may damage winter wheat crops, but the flooding of corn and soybeans during the growing season generally is not damaging. Some areas are not farmed because they are invaded by johnsongrass. The regular addition of organic matter will conserve soil moisture and increase fertility. Conserving soil moisture is the main management concern.

The Stonelick soil is well suited to pasture. Because it is droughty, grazing must be restricted and the soil carefully managed during dry periods. Overgrazing during dry years can kill or stunt pasture. The use of drought-resistant plant species increases the number of grazing days per year.

This soil is suited to trees. Many long, narrow strips along streams are wooded. There are no limitations for planting or harvesting trees on this soil. Flooding is of very brief duration, and trees generally are not damaged.

This soil is poorly suited as building sites and for sanitary facilities because it floods. Even some recreational development is limited.

Protective levees have been built in some areas, and where protected from flooding, this soil is suited to some nonfarm uses.

This soil is in capability subclass IIs; woodland suitability subclass 2o.

ThA—Thackery silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on glacial outwash terraces and plains. Most areas are long and irregular in shape and 4 to 50 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 10 inches thick. The subsoil is 42 inches thick. The upper part is yellowish brown, friable silty clay loam; the middle part is mottled yellowish brown and grayish brown, friable clay loam; and the lower part is mottled dark yellowish brown, friable gravelly sandy clay loam. The substratum, to a depth of 60 inches, is dark brown, loose very gravelly loamy sand.

Included with this soil in mapping are areas of the well drained Ockley soils on the rises and moderately well drained, darker colored Tippecanoe soils in the swales. In a few areas the subsoil extends to a depth of more than 60 inches.

This Thackery soil has moderate permeability, moderate available water capacity, and slow runoff. It has low organic-matter content in the surface layer. Reaction is neutral or slightly acid in the rooting zone. The very gravelly loamy sand substratum is rapidly permeable and effectively restricts root penetration. The water table is high from January to April in most years.

Thackery soil has high potential for crops and most areas are used for corn and soybeans. It also has high potential for pasture, woodland, and wildlife habitat. It has medium potential as building sites and for sanitary facilities and medium to high potential for most recreational development.

This soil is suited to cultivated crops, hay, and pasture and to specialty crops, such as orchards and nursery stock. Erosion is only a slight hazard. The natural drainage of the soil is adequate for farming. The regular addition of organic matter improves fertility and reduces the crusting of the surface layer.

Thackery soil is well suited to most pasture crops, but few areas are used as pasture. Pasture generally is a grass-legume mixture. Grazing when the soil is wet can cause surface compaction, poor tilth, and lower yields.

Proper stocking, pasture rotation, and restricted grazing when the soil is wet keep the pasture and the soil in good condition.

This soil is suitable for trees. There are no limitations to planting or harvesting trees. High-value trees grow well and are recommended for planting.

The seasonal high water table is a limitation for septic tank absorption fields, shallow excavations, and homes with basements. This soil is better suited to homes without basements, lawns and gardens, and most recreational uses. The frost-action potential of the soil limits its use for local roads. This soil is a good source of topsoil.

Some communities have used curtain drains and large leaching areas to make this soil suitable for septic tanks. Suitable base material should be used where roads are constructed. The substratum of the soil is so rapidly permeable that farm ponds may leak if not properly sealed with clay during construction.

This soil is in capability class I; woodland suitability subclass 2o.

TpA—Tippecanoe silt loam, 0 to 2 percent slopes. This deep, dark colored, nearly level, moderately well drained soil is on glacial outwash terraces. Most areas are irregular in shape and 2 to 150 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is very dark brown, friable heavy silt loam about 5 inches thick. The subsoil is 48 inches thick. The upper part is mottled brown, firm silty clay loam, and the lower part is yellowish brown clay loam and sandy clay loam. The substratum, to a depth of 83 inches, is yellowish brown, friable gravelly sandy loam.

Included with this soil in mapping are small areas of well drained Wea soils on the rises and areas of somewhat poorly drained soils in the swales. Also included are areas that have a thick silt mantle and areas of soils in which the thickness of the surface layer and subsoil combined is less than 40 inches.

The Tippecanoe soil has moderate permeability in the subsoil and very rapid permeability in the substratum. It has high available water capacity and slow runoff. The water table is high in March and April. The organic-matter level is high in the surface layer. The rooting zone is neutral or mildly alkaline.

This soil has high potential for cultivated crops and, in fact, is one of the most highly productive soils in the county. Most areas are used for corn or soybeans. Potential is high for pasture and woodland, medium for building site development, medium to low for sanitary facilities, and high for recreational uses.

This soil is suited to cultivated crops and specialty crops, such as orchards, nursery stock, and vegetable truck crops. The natural drainage is adequate for farming. Erosion is only a slight hazard, but the surface of this soil may crust after a rain. The regular addition of fertilizer and other soil amendments, as recommended by soil tests, helps keep the soil highly productive.

The Tippecanoe soil is well suited to pasture and hay crops. The original vegetation was prairie grasses. These prairie grasses were harvested for hay in the fall of 1791 by the troops of General St. Clair during the construction of Fort Hamilton. Not many areas of this soil are used for hay production today, however, because the soils are more valuable for crops.

This soil is suited to trees. Plant competition may be a hazard to tree seedlings, but high-value trees grow well in this soil. There are no soil limitations to harvesting trees.

The seasonal high water table limits use of this soil for septic tank absorption fields, shallow excavations, and homes with basements. The very rapid permeability of the substratum is a limitation for sewage lagoons, trench type sanitary landfills, and farm ponds. The frost-action potential of the soil limits its use for local roads and streets. The soil is a good source of roadfill material, sand, and gravel and a fair source of topsoil.

Some communities have used curtain drains, large leaching areas, or alternate leach fields to make this soil suitable for septic tank absorption fields. A suitable road base material should be used where local roads are constructed. The substratum of this soil is so rapidly permeable that farm ponds may leak if not properly sealed with clay during construction.

This soil is in capability class I; woodland suitability subclass not assigned.

Ud—Udorthents. Udorthents consists of cut and fill areas in which the soil, or the soil and the underlying material, has been greatly modified—by being removed from some places and being added to others. Throughout the major part of an individual delineation, the cuts are deep enough to remove all or nearly all of the original soil and the fills are thick enough to bury the original soil to a depth of 20 inches or more.

The pattern of cuts and fills is complex, and the soil material is variable. It is generally calcareous, especially where material has been removed from soils underlain by till or shale and limestone bedrock. Both the available moisture capacity and the content of organic matter are very low, and most areas are susceptible to erosion. Instability of the soil material causes gullying and siltation. Conditions generally are very poor for plant growth.

Included in mapping are areas having a high content of shale and limestone fragments. For example, where Interstate Highway I-75 cuts through shale-limestone hills, the bedrock was used to elevate the roadbed across the intervening valleys. These areas are very sticky when wet and hard when dry. Also included are large "pads" that consist of shale and limestone fragments from Ordovician bedrock mined from deep underground in Lemon Township. The excavated blue-gray calcareous shale and limestone was spread as elevated "pads" in a number of areas along Yankee Road and on both sides of railroad tracks north of Todhunter Road. In sections 2 and 8 of Union Township, 3-foot pads of shale and limestone fragments excavated from surrounding hillsides were used to support railroad tracks, sidings, and large warehouses. Both the hillsides from which the material was borrowed and the "pads" in the lower valley (once Patton soils) are included in mapping.

Where a cover of plants is to be established and maintained, resurfacing areas of Udorthents with favorable soil material should provide a suitable root zone. Adjacent undisturbed soils generally are good sources of suitable cover material.

Grasses and trees that are tolerant of adverse conditions can be used to provide vegetative cover. Most areas of Udorthents are suitable for wildlife habitat or for recreational development. However, the soil material that has been used for fill is so variable that no prediction can be made about its properties or behavior. Onsite investigation is needed to determine hazards, limitations, and suitability for use of individual areas.

This map unit is not assigned to a capability subclass or woodland suitability subclass.

Udorthents and Dumps. These are areas filled or covered artificially with miscellaneous material including trash, stones, and industrial waste. This miscellaneous material may or may not be covered by fine, earthy material. Sanitary landfills are included within this map unit as are slag piles representing industrial wastes from steel mills. Also included are perishable and nonperishable buried material, such as chemical wastes and clay and fibre slurry from paper mills. Instability, gullying, erosion, and siltation are hazards in most areas. Flooding is a hazard in some areas. An uneven, settling surface characterizes some areas. A few areas appear to be gaseous.

Most areas are 3 to 20 acres in size. Those used for debris disposal are continually being enlarged. They are covered by fine, earthy material, generally a mixture of subsoil and substratum of the nearby soils. Because this added soil material commonly has poor physical properties, plant growth is poor, the material is generally calcareous. It has low available moisture capacity and low organic-matter content.

When a cover of plants is to be established and maintained, resurfacing areas of Udorthents and Dumps with favorable soil material provides a more suitable root zone. Grasses and trees that are tolerant of the adverse properties of this added soil should be selected. Most of these resurfaced areas have potential for wildlife habitat or recreational development.

This map unit is not assigned to a capability or woodland subclass.

UnA—Uniontown silt loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil formed in lakebed deposits on stream terraces. It generally is in linear areas of 3 to 25 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 10 inches thick. The subsoil is about 39 inches thick. The upper part is brown, friable heavy silt loam; the middle part is yellowish brown, firm silty clay loam; and the lower part is grayish brown, mottled, firm silty clay loam. The substratum, to a depth of 66 inches, is grayish brown, mottled, friable silt loam and is mildly alkaline.

Included with this soil in mapping are a few areas of gently sloping Uniontown soils on foot slopes adjacent to the upland and a few areas of somewhat poorly drained Henshaw soils in depressions.

This Uniontown soil has moderate permeability in the surface layer and subsoil and moderate to moderately slow permeability in the substratum. The available water capacity is very high, and runoff is slow. This soil is soft and compressible when saturated. It has a deep root zone. Unless it has been limed, the soil is medium acid in the upper part of the root zone. The content of organic matter is low.

Most of the acreage of this soil is used for farming, and it has a high potential for this use. It also has high potential for pasture, woodland, and wildlife habitat. Potential is medium to high for most building site development and sanitary facilities but high for most recreational uses.

This soil has a seasonal high water table during part of the winter and spring. Minimum tillage increases the amount of residue which can be returned to the soil to improve fertility and reduce surface crusting. Maintenance of fertility and organic matter levels is the main management concern.

This soil is well suited to a variety of pasture crops, but it rarely is used as permanent pasture or woodland because of its suitability for crops.

This soil is suited to a wide variety of trees. Where new plantings are made, plant competition from grasses and shrubs is a concern.

This soil is suitable for homesites. It is better suited to dwellings with basements than to dwellings without basements. This soil is well suited to recreational uses. Because it does not have sufficient strength and stability to support vehicular traffic, the base material needs to be replaced if the soil is used for roads. The moderate to moderately slow permeability limits its use for septic tank absorption fields but can generally be overcome by increasing the absorption area using curtain drains or by providing an alternate leach field. Homesites should be landscaped so that surface drainage is away from buildings.

This soil is in capability class I; woodland suitability subclass 2o.

UnB—Uniontown silt loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil formed in lakebed deposits on stream terraces. It is on toeslopes adjacent to the uplands. Areas are irregular and linear in shape and range from 3 to 25 acres in size.

Typically this soil has a dark grayish brown, friable silt loam surface layer about 8 inches thick. The subsoil is about 35 inches thick. The upper part is brown, friable heavy silt loam; the middle part is yellowish brown, firm silty clay loam; and the lower part is grayish brown, mottled, firm silty clay loam. The substratum, to a depth of 66 inches, is grayish brown, mottled, friable silt loam and is mildly alkaline.

Included with this soil in mapping are a few, linear shaped areas of well drained, moderately sloping soils adjacent to uplands. In these areas, which range from 3 to 15 acres in extent, the erosion hazard is greater than in the Uniontown soil. Also included are intermingled areas of a wetter soil that has a grayer surface layer and a grayish mottled subsoil. A few intermingled areas also have a darker surface layer.

This Uniontown soil has moderate permeability in the surface layer and subsoil and moderately slow permeability in the substratum. The available water capacity is very high, and surface runoff is medium. The soil is soft and compressible when saturated. It has a low content of organic matter. The root zone is deep. Unless it has been limed, the soil is medium acid to slightly acid in the upper part of the root zone.

Most of the acreage of this soil is used for farming, and it has high potential for this use. It also has high potential for pasture, woodland, and wildlife habitat. Potential is medium to high for most building site development and sanitary facilities but is high for most recreational uses.

There is a moderate erosion hazard when this soil is cultivated. Minimum tillage, winter cover crops, grassed waterways, and farming on the contour help prevent excessive soil loss. Returning crop residues to the soil or the addition of organic material improves fertility, reduces crusting, and increases water infiltration. Maintenance of fertility and organic-matter levels and control of erosion are the main management concerns.

This soil is well suited to a variety of pasture crops, but it rarely is used as permanent pasture because of its suitability for farm crops.

This soil is well suited to a wide variety of trees. Where new plantings are made, plant competition from grasses and shrubs is a concern.

This soil is suitable for homesites. It is better suited to dwellings with basements than to dwellings without basements. It is well suited to recreational uses. Because it does not have sufficient strength and stability to support vehicular traffic, the base material needs to be replaced if the soil is used for roads. The moderate to moderately slow permeability limits its use for septic tank absorption fields; but this can be overcome by increasing the absorption area, using curtain drains, or providing an alternate leach field. Homesites should be landscaped so that surface drainage is away from buildings.

This soil is in capability subclass IIe; woodland suitability subclass 2o.

UpA—Urban land-Eldean complex, nearly level. This unit consists of Urban land and nearly level, well drained Eldean soils on broad, smooth terraces. Individual areas of this unit range from 20 to 300 acres in size. They are 50 to 85 percent Urban land and as much as 50 percent Eldean soils. The Urban land areas and Eldean soils are so intricately mixed, or so small in extent, that it is not practical to separate them in mapping.

This map unit occupies the closely built up parts of large cities, such as Hamilton and Middletown, and also large industrial complexes. These areas are underlain by variable thicknesses of gravelly and sandy glacial outwash deposits, are well drained, and are higher in elevation than the flood plains.

The Urban land part of the unit is covered by streets, parking lots, buildings, railroads, and other structures that obscure or alter the original soil so that identification is not feasible.

Typically, the Eldean soil has a dark brown, friable loam surface layer about 6 inches thick. The subsoil is about 26 inches thick. The upper part is friable, brown silty clay loam; the middle part is brown and dark reddish brown, firm gravelly clay; and the lower part is dark reddish brown, friable gravelly clay loam. The substratum, to a depth of about 60 inches, is yellowish brown, loose very gravelly loamy sand. In some small areas the surface layer is silt loam.

Included in mapping are small areas of deep, well drained Ockley and Wea soils on similar landscape positions. Wea and Ockley soils are more than 42 inches deep to gravel and sand, and Wea soils have a much darker surface layer than Eldean soils. A few included areas have less clay in the subsoil.

The Eldean soils have a moderate or moderately slow permeability in the surface layer and subsoil and rapid permeability in the substratum. They have a low available water capacity, and surface runoff is slow. The root zone is moderately deep. It is medium acid to moderately alkaline. The surface layer is low in organic-matter content. Because the soils dry and warm early in the spring, gardens can be planted early.

The Eldean soils are used for parks, open space, building sites, lawns, and gardens.

The Eldean soils are well suited to grasses, flowers, vegetables, trees, and shrubs. Species selected for planting should have a tolerance for droughty conditions. Erosion generally is not a major concern unless the soils are disturbed and left bare for a considerable period. In many areas that have been cut or filled, gravelly materials are exposed that can interfere with lawns and gardens. The material used for fill is so variable in characteristics that no prediction can be made about its properties or behavior. Onsite investigation is needed to determine hazards, limitations, and suitability for use of individual areas.

The Eldean soils are moderately well suited to building site development and recreational uses. They have limited use for sewage lagoons and trench-type sanitary landfills because there is a hazard of effluent seeping through the rapidly permeable sand and gravel substratum to pollute streams, lakes, springs, and shallow wells. The Eldean soils do not have sufficient strength to support vehicular traffic, but roads can be built if suitable base material is used. Storm sewers are generally needed in urban areas to handle runoff. The Eldean soils are a good source of sand and gravel.

Eldean soils are in capability subclass IIs; woodland suitability subclass 2o. Urban land is not assigned to a capability or woodland subclass.

UsA—Urban land-Patton complex, nearly level. This map unit consists of areas of Urban land and deep, nearly level, poorly drained Patton soils on broad, low lying, former lakebeds. Individual areas of this unit range from 15 to 400 acres in size. This map unit is 50 to 90 percent Urban land and as much as 50 percent Patton soils. The Urban land areas and Patton soils are so intricately mixed, or so small in extent, that it is not practical to separate them in mapping.

This map unit is mainly in the eastern part of a large industrial complex at Middletown and an adjoining shopping center. It is also in smaller truck terminals in the Mill Creek Valley near the Hamilton County line. These areas are underlain with variable thicknesses of clayey and silty lacustrine or lakebed sediment, are generally poorly drained, have a seasonal high water table, and are lower in elevation than the adjacent or surrounding uplands or terraces.

The Urban land part of the unit is covered by streets, parking lots, buildings, railroads, and other structures that obscure or alter the original soil so that identification is not feasible.

Typically, the Patton soil has a very dark gray, friable silty clay loam surface layer about 7 inches thick. A subsurface layer, about 6 inches thick, is black, friable silty clay loam mottled with yellowish brown. The subsoil is about 23 inches thick. The upper part is dark gray, firm silty clay loam, mottled with dark yellowish brown, and the lower part is dark grayish brown, firm silty clay loam, mottled with yellowish brown. The substratum, to a depth of 65 inches, is dark grayish brown and grayish brown, stratified light silty clay loam and silt loam mottled with yellowish brown.

Included with this unit in mapping are small areas along small waterways of Eel and Shoals soils that are subject to flooding. Patton soils have a darker surface layer than either of these two soils.

The Patton soils have moderate permeability and very high available water capacity. They have a high water table in spring unless artificially drained. Surface runoff is slow. The root zone is neutral. The surface layer is high in organic-matter content.

The Patton soils are used for parks, open space, building sites, and lawns and gardens.

The Patton soils are poorly suited to building site development, sanitary facilities, and recreation uses because of the seasonal high water table and wetness. Subsurface and open ditch drainage can help overcome some limitations if suitable outlets are available. Local roads can be improved by artificial drainage and a suitable base material.

The areas that have been cut or filled often expose clayey or silty materials that are somewhat unstable and are sticky when wet and hard when dry. The material used for fill is so variable in characteristics that no prediction can be made about its properties or behavior. Onsite investigation is needed to determine hazards, limitations, and suitability for use of individual areas.

Patton soil is in capability subclass IIw, woodland suitability subclass 2w. Urban land is not assigned to a capability or woodland subclass.

WbA—Warsaw loam, 0 to 3 percent slopes. This deep, nearly level, well drained soil is on stream terraces and outwash plains. Most areas are irregular and broad in shape and range from 5 to 80 acres in size.

Typically, the Warsaw soil has a very dark brown, friable loam surface layer about 9 inches thick. A subsurface layer, about 8 inches thick, is very dark brown, friable loam. The subsoil is about 15 inches thick. The upper part is brown, firm light sandy clay loam; the middle part is brown, firm sandy clay loam; and the lower part is dark brown, friable gravelly sandy clay loam. The substratum, to a depth of 60 inches, is brown, stratified, calcareous very gravelly loamy sand.

Included with this soil in mapping are a few small intermingled areas of well drained, deep Wea soils and a few areas of soils where slopes are 3 to 6 percent.

This Warsaw soil has moderate permeability in the subsoil and very rapid permeability in the substratum. This soil has good tilth and warms early in spring, allowing for early planting. Available water capacity is moderate. Runoff is slow. The root zone is moderately deep to the sand and gravel substratum, and roots generally do not extend into the substratum. The surface layer is high in organic-matter content.

This soil is well suited to crops that are important to local farming. It is especially well suited to specialty crops and is ideally suited to irrigation. Corn, wheat, soybeans, and hay are commonly grown. This soil has high potential for pasture, woodland, and wildlife habitat. It has high potential for most building site development, sanitary facilities, and recreational uses. Home vegetable, fruit, and flower gardens do well on these soils.

This soil has no features that limit its use for field crops or pasture. There is little or no erosion hazard. It is suitable for minimum tillage, which increases fertility and water infiltration and conserves water. Maintenance of the fertility level is the main management concern.

This soil is well suited to a variety of pasture crops, but it rarely is used as permanent pasture because of its suitability for row crops.

This soil is suited to trees. Where new plantings are made, competition from grasses, weeds, and shrubs is a concern.

This soil is well suited to building site development and recreational uses, but it has limited use for some sanitary facilities because of the very rapid permeability in the substratum. Seepage from sanitary facilities may cause pollution of underground water supplies. Storm sewers are usually needed in urban areas to handle storm-water runoff. Trench sides need shoring up to prevent caving. Warsaw soils is a good source of topsoil, sand, and gravel.

This soil is in capability subclass IIs; woodland suitability subclass not assigned.

WeA—Wea silt loam, 0 to 2 percent slopes. This deep, nearly level, well drained soil is on glacial outwash terraces and plains. Most areas are broad and irregular in shape and 8 to 75 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 14 inches thick. The subsoil is 42 inches thick. The upper part is dark yellowish brown and dark brown heavy silt loam; the middle part is dark yellowish brown silty clay loam; and the lower part is dark yellowish brown and dark brown clay loam. The substratum, to a depth of 60 inches, is yellowish brown and brown, stratified gravelly loamy sand.

Included with this soil in mapping are small areas of the well drained Ockley soils on knolls and Warsaw soils that are less than 40 inches deep to sand and gravel. Also included are areas of soils that have a loam surface layer or a solum that is more than 70 inches thick.

This Wea soil has moderate permeability in the subsoil and very rapid permeability in the substratum. It has high available water capacity and slow runoff. Organic-matter content of the surface layer is high. The rooting zone is medium acid to neutral.

This soil has high potential for cultivated crops, pasture, hay, and woodland. Most areas are used to grow corn and soybeans. The soil is seldom used for pasture or hay because of its suitability for cultivated crops. It has high potential for building site development and for onsite sewage treatment facilities. It also has high potential for camp areas, playgrounds, picnic areas, and hiking paths and trails.

This soil does not need artificial drainage, and there is only a slight erosion hazard. It is well suited to specialty crops and irrigation. This is one of the best soils in the county for farming. Because it dries and warms early in spring, most crops can be planted early. The soil is naturally highly fertile, but the addition of fertilizer and other soil amendments, as recommended by soil tests, helps keep it that way. Controlling soil reaction in the rooting zone is the main management problem.

The Wea soil is well suited to pasture and hay crops. Although native vegetation was tall prairie grasses, few areas are now used for pasture or for hay because of the suitability of this soil for cultivated crops. Most pasture and hay are grass-legume mixtures. Grazing when the soil is wet will cause surface compaction and lower yields. Proper stocking and pasture rotation help keep the pasture and the soil in good condition. Irrigated hayland can produce up to four cuttings per year.

This soil is suitable for trees. Plant competition may be a hazard, but tree seeds and seedlings survive and grow well if the competing vegetation is controlled. High-value trees grow well and are recommended for planting. There are few limitations for planting or harvesting trees on this soil.

This soil is well suited as building sites and for sanitary facilities and recreational uses. The very rapid permeability of the substratum is a limitation for ponds, landfills, and sewage lagoons, but clay blanketing of reservoir areas can stop excessive seepage. The substratum is a good source of sand, gravel, and roadfill. The sides of trenches need to be shored up, since they cave easily. If this soil is used for septic tank absorption fields, ground water supplies may become polluted because of inadequate filtration through the sand and gravel. This soil does not have sufficient strength to support vehicular traffic, but roads can be built if a suitable base material is used.

This soil is in capability class I; woodland suitability subclass not assigned.

WeB—Wea silt loam, 2 to 6 percent slopes. This deep, gently sloping, dark colored, well drained soil is on glacial outwash terraces and plains. Most areas are long and irregular in shape and 4 to 40 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 12 inches thick. The subsoil is 40 inches thick. The upper part is dark yellowish brown and dark brown heavy silt loam; the middle part is dark yellowish brown silty clay loam; and the lower part is dark yellowish brown and dark brown clay loam. The substratum, to a depth of 60 inches, is yellowish brown and brown, stratified gravelly loamy sand.

Included with this soil in mapping are a few areas of nearly level, moderately well drained Tippecanoe soils and a few areas of the lighter colored Ockley soils on side slopes.

The Wea soil has moderate permeability in the subsoil and very rapid permeability in the substratum. Available water capacity is high, and runoff is slow. The soil has high organic-matter content in the surface layer. The rooting zone is medium acid to neutral in reaction.

This soil has high potential for cultivated crops, pasture, hay, and woodland. Most areas are used to grow corn and soybeans. It has high potential as building sites and for onsite sewage treatment facilities. It also has high potential for camping areas, hiking paths and trails, and picnic areas.

The erosion hazard is moderate. The soil does not need artificial drainage. It is well suited to special crops and irrigation. This is one of the best soils in the county for farming. Because it dries and warms early in spring, most crops can be planted early. The soil is naturally high in fertility, but the regular addition of fertilizer and other soil amendments, as recommended by soil tests, helps keep it highly fertile. Controlling erosion and keeping the proper reaction in the rooting zone are the main management concerns.

The Wea soil is well suited to pasture and hay crops. Although native vegetation was tall prairie grasses, few areas are used for pasture or hay production today because of the suitability of the soil for cultivated crops. Most pasture and hay produced are grass-legume mixtures. Grazing when the soil is wet will cause surface compaction, excessive runoff, and lower yields. Proper stocking rates and pasture rotation keep the pasture and soil in good condition. Irrigated hayland can produce up to four cuttings per year.

This soil is suitable for trees. Plant competition may be a hazard, but tree seeds and seedlings survive and grow well if the competing vegetation is controlled. There are no limitations for harvesting trees on this soil.

The Wea soil is well suited to building site development, sanitary facilities, and recreational uses. The very rapid permeability of the substratum is a limitation for sewage lagoons, farm ponds, and sanitary landfills. Clay blanketing of reservoir areas can be used to stop excessive seepage. The substratum is a good source of sand, gravel, and roadfill. The sides of shallow excavations cave easily and need to be shored up. Footings and foundations of buildings should be constructed below the frost line. Groundwater supplies may become polluted where the soil is used for septic tank absorption fields. Because the soil does not have sufficient strength to support vehicular traffic, a suitable base material is required.

This soil is in capability subclass IIe; woodland suitability subclass not assigned.

WyB—Wynn silt loam, 2 to 6 percent slopes. This gently sloping, moderately deep, well drained soil is on high upland ridges and on hillsides where the glacial till is thin over shale and limestone bedrock. Most areas are elongated in shape and range from 3 to 80 acres. Slopes are long and smooth with a few shallow drainageways in some areas. Bedrock is at a depth of 20 to 40 inches.

Typically, the surface layer is brown, friable silt loam about 9 inches thick. The subsoil is about 22 inches thick. The upper part is dark yellowish brown and brown silty clay loam; the middle part is dark reddish brown, firm clay and about 10 percent stone fragments; and the lower part is dark reddish brown and light olive brown, firm clay and about 10 percent stone fragments. The substratum, to a depth of about 35 inches, is calcareous till consisting of olive brown clay and dark reddish brown, firm heavy clay loam. Below 35 inches olive brown, calcareous clay shale is interbedded with dark gray, thin strata of fossiliferous limestone.

Included with this soil in mapping are small areas, generally less than 2 acres, of moderately deep, moderately well drained, nearly level soils that have some gray mottling in the subsoil. Also included are small areas of Russell-Miamian, bedrock substratum, soils on the lower part of slopes. These soils are deeper to bedrock than this Wynn soil and have a layer of stony till over shale and limestone. An additional inclusion in many areas are small areas of dark yellowish brown, eroded soils on slope breaks and small areas of Dana silt loam, bedrock substratum, soils. The Dana soils have a darker surface layer and greater depth to bedrock. They make up about 15 percent of some of the larger mapped areas.

In this Wynn soil permeability is moderately slow to slow and available water capacity is low. Runoff is medium. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. Organic-matter content is low. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. It has a tendency to crust or puddle after hard rains, especially in areas where the plow layer contains clayey subsoil material. Root development is restricted by the shale and limestone bedrock at a depth of 20 to 40 inches. The silty surface layer and long slopes makes this unit especially susceptible to sheet and rill erosion if not protected.

Most areas of this soil are farmed. It has medium potential for growing cultivated crops, hay, pasture, and trees. It has low potential as building sites and for sanitary facilities.

This soil is suited to cultivated crops, small grain, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion damage. Control of erosion, maintenance of good tilth, and increase of organic matter are important to good management. No-tillage or minimum tillage using crop residues, winter cover crops, and grassed waterways reduces erosion and help maintain the organic-matter content of the soil. Many slopes are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residues to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

Using this soil for pasture or hay is also effective in controlling erosion. Grazing when the soil is too wet, however, will cause surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees, and some areas remain in hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation and by spraying, cutting, or girdling. There are few soil limitations that affect planting or harvesting trees. Tree seedlings are machine planted on this soil.

This soil has limitations as building sites and for sanitary facilities. The interbedded shale and limestone bedrock that underlies this soil at a depth of 20 to 40 inches, makes excavation difficult and expensive; however, the bedrock is rippable by heavy equipment and rarely requires blasting. The many flagstones are undesirable in a pond embankment. Ground water flowing on the surface of the nearly impervious shale will cause wet-weather seeps on some slopes and in waterways. Water can also seep into excavations if not intercepted and drained off. This is common on the lower parts of slopes and foot slopes of hills. Low strength and potential frost action are limitations for local roads but can be overcome by using suitable base material.

This soil is in capability subclass IIe; woodland suitability subclass 2o.

WyB2—Wynn silt loam, 2 to 6 percent slopes, moderately eroded. This gently sloping, moderately deep, well drained soil is on rims of high, upland ridges and crests and on hillsides where the glacial till is thin over shale and limestone bedrock. Most areas are elongated in shape and range from 3 to 100 acres in size. Many larger areas are dissected by shallow waterways. Most areas, especially those surrounding the waterways, are moderately eroded. Many areas have common, flat limestone flagstones and igneous pebbles lying on the surface, especially on slope breaks. Slopes are quite long in some areas. Depth to bedrock ranges from 20 to 40 inches.

Typically, the surface layer is brown, friable silt loam about 8 inches thick. The subsoil is about 22 inches thick. The upper part is dark yellowish brown and brown, firm silty clay loam; the middle part is dark reddish brown, firm clay with about 10 percent stone fragments; and the lower part is dark reddish brown clay and light olive brown, firm clay with about 10 percent stone fragments. The substratum, to a depth of about 33 inches, is olive brown clay and dark reddish brown, firm clay and heavy clay loam that is calcareous. Below 33 inches it is olive brown, calcareous clay shale interbedded with dark gray, thin-bedded strata of fossiliferous limestone of Ordovician age.

Included with this soil in mapping are small areas, generally less than 2 acres in size, of moderately well drained, nearly level soils that have some gray mottling in the subsoil. Also included are small areas of Russell-Miamian, bedrock substratum, soils on the lower part of slopes. They are deeper than 40 inches to bedrock and have a layer of stony till over shale and limestone. In addition, there are many, small, reddish brown or olive brown eroded spots that are sticky when wet and cloddy when dry because the clayey subsoil has been exposed by erosion. Small areas of Dana silt loam, bedrock substratum, soils are inclusions in some areas. They have a darker surface layer and greater depth to bedrock. These inclusions make up about 15 percent of some of the high areas.

In this Wynn soil, permeability is moderately slow to slow, and available water capacity is low. Runoff is medium. Reaction ranges from strongly acid to neutral in the subsoil, and varies widely in the surface layer as a result of past liming practices. The organic-matter content is low as a result of the loss of surface soil by erosion. The surface layer tends to crust or puddle after a hard rain. Root development is restricted by the shale and limestone bedrock.

Most areas of this soil are farmed. Potential is medium for cultivated crops, hay, pasture, and trees. It is low for building site development and sanitary facilities.

This soil is suited to cultivated crops, small grain, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of further erosion. The control of erosion, maintenance of good tilth, and increase of organic matter are important to good management. No-till or minimum tillage, using crop residues, winter cover crops and grassed waterways, reduces erosion and helps maintain the organic-matter content of the soil. In many areas, slopes are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residues to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration. The soil tends to become droughty in summer and fall because of the limited depth to bedrock.

The use of this soil for pasture or hay is also effective in controlling erosion. Grazing when the soil is too wet, however, will cause surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees, and some areas remain in hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation and by spraying, cutting, or girdling. There are few soil limitations that affect planting or harvesting trees. Tree seedlings are machine planted on this soil.

This soil has limitations for building site development and for sanitary facilities. The interbedded shale and limestone bedrock, at a depth of 20 to 40 inches, make excavations difficult and expensive; however, the bedrock is rippable by heavy equipment and rarely requires blasting. The many flagstones in this soil make it undesirable for use in pond embankments. Ground water flowing on the surface of the nearly impervious shale causes wet weather seeps on some slopes and in waterways. Water can seep into excavations if not intercepted and drained off. This is common on the lower parts of slopes and foot slopes of hills. Low strength and potential frost action are limitations for local roads but can be overcome by using suitable base material.

This soil is in capability subclass IIe; woodland suitability subclass 2o.

WyC2—Wynn silt loam, 6 to 12 percent slopes, moderately eroded. This moderately sloping, moderately deep, well drained soil is on sides and crests of high, upland ridges and hills where the glacial till is thin over shale and limestone bedrock. Many areas are crescent shaped belts around rather large waterways, between the higher ridgetop divides and the steep soils immediately adjacent to the waterway. Individual areas range from 3 to 120 acres in size. Most areas are dissected by waterways, and, especially around the waterways, are moderately eroded. Slopes are quite long in some areas. Depth to bedrock is 20 to 40 inches. Many areas have common flagstones and igneous pebbles on the surface, especially on slope breaks in cultivated fields and in and around waterways.

Typically, the surface layer is brown, friable silt loam about 8 inches thick. The subsoil is about 21 inches thick. The upper part is dark yellowish brown and brown, firm silty clay loam; the middle part is dark reddish brown, firm clay with about 10 percent stone fragments; and the lower part is dark reddish brown clay intermingled with light olive brown firm clay. The substratum, to a depth of about 33 inches, is calcareous, olive brown clay and dark reddish brown, firm clay and heavy clay loam. Below 33 inches, olive brown, calcareous clay shale is interbedded with dark gray, thin-bedded strata of fossiliferous limestone bedrock.

Included with this soil in mapping are small areas of Eden soils. Wynn soils have a component of till in the subsoil, and Eden soils do not. Also included are small areas of Miamian-Russell, bedrock substratum, soils. They are deeper to bedrock than Wynn soils, and generally have a layer of stony till over the bedrock. Also included are small areas where the soil is severely eroded. These show up on the landscape as olive brown, "eroded" spots. They are sticky when wet and cloddy when dry because the weathered clayey shale is exposed. These areas are generally less than 24 inches to interbedded shale and limestone. Small areas of Dana silt loam, bedrock substratum, soils are inclusions in some places. They have a darker surface layer and are deeper to bedrock than Wynn soils. These included soils make up about 20 percent of some of the larger areas.

In this Wynn soil permeability is moderately slow to slow, and available water capacity is low. Runoff is rapid. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. The organic-matter content is low as a result of the loss of surface soil by erosion. The surface layer tends to crust or puddle after a hard rain. Root development is restricted by the shale and limestone bedrock.

While many areas of this soil are farmed, about an equal acreage is in pasture or trees. The soil has medium potential for growing cultivated crops, hay, pasture, and trees. It has low potential for building site development and sanitary facilities because of slope and limited depth to bedrock.

This soil is suited to cultivated crops, small grain, and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a severe hazard of further erosion. The control of erosion, maintenance of good tilth, and increase of organic matter are important to good management. No-till or minimum tillage using crop residues, winter cover crops, and grassed waterways reduces erosion and helps maintain the organic-matter content of the soil. Many slopes are long enough and smooth enough to be stripcropped or terraced and farmed on the contour. Returning crop residues to the soil or the regular addition of other organic material helps to improve fertility, prevent crusting, and increase water infiltration. This soil tends to become droughty in summer and fall because of limited depth to bedrock and rapid runoff.

The use of this soil for pasture or hay is also very effective in controlling erosion. Grazing when the soil is too wet, however, will cause surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees, and some areas remain in hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation and by spraying, cutting, or girdling. There are few soil limitations that affect planting or harvesting trees. Tree seedlings are machine planted on this soil.

This soil has limitations for building site development and for sanitary facilities. The interbedded shale and limestone bedrock underlying this soil, at a depth of 20 to 40 inches, make excavation difficult and expensive; however, the bedrock is rippable by heavy equipment and rarely requires blasting. The many flagstones are undesirable in a pond embankment. Ground water flowing on the surface of the nearly impervious shale causes wet weather seeps on some slopes and in waterways. Water can also seep into excavations if not intercepted and drained off. This is common on the lower parts of slopes and foot slopes of hills. Low strength and potential frost action are limitations for local roads, but can be overcome by using suitable base material.

This soil is in capability subclass IIIe; woodland suitability subclass 2o.

WzC3—Wynn silty clay loam, 6 to 12 percent slopes, severely eroded. This moderately sloping, moderately deep, well drained soil is on knobs, on the upper part of the long side slopes, and on side slopes that receive surface runoff from higher areas. Some fan shaped areas are on hillsides where the glacial till is only a thin smear over shale and limestone bedrock. Most areas have been cultivated up and down the hill and have become dissected by shallow gullies and waterways because of very rapid surface runoff. These areas are now severely eroded and are characterized by a clayey, olive brown surface layer containing common, flat limestone flagstones and igneous glacial pebbles. Individual areas range from 5 to 20 acres. Slopes are commonly short and abrupt.

Typically, the surface layer is olive brown, firm silty clay loam about 5 inches thick. The subsoil is about 15 inches thick. The upper part is olive brown, firm clay loam, and the lower part is light olive brown and dark reddish brown, firm clay. The substratum, to a depth of about 23 inches, is calcareous till consisting of olive brown clay and dark reddish brown firm clay loam. Below 23 inches is olive brown, calcareous clay shale interbedded with dark gray, thin-bedded strata of fossiliferous limestone bedrock.

Included with this soil in mapping are small areas of Eden soils that do not have a component of till in the subsoil. Also included are small areas of Miamian-Russell, bedrock substratum, soils on similar landscape positions. These soils are deeper to bedrock than Wynn soils and generally have a layer of stony till over the bedrock.

In this Wynn soil, permeability is moderately slow to slow, and the available water capacity is very low. Runoff is very rapid. Reaction ranges from neutral to moderately alkaline. Organic-matter content is very low as a result of the loss of surface soil by erosion. Root development is restricted by the dense shale and limestone bedrock at a depth of 20 to 40 inches.

Because of severe erosion and limited depth to bedrock, this soil has low potential for farming. Most acreage is in pasture, and the soil has a medium potential for this use. It has low potential as building sites and for sanitary facilities, mainly because of slope and limited depth to bedrock.

This soil is commonly used for pasture, and if overgrazed, continues to deteriorate, mainly as a result of severe erosion of the surface layer. All the silt and some of the clay erodes, leaving only clay and shale and limestone flagstones. The control of erosion and the maintenance of a good stand of key forage plants are important to good management. During seeding, the use of cover crops or companion crops, trash mulching, or no-till seeding helps control erosion. Some legumes, such as crownvetch, grow well on this soil. Proper stocking, pasture rotation, and timely application of fertilizer help maintain a maximum stand of key forage species.

This soil is suited to woodland, and a few areas have stands of native hardwoods. Only slight soil limitations affect the planting and harvesting of trees. Surface crusting and poor soil moisture hinder the emergence and growth of seedlings, but tree planting and weed control are easily accomplished by mechanical means. Undesirable species and poorly formed trees must be removed, however, when woodland is improved for timber production. When trees are harvested, the hazard of erosion is moderate and the use of equipment is moderately restricted. These limitations can be overcome be constructing logging roads and skid trails on the contour wherever practical.

This soil has low potential for building site development and sanitary facilities. The main concern is the limited depth to bedrock. Sanitary facilities should be connected to municipal sewers if at all possible. The surface layer has a high content of clay and is sticky when wet. It requires a topdressing of friable topsoil for successful use on lawns and gardens.

The interbedded shale and limestone bedrock underlying this mapping unit, at a depth of 20 to 40 inches, makes excavation difficult and expensive; however, the bedrock is rippable by heavy equipment and rarely requires blasting. The many flagstones are undesirable in pond fill. Ground water flowing on the surface of the nearly impervious shale causes wet weather seeps on some slopes and in waterways. Water can seep into excavations if not intercepted and drained off. This is common on the lower parts of slopes and foot slopes of hills. Low strength and potential frost action are limitations for local roads, but can be overcome by using suitable base material.

This soil is in capability subclass IVe; woodland suitability subclass 2o.

WuB—Wynn-Urban land complex, gently sloping. This map unit consists of gently sloping, well drained, moderately deep Wynn soils and areas of Urban land. It is on ridgetops and on hillsides where the glacial till is thin over shale and limestone bedrock. Depth to bedrock ranges from 20 to 40 inches. Individual areas of this map unit range from 5 to 400 ares. They are 50 to 65 percent Wynn soils and 20 to 35 percent Urban land. Wynn soils and Urban land areas are so intricately mixed, or so small in extent, that it is not practical to separate them in mapping.

Typically, the Wynn soil has a brown, friable silt loam surface layer about 8 inches thick. The subsoil is about 18 inches thick. The upper part is dark yellowish brown and brown, firm silty clay loam; the middle part is dark reddish brown, firm silty clay that is about 10 percent stone fragments; and the lower part is dark reddish brown clay intermingled with light olive brown, firm clay. The substratum, to a depth of 33 inches, is calcareous, olive brown clay and dark reddish brown, firm clay and calcareous glacial till of heavy clay loam. Below 33 inches, olive brown, calcareous clay shale is interbedded with dark gray, thin strata of fossiliferous limestone bedrock of Ordovician age.

Urban land is covered by streets, parking lots, buildings, and other structures that obscure or alter the original soil so that identification is not feasible.

Included with this soil in mapping, and making up 10 to 20 percent of the map unit, are small areas of Russell-Miamian, bedrock substratum, soils that are deeper than 40 inches to bedrock and have a layer of stony till over the bedrock. Also included are small areas of Dana, bedrock substratum, soils that have a darker surface layer and are deeper to bedrock than Wynn soils.

Most areas of this map unit are artificially drained by sewer systems and gutters. In Wynn soils permeability is moderately slow to slow, and the available water capacity is low. Runoff is medium. Reaction ranges from strongly acid to neutral in the subsoil, and varies widely in the surface layer as a result of past liming practices. Organic-matter content is low. Root development is restricted by the shale and limestone bedrock.

The Wynn soils are used for parks, open space, building sites, and lawns and gardens. They have medium potential for lawns, vegetable and flower gardens, and trees and shrubs. Potential is medium for most recreational uses and low for building site development and for sanitary facilities.

Perennial plants that are selected for planting should have a tolerance for high soil pH, or alkaline soil. Because of the silty surface layer and upper part of the subsoil, erosion can be a concern, especially where the soil is disturbed and left bare for a considerable time. The surface layer also has a tendency to crust or puddle after hard rains. Areas that have been cut and filled are not well suited to lawns and gardens. Clayey subsoil material that is exposed on the surface has poor tilth and is sticky when wet and hard when dry. It may also contain numerous till pebbles and limestone fragments.

The Wynn soils have severe limitations for building sites, but are suited for most recreational uses. Foundations and footings should be designed to prevent structural damage caused by frost action. All sanitary facilities should be connected to municipal sewers and treatment facilities. The upper part of the Wynn soil needs to be replaced or covered with a suitable base material if local roads and streets are to function properly. Onsite investigation is needed to determine hazards, limitations, and suitability for use of individual areas.

The interbedded shale and limestone bedrock underlying the Wynn soils, at a depth of 20 to 40 inches, make excavation difficult and expensive; however, the bedrock is rippable by heavy equipment and rarely requires blasting. The many flagstones make use of the soil undesirable for pond embankments. Ground water flowing on the surface of the nearly impervious shale will cause wet weather seeps on some slopes and in waterways. Water can seep into excavations if not intercepted and drained off. Low strength and potential frost action are limitations for local roads, but can be overcome by using suitable base material.

Wynn soil is in capability subclass IIe; woodland suitability subclass 2o. Urban land is not assigned to a capability subclass or woodland suitability subclass.

WuC—Wynn-Urban land complex, sloping. This map unit consists of relatively undisturbed Wynn soils and areas where the soil material has been disturbed by cutting and filling. Slope ranges from 6 to 18 percent. Most areas are on hillsides where the glacial till is thin over shale and limestone bedrock. Soils in this map unit are well drained and moderately deep. Depth to bedrock ranges from 20 to 40 inches. Individual areas of this map unit range from 5 to 70 acres. They are 50 to 65 percent Wynn soils and 20 to 35 percent Urban land. The Wynn soils and Urban land are so intricately mixed, or so small in extent, that it is not practical to separate them in mapping.

Typically, the Wynn soil has a brown, friable silt loam surface layer about 8 inches thick. The subsoil is about 14 inches thick. The upper part is dark yellowish brown and brown, firm silty clay loam; the middle part is dark reddish brown, firm clay with about 10 percent stone fragments; and the lower part is dark reddish brown clay intermingled with light olive brown, firm clay. The substratum, to a depth of about 33 inches, is calcareous, olive brown clay and dark reddish brown, firm clay and heavy clay loam till. Below 33 inches, it is olive brown, calcareous clay shale interbedded with dark gray, thin strata of fossiliferous limestone bedrock.

The Urban land part of this map unit is covered by streets, parking lots, buildings, and other structures that obscure or alter the original soil so that identification is not feasible.

Included in mapping, and making up 10 to 20 percent of the unit, are small areas of Miamian-Russell, bedrock substratum, soils that are deeper than 40 inches to bedrock and have a layer of stony till over the bedrock. Also included are small areas of Eden soils. Wynn soils have a component of till in the subsoil, and Eden soils do not.

Most areas of this map unit are artificially drained by sewer systems and gutters.

In the Wynn soils, permeability is moderately slow to slow, and available water capacity is low. Runoff is rapid. Reaction ranges from strongly acid to neutral in the subsoil and varies widely in the surface layer as a result of local liming practices. The organic-matter content is low as a result of the loss of surface soil by erosion. Root development is restricted by the shale and limestone bedrock at a depth of 20 to 40 inches.

The Wynn soils are used for parks, open space, building sites, and lawns and gardens. It has medium potential for lawns, vegetable and flower gardens, and trees and shrubs. It has low potential for recreational areas, for building sites, and for sanitary facilities because of the limited depth to bedrock, slope, and clayey subsoil.

Perennial plants that are selected for planting should have a tolerance for high soil pH, or alkalinity. Because of the silty surface layer and upper part of the subsoil, erosion can be a concern, especially where the soil is disturbed and left bare for a considerable time. The surface layer also has a tendency to crust or puddle after hard rains. Areas that have been cut and filled are not well suited to lawns and gardens. Clayey subsoil material that is exposed on the surface has poor tilth and is sticky when wet and hard when dry. It may also contain many till pebbles and limestone fragments.

The Wynn soils are limited as building sites, but are suited to most recreational uses. Foundations and footings should be designed to prevent structural damage caused by frost action. All sanitary facilities should be connected to municipal sewers and treatment facilities. The upper part of the Wynn soil needs to be replaced or covered with a suitable base material if local roads and streets are to function properly. Onsite investigation is needed to determine hazards, limitations, and suitability for use of individual areas.

Interbedded shale and limestone bedrock underlying this map unit, at a depth of 20 to 40 inches, make excavation difficult and expensive; however, the bedrock is rippable by heavy equipment and rarely requires blasting. The many flagstones make the soil undesirable for pond embankments. Ground water flowing on the surface of the nearly impervious shale will cause wet weather seeps on some slopes and in waterways. Water can seep into excavations if not intercepted and drained off. This is common on the lower parts of slopes and on foot slopes of hills where till covers the bedrock.

Wynn soils in capability subclass IIIe; woodland suitability subclass 2o. Urban land is not assigned to a capability subclass or woodland suitability subclass.

XeA—Xenia silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on the till plains in the till filled valleys. Most areas are irregular in shape and 2 acres to over 100 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsoil is 31 inches thick. The upper part is dark yellowish brown silt loam and silty clay loam; the middle part is yellowish brown, firm silty clay loam with grayish brown mottles; and the lower part is dark yellowish brown and brown, firm clay loam. The substratum, to a depth of 60 inches, is yellowish brown and olive brown loam.

Included with this soil in mapping are small areas of Celina soils where the loess mantle is less than 18 inches thick. Areas of the somewhat poorly drained Fincastle soils that have a gray colored subsoil are included in shallow depressions. A few areas of the well drained, gently sloping Russell-Miamian soil complex are on knolls.

This Xenia soil has moderately slow permeability. Available water capacity is high and runoff is slow. The water table is high in spring. Organic-matter content of the soil is low in the surface layer, and tilth is good. Reaction is medium acid to mildly alkaline in the rooting zone.

Most areas of this soil are used for crops, and corn, soybeans, wheat, and hay are the principal crops. This soil has high potential for cultivated crops and for pasture. It also has high potential as woodland and for wildlife habitat. Potential is medium for building site development, low for sanitary facilities, and high to medium for most recreational uses.

There is a slight erosion hazard. Internal soil drainage generally is adequate for farming, but the use of subsurface drains is beneficial in draining wet spots. Some areas require applications of lime to maintain the proper soil reaction in the rooting zone. The surface layer of this soil crusts after a hard rain, but the regular addition of organic matter will reduce the crusting and increase the fertility level. Maintenance to control soil reaction and fertility levels is the main management concern.

This soil is well suited to a variety of pasture crops, but rarely is used as permanent pasture because of its suitability for more valuable cultivated crops. The few pastures on this soil generally are bluegrass-clover mixtures. Grazing when the soil is wet will cause surface compaction and poor tilth. Proper stocking and pasture rotation and restricted use during wet periods help keep the pasture and the soil in good condition.

This soil is well suited to trees, and a few areas are used as woodland. High-value trees grow well on this soil if properly managed. Woodland improvement for good timber production requires removal of undesirable tree species and poorly formed trees. Plant competition from grasses and shrubs is a moderate limitation for planting tree seeds or seedlings. There are no other limitations for growing or harvesting trees on this soil.

This Xenia soil has limitations for septic tank absorption fields because of its moderately slow permeability and seasonally high water table. These limitations can be overcome in some areas, however, by using subsurface curtain drains to lower the water table and by increasing the leaching area or providing for an alternate leach field. Wetness and low strength are limitations for homes with basements and for small commercial buildings. The seasonal high water table is also a limitation for homes without basements. The high frost action potential of the soil requires that footings and foundations be placed below the frost line. The potential frost action and low strength are limitations for roads and streets. Suitable base material should be used where roads and streets are to constructed.

This soil is in capability class I; woodland suitability subclass 1o.

XeB—Xenia silt loam, 2 to 6 percent slopes. This deep, gently sloping, moderately well drained soil is on the till plain and in the till filled valleys. Most areas are rounded or irregular in shape and 2 to 90 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 6 inches thick. The next layer is brown and grayish brown, heavy silt loam. The subsoil is about 27 inches thick. The upper part is dark yellowish brown and yellowish brown, mottled silty clay loam, and the lower part is dark yellowish brown, mottled clay loam. The substratum, to a depth of 60 inches, is olive brown, mottled light clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Fincastle soils in the low areas and the well drained Russell-Miamian soil complex on rises. A few areas of the moderately well drained Celina soils are included where the loess cap is less than 18 inches thick.

The Xenia soil has moderately slow permeability, high available water capacity, and medium runoff. It has a high water table in the subsoil in spring. It has low organic-matter content in the surface layer, and it has good tilth. Reaction is medium acid to mildly alkaline in the rooting zone.

This soil has high potential for cultivated crops, and most areas are used as cropland. Corn, soybeans, small grains, and hay are the principal crops. Potential is high for pasture, woodland, and wildlife habitat. Potential is medium for building site development, and low for most sanitary facilities, and medium for most recreational developments.

The erosion hazard is moderate. Minimum tillage, winter cover crops, and grassed waterways will prevent excessive soil loss. The soil's natural drainage generally is adequate for farming, but random subsurface drainage lines to drain wet spots will benefit most crops. Some areas require lime applications to maintain proper soil reaction in the rooting zone. The surface layer of this soil crusts after a hard rain, but the regular addition of organic matter reduces the crusting and also increases the fertility level. Maintenance to control erosion and the fertility and organic matter levels are the main management concerns.

The use of this soil for pasture or hay is effective in controlling erosion. Grazing when the soil is wet, however, will cause surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help keep the pasture and soil in good condition.

This soil is well suited to trees. Various adapted species grow in the woodlots. Plant competition is a moderate limitation, but tree seedlings survive and grow well if the competing vegetation is controlled. There are no other limitations for planting or harvesting trees on this soil.

This soil is suited to homesites, and it is well suited to recreational uses. Because it does not have sufficient strength and stability to support vehicular traffic, the base material needs to be replaced if the soil is used for roads. The moderately slow permeability limits use for septic tank absorption fields but can generally be overcome by increasing the absorption area, using curtain drains, or providing an alternate leach field. Homesites should be landscaped so that surface drainage is away from buildings.

This soil is in capability subclass IIe; woodland suitability subclass 1o.

XeB2—Xenia silt loam, 2 to 6 percent slopes, moderately eroded. This deep, gently sloping, moderately well drained soil is on till plains and in till filled valleys. Most areas are rounded or regular in shape and range from 2 to 75 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 6 inches thick. The next layer is brown and grayish brown heavy silt loam. The subsoil is about 26 inches thick. The upper part is dark yellowish brown and yellowish brown, mottled silty clay loam, and the lower part is dark yellowish brown, mottled clay loam. The substratum, to a depth of 60 inches, is olive brown, mottled light clay loam.

Included with this soil in mapping are small areas of the moderately well drained Celina soils where the loess mantle is less than 18 inches thick. Also included are a few areas of the Russell-Miamian soil complex near streambanks.

The Xenia soil has moderately slow permeability, high available water capacity, and medium runoff. It has a high water table in spring. The soil has low organic-matter content in the surface layer, and it has fair tilth. Reaction is medium acid to mildly alkaline in the rooting zone.

This soil has high potential for cultivated crops, and most areas are used as cropland. Corn, soybeans, small grains, and hay are the principal crops. Potential is high for pasture, woodland, and wildlife habitat. It is fair for building site development, low for most sanitary facilities, and medium for most recreational developments.

The erosion hazard is moderate. Minimum tillage, winter cover crops, and grassed waterways help prevent excessive soil loss. Internal natural drainage of the soil generally is adequate for farming, but random subsurface tile lines to drain wet spots will benefit most crops. Some areas require lime applications to maintain the proper soil reaction in the rooting zone. The surface layer of this soil crusts after a hard rain, but the regular addition of organic matter will reduce soil crusting and also improve soil fertility. Maintenance to control erosion, soil fertility, and organic-matter levels is the main management concern.

The use of this soil for pasture or hay is effective in controlling erosion. Grazing when the soil is wet will cause surface compaction, excess runoff, and poor tilth. Proper stocking rates, pasture rotation, and restricted use during wet periods will help keep the pasture and the soil in good condition.

This soil is well suited to trees. A wide variety of adapted species are commonly in the woodlots. Plant competition is a moderate limitation, but tree seedlings survive and grow well if the competing vegetation is controlled. There are no other limitations for planting or harvesting trees.

This soil has limited use for septic tank absorption fields because of its moderately slow permeability and seasonally high water table. Those limitations have been minimized in some areas, however, by using subsurface drains to lower the water table and by increasing the leaching area or providing for an alternate leach field. The soils wetness and low strength limit use for homes with basements and small commercial buildings. The seasonal high water table is also a limitation for homes without basements. The high frost action potential requires that footings and foundations be placed below the frost line. Suitable base material should be used where roads and streets are constructed.

This soil is in capability subclass IIe; woodland suitability subclass 1o.

XfA—Xenia silt loam, bedrock substratum, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on the bedrock controlled glacial till plain. Most areas are irregular in shape and 2 to 44 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 8 inches thick. The subsoil is 34 inches thick. The upper part is firm, brown silty clay loam; the middle part is firm, dark yellowish brown silty clay loam with grayish brown mottles; and the lower part is firm, dark yellowish brown clay loam with grayish brown mottles. The substratum, to a depth of about 59 inches, is dark yellowish brown stony clay loam. Below 59 inches, it is shale and limestone bedrock. The substratum is calcareous and is 15 to 30 percent limestone flagstones. The bedrock is more than 66 percent soft, clay shale and less than 33 percent fossiliferous, crystalline limestone of Ordovician age.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Fincastle, bedrock substratum, soil in depressional areas. Also included are a few areas of gently sloping soils and small areas of soils that are deeper than 60 inches to bedrock.

This Xenia soil has moderately slow permeability, high available water capacity, and slow runoff. It has low organic-matter content in the surface layer, and it has good tilth. Reaction is medium acid to mildly alkaline in the rooting zone. There is a perched water table in spring.

This soil has high potential for cultivated crops and pasture, and most areas are used as cropland. Corn, soybeans, wheat, and hay are the principal crops. The soil has high potential for woodlands and for wildlife habitat. Potential is medium for building site development and for sanitary facilities and high to medium for most recreational uses.

The erosion hazard is slight. Internal soil drainage generally is adequate for farming, but subsurface drains are beneficial in draining wet spots. In some areas, lime applications are required to maintain the proper reaction in the rooting zone. The surface layer crusts after a hard rain, but the regular addition of organic matter reduces crusting and increases the fertility level. Maintenance to control soil reaction and fertility levels is the main management concern.

This soil is well suited to a wide variety of pasture crops but rarely is used as permanent pasture because of its suitability for cultivated crops. The few pastures on this soil generally are bluegrass-clover mixture. Grazing when the soil is wet can cause surface compaction and poor tilth. Proper stocking rates, pasture rotation, and restricted use during wet periods will help keep the pasture and the soil in good condition.

This soil is well suited to trees, and a few areas are wooded. Woodland improvement for good timber production requires removal of undesirable tree species and poorly formed trees. Plant competition is a moderate limitation. Tree seeds and seedlings survive and grow well, however, if competing vegetation is controlled. There are no other limitations for growing or harvesting trees.

The moderately slow permeability and seasonal high water table limit use of this soil for septic tank absorption fields. The seasonal high water table and the depth to rock are also limitations for most shallow excavations. The soil's wetness, low strength, and seasonal high water table limit use for homes with basements. The high frost action potential and low strength are also limitations for local roads.

The stony glacial till or shale and limestone bedrock in the substratum makes all excavation difficult and expensive. It is rippable by heavy equipment, however, and rarely requires blasting. The many stones in the till are undesirable in pond embankments, and ground water flowing on the surface of the till or bedrock can seep into excavations if not intercepted and diverted.

This soil is in capability class I; woodland suitability class 1o.

XfB—Xenia silt loam, bedrock substratum, 2 to 6 percent slopes. This deep, gently sloping, moderately well drained soil is on the bedrock-controlled till plains. Most areas are oval or irregular in shape and 4 to 150 acres in size.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsoil is 38 inches thick. The upper part is firm, brown silty clay loam; the middle part is firm, dark yellowish brown silty clay loam with grayish brown mottles; and the lower part is firm, dark yellowish brown clay loam with grayish brown mottles. The substratum, to a depth of 55 inches, is dark yellowish brown stony clay loam with grayish brown mottles. The substratum is 15 to 30 percent limestone flagstones. Interbedded shale and limestone bedrock of Ordovician age is at a depth of 55 inches. The bedrock is more than 66 percent clay shale.

Included with this soil in mapping are small areas of somewhat poorly drained Fincastle, bedrock substratum, soils in low parts of the landscape and a few areas of the Russell-Miamian, bedrock substratum, soil complex on knolls. The Fincastle soils have grayer colors in the subsoil than Xenia soils, and the Russell and Miamian soils have less gray colors in the subsoil. Also included are a few areas of Xenia soils that are deeper than 60 inches to stony till or bedrock.

This Xenia soil has moderately slow permeability, moderate available water capacity, and medium runoff. The surface layer is low in organic-matter content, and tilth is good. Reaction is medium acid to mildly alkaline in the rooting zone. There is a perched water table in the subsoil in spring.

Most areas of this soil are used for crops. Corn, soybeans, small grain, and hay are the major crops. This soil has high potential for cultivated crops. It also has high potential for pasture and woodland and for wildlife habitat. Potential is medium to low for building site development and low for sanitary facilities. Potential is medium to high for most recreational development.

The erosion hazard is moderate. Minimum tillage, winter cover crops, and grassed waterways can prevent excessive soil loss. The soil's natural drainage generally is adequate for farming, but most crops will be benefited if random subsurface lines are installed to drain wet spots. In some areas, lime applications are required to maintain proper reaction in the rooting zone. The surface layer crusts after rain, but the regular addition of organic matter reduces crusting and improves fertility. Maintenance to control erosion and soil fertility and organic-matter levels is the main management concern.

Using this soil for pasture or hay is effective in controlling erosion. Grazing when the soil is wet, however, can cause surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is well suited to trees. Plant competition is a moderate limitation, but tree seeds and seedlings survive and grow well if the competing vegetation is controlled. There are no other limitations for planting or harvesting trees.

The moderately slow permeability and seasonal high water table limit use of the soil for septic tank absorption fields. The seasonal high water table and depth to bedrock limit shallow excavations. The soil's wetness, low strength, and seasonal high water table limit its use for small commercial buildings. The seasonal high water table is also a limitation for homes with basements. High frost action potential and low strength are limitations for local roads, which can be overcome by using a suitable base material.

The stony till or bedrock in the substratum of this soil makes all excavation difficult and expensive. It is rippable, however, by heavy equipment and rarely requires blasting. The many flagstones in the till make it undesirable for pond embankment. Water flowing over the bedrock can seep into excavations if it is not intercepted and diverted.

This soil is in capability subclass IIe; woodland suitability subclass 1o.

XfB2—Xenia silt loam, bedrock substratum, 2 to 6 percent slopes, moderately eroded. This deep, gently sloping, moderately well drained soil is on bedrock-controlled till plains. Most areas are circular or irregular in shape and 2 to 200 acres.

Typically, the surface layer is dark grayish brown, friable silt loam about 7 inches thick. The subsoil is 29 inches thick. The upper part is firm, brown silty clay loam; the middle part is firm, dark yellowish brown silty clay loam that has grayish brown mottles; and the lower part is firm, dark yellowish brown clay loam with grayish brown mottles. The substratum, to a depth of 50 inches, is dark yellowish brown stony clay loam that is 15 to 30 percent limestone flagstones. Interbedded shale and limestone bedrock of Ordovician age is at a depth of 50 inches. The bedrock is at a depth of 48 to 72 inches. It is more than 66 percent soft clay shale and less than 34 percent crystaline, fossiliferous, thin-bedded limestone.

Included with this soil in mapping are small areas of the somewhat poorly drained Fincastle, bedrock substratum, soils, the well drained Russell-Miamian, bedrock substratum, soils, and the well drained Wynn soils. The Fincastle soils are grayer in the subsoil than this Xenia soil and are in low areas, usually at the head of waterways and in shallow basins. The Russell-Miamian soils are less gray in the subsoil and are on the upper part of the slopes, generally near the crest and shoulder. The Wynn soils are also less gray in the subsoil but have bedrock 20 to 40 inches below the surface. Also included are some areas that are deeper than 72 inches to bedrock.

This soil has moderately slow permeability, moderate available water capacity, and medium runoff. The surface layer is low in organic-matter content, and tilth is good. Reaction is medium acid to mildly alkaline in the rooting zone. The water table is perched over the subsoil in spring.

This soil has high potential for cultivated crops, and most areas are used as cropland. Corn, soybeans, wheat, and hay are the major crops. This soil also has high potential for pasture and woodland and for wildlife habitat. Potential is medium for building site development and low for sanitary facilities. Potential is medium to high for most recreational development.

The erosion hazard is moderate. Minimum tillage, winter cover crops, and grassed waterways prevent excessive soil loss. Natural drainage of the soil generally is adequate for farming, but installing random subsurface lines to drain wet spots will benefit most crops. In some areas of this soil, lime applications are required to maintain proper reaction in the rooting zone. The surface layer crusts after rain, but the addition of organic matter reduces crusting and improves soil fertility. Maintenance to control erosion and soil fertility and organic-matter levels is the main management concern.

Using this soil for pasture or hay is effective in controlling erosion. Grazing when the soil is wet, however, can cause surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help keep the pasture and the soil in good condition.

This soil is well suited to trees. Plant competition is a moderate limitation, but tree seeds and seedlings survive and grow well if the competing vegetation is controlled. There are no other limitations for planting or harvesting trees.

Moderately slow permeability and a seasonal high water table limits use of this soil for septic tank absorption fields. The high water table and depth to bedrock are also limitations for shallow excavations. Soil wetness, low strength, and a seasonal high water table are limitations for homes without basements. The seasonal high water table is a limitation for homes with basements. High frost action potential and low strength also limit use of the soil for local roads. These limitations can be overcome by using suitable base material.

The stony till and depth to bedrock of this soil make all excavation difficult and expensive. The bedrock is rippable by heavy equipment, however, and rarely requires blasting. The many flagstones in the till make it undesirable for use in pond embankments, and water flowing over the bedrock can seep into excavations if not intercepted and diverted.

This soil is in capability subclass IIe; woodland suitability subclass 1o.

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 or wetness can cause difficulty in excavation.

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

Crops and pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils 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 "Soils maps for detailed planning." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

New methods, practices, and systems for producing crops and pasture are likely to be introduced during the coming years. To keep current on the latest varieties, fertilizers, herbicides, tillage methods, etc., the reader should refer to the "Agronomy Guide" published biannually by the Agronomy Department of The Ohio State University, Ohio Agricultural Research and Development Center, and the Cooperative Extension Service. This section of the Soil Survey is not intended to provide the latest recommendations; rather, it discusses problems and potentials for cropland and pasture in the county based on the properties of the soils.

Although the soils in Butler County vary in their suitability for specific crops and require widely different management, some basic, or general, management practices are needed on practically all of the soils. This section discusses the basic practices used to maintain soil fertility, utilize crop residue, improve drainage, and control erosion. Also, suitable cropping systems are discussed. More specific information can be obtained by consulting a representative of the Soil Conservation Service or the Ohio Cooperative Extension Service.

Maintenance of adequate levels of fertility.—Because many of the soils in this county, particularly the light colored ones, are somewhat acid and medium to low in content of plant nutrients, additions of lime and fertilizer are needed. Such additions should be based on the results of soil tests, on the need of the crop, and on the crop growth desired. Maintaining the organic-matter content of soils helps to insure good soil structure and tilth.

Use of crop residue.—Many of the soils in the county, particularly the light-colored ones, are not naturally high in organic-matter content. To offset this deficiency, all crop residue should be returned to the soil. If soybeans or other crops that produce little residue are grown, the cropping system should include cover crops and sod crops.

Drainage.—About 12 percent of the county contains soils that are limited in their suitability for farm crops by wetness. These soils have a seasonal high water table and are periodically flooded. Some areas of the clayey, very poorly drained soils are subject to ponding. Most of the seasonally wet soils on the uplands have a moderately slowly permeable or slowly permeable substratum. Because of the substratum, the soils are saturated in the upper 2 to 3 feet during winter and spring. Subsurface drains can be used in most of the wet soils if the substratum of dense compact till is at sufficient depth to permit proper drainage. On all of the somewhat poorly drained soils, crops respond well to artificial drainage. The Ragsdale and Patton soils are well suited to crops if properly drained. Subsurface drains, open ditches, and land smoothing are most commonly used to achieve drainage. A combination of some of these practices may be needed in some areas. Artificial drainage is not commonly needed for farm crop production on the Xenia, Celina, Dana or other moderately well drained soils.

Control of erosion.—Many of the soils in this county have a surface layer that is fairly high in silt content and low in organic-matter content. Such a surface layer is highly susceptible to erosion by running water. The soils in about 43 percent of the county are moderately eroded, and in about 1 percent are severely eroded. Exclusive of sloping urban land, much of the acreage that is susceptible to erosion is eroded. Erosion control practices commonly used include terrace and waterway systems, diversion terraces, stripcropping on the contour, contour tillage, minimum tillage, use of crop residue, and maintenance of close-growing crops for protective cover.

Irrigation.—Irrigation is a specialized practice that requires very intensive management. Many soils in this county that are suited to crops are also suited to irrigation. Generally, soils well suited to irrigation absorb water readily, have adequate available water capacity, and drain readily. Among those considered suitable for irrigation are the nearly level and gently sloping Eel, Eldean, Genesee, Landes, Lanier, Ockley, Princeton, Ross, Stonelick, Thackery, Tippecanoe, Uniontown, Warsaw, and Wea soils.

Industries that need to dispose of waste water may be able to dispose of it through irrigation. Industrial wastes diverted to a natural stream can pollute the stream. Where no outlet for industrial wastes is available except through a stream, the pollutants should be eliminated before waste is delivered to the stream. Industries that irrigate with water containing waste products need carefully to select the site for disposing of this waste to prevent contamination of the underground water supply. Some soils are not deep enough to assure filtration.

Cropping systems.—A cropping system can be defined as the cultivation and management of appropriate crops. It includes rotations that contain grasses and legumes as well as systems in which the desired benefits are achieved without the use of such crops.

A satisfactory cropping system improves or maintains the physical condition of the soils; protects the soil during critical periods when erosion usually occurs; and aids in the control of weeds, insects, and diseases.

As row crops are grown more intensively, the need for conservation measures increases accordingly. It is impractical to list all of the possible cropping systems for any particular soil. For example, if contour stripcropping is used on sloping soils, a satisfactory system is a 4-year rotation of a row crop, a small grain, and 2 years of meadow. If the contour strip were not established, however, the row crop might not be satisfactory because erosion would be excessive.

Since much of the land in Butler County is susceptible to erosion and cost of energy is increasing, many farmers are using minimum tillage as a management tool. There are many forms of minimum tillage in use, but in general they all reduce operational costs by allowing fewer passes through the field. Minimum tillage has been shown to reduce erosion, but insufficient data is available at this time to show the long term effect on crop yields.

Pasture management.—Most of the permanent pasture in the county is on soils on which erosion is a hazard. These soils generally are eroded, are low in natural fertility, and are in poor tilth. Some pasture is on soils that need artificial drainage. Soils that require artificial drainage for optimum growth of row crops also require drainage for optimum growth of pasture. The following general management suggestions apply to all or most of the soils in the county.

Many of the soils used for pasture in Butler County are already eroded. Control of erosion is particularly important during seeding operations and mulch seeding or use of a nurse crop can help to control further erosion. Artificial drainage, if needed, must be as well established for pasture as for row crops. The need for lime and fertilizer should be determined by soil tests, and adequate amounts should be supplied.

Soil compaction, caused by grazing when the soils are wet, results in decreased growth of pasture. Harvesting methods, such as those for hay, silage, or haylage, help to increase plant growth and reduce soil compaction. Tilling when the soil is at optimum moisture content also helps to reduce soil compaction.

The productivity of a pasture and its ability to protect the surface of the soil is influenced by the number of livestock it supports, the length of time they graze, the season they graze, and rainfall distribution. Good pasture management includes the use of stocking rates that maintain key forage species, pasture rotation, deferred grazing, grazing at the proper season, and supplying ample water at strategic locations for livestock.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

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

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

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 if they are used for field crops, the risk of damage if they are used, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider 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 (*8*). Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight 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 6. The capability classification of each map unit is given in the section "Soil maps for detailed planning."

Woodland management and productivity

When the early settlers arrived in the area that is now Butler County, it was almost completely covered by a forest of mixed hardwoods. Scattered woodlots that average about 20 acres in size now cover about 10 percent of the land area, or 31,973 acres. They are mostly on steep soils that border the streams of the county. Two-thirds of this total, or 20,341 acres, is in land capability classes 3, 4, 6, and 7. Trees also grow in scattered tracts on wet uplands and on the flood plains.

Most of the potential farmland and some marginal areas have been cleared for farming. Farming was abandoned on the poorest soils, however, and they reverted to woodland.

Through the years, timber apparently was harvested selectively. The best trees were cut, but not enough trees of low potential were removed. The present stand generally is of poor quality. With proper management, however, most woodland in the county increases in value. Although there are no commercial sawmills in the county, loads of sawlogs occasionally are hauled to several small, semi-portable saws scattered over the county. A small amount of hardwood pulpwood is marketed in Middletown. A large, important concentration of paper and fiber industries has developed in the Miami River Valley, north of Hamilton, but these factories depend on pulpwood from southern and western sources.

Compared to the returns from the sale of other farm products, income from the sale of wood products is small. Good quality logs of red oak, white oak, and black walnut are still being cut from the better managed woodland, however, and these bring a good return when sold. Also, farm woodlots are still a source of wood for the fireplace, rough construction lumber, and edible nuts. The demand for clear, high-quality logs has increased; consequently, there is need for planting and improving the management of existing stands of sugar maple, white ash, white and red oaks, and black walnut trees. The demand for fuel wood is also increasing and providing a ready market for low-value trees and logging waste.

Besides adding to farm income, woodland provides esthetic benefits that cannot be measured in monetary terms. Trees add natural beauty to the landscape and provide a more desirable environment for humans and wildlife. They contribute to the well-being and enjoyment of the people in the county.

Woodland is becoming increasingly important for its recreational value. As the population increases, the need increases for woodland in which to camp, hike, and hunt.

The existence of the large metropolitan areas of Cincinnati and Dayton, as well as the sizable areas of Hamilton and Middletown within the county, makes the development of outdoor open space imperative. The proper use of woodland as well as recreational areas, is increasingly important.

Butler County is within the north-central hardwood forest region. Species such as black, red, and white oaks, ash, beech, and sugar maple occur throughout the county. Hueston Woods State Park, north of Oxford, has a virgin beech-maple forest. It is an outstanding example of the dominant forest type which once covered large areas on the better drained soils of the county.

For specific information about managing woodland on individual soils in Butler County, the reader should contact the local district conservationist, the local Agricultural Extension Office, or the local Service Farm Forester of the Ohio Division of Forestry.

Suitable kinds of trees to plant and to favor in existing woodland depend, to a great extent, on drainage of the soils. Some trees grow well only on well drained or moderately well drained soils. Others grow best in moist areas.

A few farms in this county have windbreaks; trees planted mainly to protect the farmstead from winds in winter and early in spring. These windbreaks also add beauty to the landscape. If planted in the proper places, they prevent drifting snow from blocking the roads. By reducing the velocity of the wind near the ground and holding snow where it falls, windbreaks conserve soil and moisture to a limited extent.

Evergreens are suitable for planting in windbreaks, and they are more effective in winter than deciduous trees. Norway spruce, Austrian pine, white pine, and eastern redcedar reduced grow well on many soils.

Table 7 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 (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; and 4, moderate. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *w*, indicates excessive water in or on the soil; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: w, c, s, f, and r.

In table 7, *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* consider the 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 a 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 blow 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.

Recreation

The soils of the survey area are rated in table 8 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 8, 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 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

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

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, horseback riding, and bicycling 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

Wildlife is an important natural resource of Butler County. The species most common in the county are cottontail rabbit, fox squirrel, gray squirrel, raccoon, gray and red foxes, and many songbirds and other nongame birds. Most of the soils in the county are suitable for use as habitat for some kind of wildlife. Interested persons should contact the local game protector, county Agricultural Extension agent, or a representative of the Soil Conservation Service, for specific information about managing areas for wildlife.

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 9, 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 creating, 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 created, 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 created, 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 rooting, 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 soybeans.

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, lovegrass, 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 fall panicum.

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 rooting zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, wild cherry, grapes, apple, 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, seeds, and cones. 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, northern white-cedar, and eastern redcedar.

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, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, willow, 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.

Habitats for various kinds of wildlife are 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 white-tailed 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, 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 10 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 or a cemented pan; 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 (fig. 8).

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, 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 in-

Figure 8.—Wetness limits the construction of dwellings with basements on Raub silt loam, 0 to 2 percent slopes.

ferred 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 11 shows the degree and the 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 11 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 one or more 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 effectively filter the effluent. 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 11 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 cause 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 11 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 12 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, topsoil, 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 used in great quantities in many kinds of construction. The ratings in table 12 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavations of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 14.

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

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

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel and stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel or stones, have slopes of more than 15 percent, or have a seasonal 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 13 gives information on the soil properties and site features that affect water management. The kind of soil limitations is given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed ponds. This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

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 stability of cutbanks. 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.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering properties and classifications

Table 14 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 morphology."

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

Classification of the soils is determined according to the Unified soil classification system (*3*) and the system adopted by the American Association of State Highway and Transportation Officials (*2*).

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, SP-SM.

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, 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 oven-dry 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 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 15 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.

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 wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. 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 wind erosion 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 wind erosion 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 wind erosion 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 wind erosion 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 wind erosion 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 wind erosion.

Soil and water features

Table 16 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.

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 and water in swamps and marshes is not considered flooding.

Table 16 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, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

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. The extent of flooding based on soil data are less specific than those 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 16 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, 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 16.

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. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. 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 shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

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 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 analysis of selected soils

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

These data were used in the classification and correlation of these soils and in evaluating their behavior under various land uses. Among these data seven of the profiles were selected as representative for the respective series and are described in the section "Soil series and morphology" of this publication. These series and their laboratory identification numbers are: Casco (BR-12), Eldean (BR-5), Fincastle (BR-13), Miamian (BR-2), Ross (BR-10), Wynn (BR-1), and Xenia (BR-15).

In addition to the Butler County data, laboratory data are also available from nearby counties with many of the same soils. These data, as well as the Butler County data, are on file at the Department of Agronomy, Ohio State University, Columbus, Ohio; the Ohio Department of Natural Resources, Division of Lands and Soil; and the Soil Conservation Service, State Office, Columbus, Ohio.

Engineering test data

Several of the soils in Butler County were analyzed for engineering properties by the Soil Physical Studies Laboratory, Department of Agronomy, Ohio State University. Part of the moisture-density determinations were made by the Ohio Department of Transportation Soil Testing Laboratory. Two of the series described in this publication were tested. These series and their laboratory identification numbers are the Fincastle series (BR-13) and Xenia series (BR-15).

In addition to the Butler County data, engineering test data are also available from nearby counties that have many of the same soils. These data and the Butler County data are on file at the Department of Agronomy, Ohio State University, Columbus, Ohio; the Ohio Department of Natural Resources, Division of Lands and Soil, Columbus, Ohio; and the Soil Conservation Service, State Office, Columbus, Ohio.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*9*). 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. In table 17, the soils of the survey area are classified according to the system. 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 Udalf (*Ud*, meaning humid, 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 Hapludalfs (*Hapl*, meaning minimal horizonation, plus *udalf*, the suborder of the Alfisols that have a humid 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 preceeding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Hapludalfs.

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, nonacid, mesic Typic Hapludalfs.

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 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 (*7*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*9*). 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 "Soil maps for detailed planning."

Avonburg series

The Avonburg series consists of deep, somewhat poorly drained soils that have a fragipan and very slow permeability. These soils formed partly in loess and partly in the underlying glacial till of Illinoian age. Slope is 0 to 2 percent.

Avonburg soils are adjacent to moderately well drained Rossmoyne soils. Rossmoyne soils do not have colors with chroma of 2 in the B horizon. They commonly are more sloping and are on higher parts of the landscape than Avonburg soils.

Typical pedon of Avonburg silt loam, 0 to 2 percent slopes, about 1.8 miles southeast of Pisgah, Union Township, R. 2, T. 3, section 8, from southeast corner, 1,600 feet north and 550 feet west:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; many small roots; medium acid; clear smooth boundary.

A2—9 to 14 inches; brown (10YR 5/3) silt loam; common fine distinct light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/6) mottles; weak medium platy structure; friable; common roots; few fine very dark brown (10YR 2/2) iron-manganese concretions; medium acid; clear smooth boundary.

B2tg—14 to 24 inches; grayish brown (10YR 5/2) light silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; firm; few thin patchy light brownish gray (10YR 6/2) clay and silt films on some faces of peds and in a few voids; common fine very dark brown (10YR 2/2) concretions; strongly acid; clear irregular boundary.

IIBx1—24 to 35 inches; light brownish gray (10YR 6/2) silty clay loam with many medium distinct yellowish brown (10YR 5/6) mottles; moderate very coarse prismatic structure; firm, brittle; thin to thick gray (10YR 6/1) silt fillings in old root and crayfish channels; patchy gray (10YR 5/1) clay films on faces of peds and lining voids; clay films commonly have gray silt coatings as outer covering; few fine and medium very dark brown (10YR 2/2) concretions; strongly acid; gradual wavy boundary.

IIBx2—35 to 43 inches; gray (10YR 6/1) clay loam; many coarse distinct yellowish brown (10YR 5/6 and 5/8) mottles; moderate very coarse prismatic structure parting to moderate thick platy; firm, brittle; light gray (10YR 7/1) thin silt coatings on tops and faces of prisms; common light gray (10YR 7/1) silt fillings in old root and crayfish channels; patchy gray (10YR 6/1) clay films on many faces of peds and lining some voids; common fine very dark brown (10YR 2/2) or black (10YR 2/1) concretions staining faces of peds lacking clay films; 2 percent small angular till pebbles and sand; strongly acid; gradual wavy boundary.

IIB3—43 to 64 inches; dark yellowish brown (10YR 4/4) clay loam; common coarse distinct gray (10YR 5/1) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; firm; patchy gray (10YR 5/1) clay films on some faces of peds and lining voids; 2 percent small angular till pebbles and sand; few very dark brown (10YR 2/2) concretions; strongly acid in the upper part and slightly acid in the lower part; gradual wavy boundary.

IIC—64 to 80 inches; yellowish brown (10YR 5/4) light clay loam; many coarse distinct gray (10YR 6/1) mottles and streaks; structureless, massive; friable; common till pebbles, few hard chert fragments; few silty limestone segregations in upper part; few concretions; slight effervescence; mildly alkaline.

The solum ranges from about 60 to 88 inches in thickness. The loess mantle ranges from 20 to 48 inches in thickness. The fragipan is at a depth of about 22 to 36 inches.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2 to 4. It normally is strongly acid but is slightly acid if it has been limed.

The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 6. The B2t horizon ranges from heavy silt loam to light silty clay loam. It is strongly acid to very strongly acid.

The Bx horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2 to 6. It is strongly acid to very strongly acid.

The B3 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 6. It is commonly clay loam, but is clay where the till has a large component of Ordovician limestone and calcareous clay shale. It is strongly acid in the upper part and ranges to medium acid or slightly acid in the lower part.

The C horizon is commonly clay loam, but is clay where the till has a large component of Ordovician shale and limestone. It ranges from medium acid to slightly acid in the upper part and becomes moderately alkaline as depth increases.

Brenton series

The Brenton series consists of deep, somewhat poorly drained soils that have moderate permeability. These soils are nearly level and are on outwash plains and alluvial terraces. They formed in loess or silty material and in the underlying loamy outwash or alluvium. Slope is 0 to 2 percent.

Brenton soils are similar to Raub soils and are commonly adjacent to Henshaw, Patton, and Uniontown soils. Raub soils formed in loess or silty material and in underlying glacial till material. Brenton soils are less gray in the B horizon than Patton soils. They have a darker colored, thicker A horizon than Henshaw soils. They have more gray mottling in the B horizon and are naturally wetter than Uniontown soils.

Typical pedon of Brenton silt loam, about 1.7 miles northwest of Port Union, Fairfield Township, R. 2, T. 2, section 16, from center of section, 600 feet south and 660 feet west:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam; weak fine and granular structure; friable; many roots; slightly acid; gradual smooth boundary.

A12—8 to 12 inches; very dark grayish brown (10YR 3/2) silt loam; weak fine subangular blocky structure; friable; many roots; slightly acid; gradual smooth boundary.

B21t—12 to 18 inches; brown (10YR 4/3) silty clay loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; common roots; medium continuous dark grayish brown (10YR 4/2) clay films on vertical faces of peds; very dark grayish brown (10YR 3/2) organic coatings on some faces of peds and lining root channels; slightly acid; clear smooth boundary.

B22t—18 to 26 inches; brown (10YR 5/3) silty clay loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; friable; common roots; thin continuous dark grayish brown (10YR 4/2) clay films; very dark grayish brown (10YR 3/2) organic coatings on a few faces of peds; few dark iron-manganese concretions; neutral; clear smooth boundary.

B31—26 to 34 inches; brown (10YR 5/3) silt loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; friable; few roots; few white secondary calcium carbonate segregations; neutral; clear smooth boundary.

B32—34 to 44 inches; brown (10YR 5/3) silt loam and some fine sand; common medium distinct grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/4) mottles; weak coarse prismatic structure; friable; few white (10YR 8/2) secondary calcium carbonate segregations; mildly alkaline; clear wavy boundary.

IIC1—44 to 53 inches; yellowish brown (10YR 5/4) silt loam with thin strata of loam; common medium distinct grayish brown (10YR 5/2) mottles; massive; friable; many white secondary carbonate segregations; slight effervescence; moderately alkaline; clear wavy boundary.

IIC2—53 to 60 inches; yellowish brown (10YR 5/4) loam containing thin strata of silt loam; few fine faint yellowish brown (10YR 5/6) mottles; massive; friable; many white secondary calcium carbonate segregations; 2 percent pebbles; slight effervescence; moderately alkaline.

The solum commonly is 40 to 55 inches thick and ranges from 36 to 60 inches. Calcareous material generally is at a depth of more than 40 inches, and the solum generally does not extend into calcareous material.

The A horizon is typically 10 to 14 inches thick but ranges from 10 to 20 inches. It has hue of 10YR, value of 2 or 3, and chroma of 1 or 2.

The matrix of the B horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. Mottles are dominantly of higher chroma than the matrix, but if the matrix has chroma of 3, mottles of 10YR hue have chroma of 2 or less. The upper part of the B horizon is silty clay loam that averages 27 to 35 percent clay in the upper 20 inches. Sand content increases as depth increases, and layers below a depth of about 30 to 40 inches are noticeably more sandy.

The C horizon is stratified silt loam, loam, fine sandy loam, and thin layers of loamy sand. Reaction ranges from neutral to moderately alkaline, and pH commonly increases with depth.

Casco series

The Casco series consists of deep, well drained soils on stream terraces. These soils formed in loamy material that is underlain by stratified, calcareous, sandy and gravelly outwash at a depth of 10 to 24 inches. Permeability is moderately rapid in the subsoil and very rapid in the substratum. Slope ranges from 6 to 35 percent.

Casco soils are commonly adjacent to the Eldean soils and have a thinner solum than those soils.

Typical pedon of Casco gravelly loam, from an area of Casco and Rodman gravelly loams, 6 to 18 percent slopes, moderately eroded, about 0.8 miles northeast of Overpeck, St. Clair Township, T. 2 N., R. 3 E., section 11, from northwest corner, 1,900 feet south and 1,950 feet east:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) gravelly loam; weak fine granular structure; friable; common roots; 15 percent coarse gravel; neutral; abrupt smooth boundary.

B21t—8 to 14 inches; dark brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; common roots; 10 percent coarse gravel; thin patchy clay films; neutral; clear gradual boundary.

B22t—14 to 18 inches; reddish brown (5YR 4/3) gravelly clay loam; moderate medium subangular blocky structure; firm; thin patchy clay films; dark brown (7.5YR 3/2) coatings on faces of peds and pebbles; few limestone segregations and soft light gray surfaces on limestone gravel; 15 percent coarse gravel; neutral; abrupt wavy boundary.

IIC—18 to 60 inches; brown (10YR 5/3) very gravelly loamy sand; single grained; loose; strong effervescence; moderately alkaline; many feet thick.

The solum typically is 14 to 18 inches thick and ranges from 10 to 24 inches. Locally, the soil has a silt mantle less than 12 inches thick. The solum of most pedons is 15 to 25 percent gravel. It ranges from neutral to slightly acid.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 2.

The Bt horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. It is sandy clay loam, heavy loam, or clay loam.

The C horizon ranges from well graded, stratified sand and gravel to various mixtures of sand and gravel.

Celina series

The Celina series consists of deep, moderately well drained, moderately slowly permeable soils on the Camden end moraine. They formed in a thin loess mantle and the underlying loamy till. Slope ranges from 2 to 6 percent.

Celina soils are commonly adjacent to Crosby and Miamian soils. Crosby soils have more 2-chroma mottles in the upper 10 inches of the argillic horizon than the Celina soils, and the Miamian soils lack 2-chroma mottles in the upper 10 inches of the argillic horizon.

Typical pedon of Celina silt loam, 2 to 6 percent slopes, about 1 mile northeast of Astoria, Madison Township, T. 3 N., R. 4 E., section 32, from southwest corner, 1,800 feet north and 165 feet east:

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

B1—7 to 10 inches; yellowish brown (10YR 5/4) silty clay loam; moderate medium and fine subangular blocky structure; firm; thin patchy dark grayish brown (10YR 4/2) clay films and pale brown (10YR 6/3) silt coatings on faces of peds; medium acid; clear smooth boundary.

IIB21t—10 to 15 inches; dark yellowish brown (10YR 4/4) light clay; few fine faint yellowish brown (10YR 5/4) mottles; moderate medium subangular and angular blocky structure; very firm; continuous dark brown (10YR 4/3) clay films on faces of peds; 3 percent coarse fragments; medium acid; gradual smooth boundary.

IIB22t—15 to 23 inches; dark yellowish brown (10YR 4/4) light clay; common medium distinct grayish brown (10YR 5/2), yellowish brown (10YR 5/4) and brownish yellow (10YR 6/8) mottles; moderate medium subangular and angular blocky structure; very firm; continous dark grayish brown (10YR 4/2) clay films on faces of peds; 5 percent coarse fragments; slightly acid; clear smooth boundary.

IIB3t—23 to 27 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct grayish brown (10YR 5/2), yellowish brown (10YR 5/4), and brownish yellow (10YR 6/6) mottles; moderate medium and coarse subangular blocky structure; firm; thin patchy dark grayish brown (10YR 4/2) clay films on faces of peds, more frequent on vertical surfaces; 10 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

IIC1—27 to 33 inches; yellowish brown (10YR 5/4) loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; massive; firm; 10 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

IIC2—33 to 60 inches; yellowish brown (10YR 5/4) loam; gray (10YR 6/1) seams; massive; friable; 10 percent coarse fragments; strong effervescence; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness, and the loess mantle is less than 18 inches thick.

The Ap horizon has hue of 10YR, value of 4, and chroma of 2 or 3. It is silt loam and ranges from medium acid to neutral.

The B1 horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. It is heavy clay loam, heavy silty clay loam, or light clay. It ranges from medium acid to mildly alkaline. Mottles are both high and low chroma.

The B2 horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 5. Clay coating on faces of peds have hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. The B2 horizon is light clay or clay loam.

The B3 horizon has colors similar to those of the B2 horizon. It is clay loam or heavy loam.

The C horizon is mildly or moderately alkaline loam.

Cincinnati series

The Cincinnati series consists of deep, well drained soils that have a fragipan and moderately slow to slow permeability. These soils formed partly in loess and partly in the underlying glacial till of Illinoian age. Slope ranges from 6 to 12 percent.

Cincinnati soils are commonly adjacent to the moderately well drained Rossmoyne soils, well drained Eden soils, and somewhat poorly drained Avonburg soils. Cincinnati soils have mottling at a greater depth than Rossmoyne and Avonburg soils. They have a thicker solum than Eden soils, which do not have a fragipan.

Typical pedon of Cincinnati silt loam, 6 to 12 percent slopes, moderately eroded, about 2.5 miles southwest of Symmes Corner, Fairfield Township, R. 2, T. 1, section 8, from section center, 1,250 feet north:

Ap—0 to 6 inches; dark brown (10YR 4/3) silt loam; moderate fine and medium subangular structure; friable; many roots; slightly acid; abrupt smooth boundary.

B1—6 to 12 inches; brown (7.5YR 5/4) silty clay loam; moderate fine and medium subangular blocky structure; friable; many roots; medium acid; clear wavy boundary.

B21t—12 to 20 inches; yellowish brown (10YR 5/6) silty clay loam; moderate medium subangular blocky structure; friable; common roots; thin patchy dark yellowish brown (10YR 4/4) clay films; few fine very dark brown (10YR 2/2) stains; medium acid; clear wavy boundary.

B22t—20 to 28 inches; yellowish brown (10YR 5/6) silty clay loam; moderate medium subangular blocky structure; firm; few roots; thin patchy dark yellowish brown (10YR 4/4) clay films; few fine very dark brown (10YR 2/2) stains and concretions; strongly acid; clear wavy boundary.

IIBx1—28 to 35 inches; dark yellowish brown (10YR 4/4) clay loam; common fine and medium distinct yellowish brown (10YR 5/4) and common medium distinct pale brown (10YR 6/3) mottles; moderate very coarse prismatic structure; firm, brittle; few fine roots along prism faces; thin continuous light yellowish brown (10YR 6/4) silt coatings on prism faces; thin continuous dark yellowish brown (10YR 4/4) clay films on vertical faces of peds; few fine very dark brown (10YR 2/2) iron-manganese stains and concretions; 6 percent mostly small angular glacial till pebbles; very strongly acid; clear wavy boundary.

IIBx2—35 to 50 inches; yellowish brown (10YR 5/4) clay loam; many medium distinct yellowish brown (10YR 5/6) and common medium distinct gray (10YR 5/1) mottles; moderate very coarse prismatic structure; firm, brittle; thin patchy yellowish brown (10YR 5/4) silt coatings on prism faces; thin patchy dark yellowish brown (10YR 4/4) clay films; common fine very dark brown (10YR 2/2) stains and concretions; 8 percent glacial till pebbles; strongly acid; clear wavy boundary.

IIB3t—50 to 63 inches; dark yellowish brown (10YR 4/4) clay loam; common medium distinct gray (10YR 5/1) mottles; weak coarse prismatic structure parting to weak coarse subangular blocky; firm; thin patchy light yellowish brown (10YR 6/4) silt coatings on prism faces; thin patchy yellowish brown (10YR 5/4) clay films; common fine very dark (10YR 2/2) stains and concretions; 10 percent glacial till pebbles; slightly acid; gradual wavy boundary.

IIC—63 to 74 inches; yellowish brown (10YR 5/4) light clay loam; few medium distinct yellowish brown (10YR 5/8) and grayish brown (10YR 5/2) mottles; massive; firm; 12 percent glacial till pebbles; slight effervescence, mildly alkaline.

The thickness of the solum and depth to carbonates ranges from 48 to 100 inches. The loess mantle ranges from 18 to 40 inches in thickness. The fragipan is at a depth ranging from 18 to 30 inches. The soil is strongly acid at a depth of less than 40 inches if it has not been limed. Below this depth, pH increases and is medium acid or slightly acid at a depth of 60 inches in some places.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3.

The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It ranges from silty clay loam to heavy loam and is 25 to 35 percent clay. The Bx horizon is similar to the B2 horizon in color. It is light clay loam or light silty clay loam. Dark concretions and stains are few to common in the fragipan and B3 horizon. In some pedons, the fragipan is in the lower part of the loess mantle and extends into the upper part of the weathered till. In other pedons, the fragipan formed entirely in the till.

The C horizon is yellowish brown or dark yellowish brown glacial till. It is dominantly loam, but ranges to clay where the content is Ordovician bedrock in the till is high. The till is commonly underlain by bedrock at a depth of more than 8 feet.

Crosby series

The Crosby series consists of deep, somewhat poorly drained, slowly permeable soils on the till plain. These soils formed in silty material and the underlying loamy glacial till on uplands. Slope is 0 to 2 percent.

Crosby soils commonly are adjacent to Miamian and Celina soils. Miamian and Celina soils are higher lying on the landscape and are better drained. Celina soils have fewer 2-chroma mottles in the upper 10 inches of the argillic horizon than Crosby soils. Miamian soils do not have 2-chroma mottles in the upper 10 inches of the argillic horizon.

Typical pedon of Crosby silt loam, 0 to 2 percent slopes, about 2 miles north of Astoria, Madison Township, T. 3 N., R. 4 E., section 29, from southwest corner, 165 feet north and 900 feet east:

Ap—0 to 7 inches; grayish brown (10YR 5/2) silt loam, slightly lighter in color crushed, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A2—7 to 10 inches; brown (10YR 5/3) silt loam; many medium prominent yellowish brown (10YR 5/4 and 10YR 5/6) mottles; moderate medium subangular blocky structure; firm; neutral; clear smooth boundary.

B21t—10 to 15 inches; yellowish brown (10YR 5/4) heavy silty clay loam; many medium prominent grayish brown (10YR 5/2) mottles; strong medium angular blocky structure; firm; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; neutral; clear wavy boundary.

IIB22t—15 to 18 inches; yellowish brown (10YR 5/4) heavy clay loam; common medium prominent dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles and many medium prominent grayish brown (10YR 5/2) mottles; strong medium angular blocky structure; very firm; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; neutral; clear wavy boundary.

IIB23t—18 to 22 inches; yellowish brown (10YR 5/4) silty clay; few medium distinct yellowish brown (10YR 4/4) mottles and many medium prominent grayish brown (10YR 5/2) mottles; strong medium and coarse angular blocky structure; very firm; thin continuous very dark grayish brown (10YR 3/2) clay films on faces of peds; neutral; clear smooth boundary.

IIB3—22 to 26 inches; yellowish brown (10YR 5/4) loam; many medium prominent grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/4) mottles; weak coarse angular blocky structure; firm in places, friable when removed; medium continuous dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) clay films on faces of peds; mildly alkaline; diffuse wavy boundary.

IIC1—26 to 31 inches; yellowish brown (10YR 5/4) loam; common medium prominent yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; massive; very firm in place, friable when removed; light gray (10YR 6/1) seams of lime; strong effervescence; moderately alkaline; diffuse wavy boundary.

IIC2—31 to 60 inches; yellowish brown (10YR 5/4) loam; common medium prominent light gray (10YR 6/1) mottles; massive; firm in place; friable when removed; strong effervescence; moderately alkaline.

The solum ranges from 20 to 38 inches in thickness. Carbonates are at a depth of 18 to 36 inches. Reaction ranges from slightly acid to mildly alkaline.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. Most pedons have a 10YR 5/3 A2 horizon.

The B horizon matrix has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. Mottles have hue of 10YR, value of 2 to 6, and chroma of 4 or 5. The B horizon is clay loam, silty clay loam, silty clay, or clay.

The C horizon is loam or light clay loam.

Dana series

The Dana series consists of deep, moderately well drained, moderately or moderately slowly permeable soils on uplands. These soils formed in loess and the underlying calcareous glacial till. Slope ranges from 0 to 6 percent.

Dana soils commonly are adjacent to Miamian, Russell, and Wynn soils. Miamian, Russell, and Wynn soils have a lighter colored A horizon than Dana soils, and Wynn soils have bedrock at a depth of 20 to 40 inches.

Typical pedon of Dana silt loam, 2 to 6 percent slopes, about 1.5 miles southeast of Princeton, Liberty Township, R. 3, T. 3, section 31, from southwest corner, 2,100 feet north and 300 feet east:

Ap—0 to 9 inches; very dark brown (10YR 2/2) silt loam, dark brown (10YR 3/3) rubbed; weak fine granular structure; friable; many roots; medium acid; abrupt smooth boundary.

A12—9 to 13 inches; very dark brown (10YR 2/2) silt loam; weak fine subangular blocky structure; friable; common roots; pockets of brown (10YR 4/3) subsoil material in horizon; medium acid; clear smooth boundary.

B21t—13 to 20 inches; brown (10YR 4/3) silty clay loam; few fine faint brown (10YR 5/3) mottles; weak medium subangular blocky structure; friable; common roots; thin continuous dark brown (10YR 3/3) clay films on faces of peds; slightly acid; clear smooth boundary.

B22t—20 to 28 inches; dark yellowish brown (10YR 4/4) silty clay loam; many coarse faint yellowish brown (10YR 5/4) and common medium distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; friable; few roots; thin patchy dark grayish brown (10YR 4/2) clay films on faces of peds; neutral; clear smooth boundary.

B23t—28 to 40 inches; yellowish brown (10YR 5/4) silty clay loam; common medium distinct grayish brown (10YR 5/2) mottles; weak coarse subangular blocky structure; friable; few roots; neutral; abrupt smooth boundary.

IIB3—40 to 44 inches; dark yellowish brown (10YR 4/4) and brown (10YR 4/3) clay loam; few fine faint yellowish brown (10YR 5/4) mottles and common medium distinct grayish brown (10YR 5/2) mottles; massive; friable; few roots; 5 percent gravel; neutral; abrupt smooth boundary.

C—44 to 60 inches; brown (10YR 4/3) loam; massive; strong effervescence; moderately alkaline.

The solum ranges from 36 to 60 inches in thickness. The silt mantle ranges from 22 to 40 inches in thickness. Reaction ranges from medium acid to neutral.

The A horizon is 10YR 2/2 or 10YR 3/2. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 6.

Eden series

The Eden series consists of moderately deep, well drained, slowly permeable soils on hillsides. These soils formed in residuum weathered from interbedded calcareous shale and limestone. Bedrock is at a depth of 20 and 40 inches. Slope ranges from 15 to 50 percent.

Eden soils are similar to Miamian and Wynn soils. Miamian soils are deep and formed almost entirely in glacial till; they have a thin loess mantle. Wynn soils formed partly in till and commonly have a thin loess mantle.

Typical pedon of Eden silty clay loam, 25 to 50 percent slopes, moderately eroded; about 1 mile west of Ross, Ross Township, T. 3 N., R. 2 E., section 32, from northeast corner, 1,550 feet south and 400 feet west:

A1—0 to 5 inches; very dark brown (10YR 3/3) silty clay loam; moderate fine subangular blocky structure; friable; 5 percent limestone flagstones on surface and in horizon; neutral; abrupt smooth boundary.

B2t—5 to 20 inches; olive brown (2.5Y 4/4), flaggy silty clay; moderate fine subangular blocky structure; firm;

thin continuous olive brown (2.5Y 4/3) coatings; thin patchy olive brown (2.5Y 4/4) clay films; 20 percent thin limestone flagstones; neutral to mildly alkaline; neutral to mildly alkaline at a depth of 15 to 20 inches; gradual smooth boundary.

B3—20 to 27 inches; light olive brown (2.5Y 5/4) silty clay; moderate medium and fine subangular blocky structure; firm; grayish brown (2.5Y 5/2) ped surfaces; 10 percent limestone flagstones; moderately alkaline; clear smooth boundary.

Cr—27 to 40 inches; interbedded clay shale and thin bedded hard fossiliferous limestone (Ordovician age); strong effervescence; moderately alkaline.

Interbedded shale and limestone (paralithic contact) is at a depth ranging from 20 to 40 inches. The solum ranges from 14 to 30 inches in thickness. Coarse fragments of limestone flagstones make up 0 to 15 percent of the A horizon, 10 to 25 percent of the B horizon, and 25 to 40 percent of the C horizon. The solum ranges from slightly acid to moderately alkaline.

The A1 horizon generally is less than 6 inches thick and ranges from dark brown (10YR 3/3) to very dark grayish brown (2.5Y 3/2). It ranges from heavy silt loam to silty clay.

The B horizon ranges from brown (10YR 4/3) to olive (5Y 4/4). It generally does not have mottles. It is silty clay or clay. Some pedons have a silty clay loam B1 horizon less than 5 inches thick. In some pedons, the B3 horizon has few or common thin clay films.

Eel series

The Eel series consists of deep, moderately well drained soils on flood plains. These soils formed in recent alluvial material. They are moderately permeable. Slope is 0 to 2 percent.

Eel soils commonly are adjacent to Genesee and Shoals soils. Genesee soils do not have 2-chroma mottles below the A horizon, and Shoals soils are dominantly 2 in chroma below the A horizon. Genesee soils are on about the same landscape positions or are slightly higher than Eel soils, but the Shoals soils are commonly in old sloughs and slight depressions.

Typical pedon of Eel silt loam, about 2.2 miles northwest of Port Union, Fairfield Township, R. 2, T. 2, section 17, from southwest corner, 1,600 feet north and 2,300 feet east:

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

C1—9 to 17 inches; dark brown (10YR 4/3) light silty clay loam; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.

C2—17 to 31 inches; brown (10YR 5/3) light silty clay loam; many medium distinct dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky structure; friable; thin strata of silty material; neutral; gradual wavy boundary.

C3—31 to 53 inches; dark brown (10YR 4/3) light silty clay loam; many medium distinct dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky structure; friable; neutral; gradual wavy boundary.

C4—53 to 72 inches; dark grayish brown (10YR 4/2) stratified loam and silt loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; massive; friable; mildly alkaline.

The solum is neutral or mildly alkaline. Stratification and 2-chroma mottles are within a depth of 20 inches.

The Ap horizon has hue of 10YR. It has value of 4 and chroma of 2 or value of 5 and chroma of 3. It is silt loam or loam.

The C horizon is loam, silt loam, or light silty clay loam. It commonly becomes coarser as depth increases. In many pedons, free carbonates are in the lower part of this horizon.

Eldean series

The Eldean series consists of deep, well drained soils on stream terraces and outwash plains. These soils formed in loamy glacial outwash and in the underlying stratified calcareous sand and gravel outwash which is at a depth of 20 to 40 inches. Permeability is moderate or moderately slow in the surface layer and subsoil and rapid in the substratum. Slope ranges from 0 to 12 percent.

Eldean soils are similar to Miamian and Wynn soils and are commonly adjacent to Casco, Ockley, and Warsaw soils. Miamian and Wynn soils formed mainly in till. Wynn soils are underlain by bedrock at a depth of 20 to 40 inches. Eldean soils have a thicker solum than Casco soils. They have a thinner solum and a higher clay content in the B horizon than Ockley soils. They have a lighter colored A horizon and a higher clay content in the B horizon than Warsaw soils.

Typical pedon of Eldean loam, 0 to 2 percent slopes, about 1.3 miles northwest of Trenton, Madison Township, T. 2 N., R. 4 E., section 30, from southeast corner 1,425 feet north and 1,550 feet west;

Ap—0 to 6 inches; dark brown (10YR 4/3) loam; weak medium granular structure; friable; 2 percent gravel; neutral; abrupt smooth boundary.

B1—6 to 9 inches; brown (7.5YR 4/4) silty clay loam; moderate medium subangular blocky structure; friable; 5 percent gravel; brown (10YR 4/3) coatings; neutral; clear wavy boundary.

B21t—9 to 18 inches; brown (7.5YR 4/4) gravelly clay; moderate medium subangular blocky structure; firm, sticky, and plastic; thin patchy dark brown (7.5YR

4/2) clay films; 15 percent gravel; slightly acid; clear wavy boundary.

B22t—18 to 26 inches; dark reddish brown (5YR 3/4) gravelly clay; moderate coarse subangular blocky structure; firm, sticky, and plastic; thin patchy brown (7.5YR 4/2) clay films, mainly on vertical faces of peds; 20 percent gravel; slightly acid; clear wavy boundary.

B3t—26 to 32 inches; dark reddish brown (5YR 3/3) gravelly clay loam; weak coarse subangular blocky structure; friable; thin patchy dark brown (7.5YR 3/2) clay films on faces of peds; 35 percent gravel; mildly alkaline; clear irregular boundary.

C—32 to 60 inches; yellowish brown (10YR 5/4) very gravelly loamy sand; weakly stratified; single grained; loose; gravel in upper 6 inches is coated with lime; strong effervescence; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness. Reaction ranges from neutral to medium acid in the upper part of the solum and from neutral to moderately alkaline near the contact with the C horizon. Gravel ranges from 0 to 20 percent of the A horizon and upper part of the B2 horizon and from 10 to 60 percent of the lower part of the B2 horizon and the B3 horizon.

The Ap horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. It is loam or gravelly loam.

The B2t horizon has hue of 10YR to 5YR, value of 3 to 5, and chroma of 3 to 4. The fine earth fraction is clay loam or clay.

The C horizon varies considerably in proportion of sand and gravel and in thickness of the different layers.

Fincastle series

The Fincastle series consists of deep, somewhat poorly drained soils on uplands and in till filled valleys. These soils formed in a mantle of loess and in the underlying calcareous loam or clay loam glacial till of Wisconsin age. Permeability is slow or moderately slow in the subsoil and slow in the underlying till. Slope ranges from 0 to 6 percent.

Fincastle soils are commonly adjacent to Russell and Xenia soils. Russell and Xenia soils are not dominantly 2 in chroma below the Ap horizon.

Typical pedon of Fincastle silt loam, 0 to 2 percent slopes, about 1 mile northeast of Jericho, Liberty Township, R. 3, T. 3, section 9, from southwest corner, 200 feet north and 2,100 feet east:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A&B—8 to 13 inches; dark grayish brown (10YR 4/2) silt loam (A) and grayish brown (10YR 5/2) silt loam (B); few fine distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; few small very dark brown iron-manganese concretions; medium acid; clear smooth boundary.

B21tg—13 to 20 inches; dark yellowish brown (10YR 4/4) silty clay loam; common medium distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; thin continuous grayish brown (10YR 5/2) clay films on peds and lining pores; few small dark brown iron-manganese concretions and stains; medium acid; clear wavy boundary.

B22tg—20 to 28 inches; dark yellowish brown (10YR 4/4) silty clay loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; thin continuous brown (10YR 4/2) clay films on all peds and lining pores; medium acid; clear wavy boundary.

B23tg—28 to 33 inches; dark yellowish brown (10YR 4/4) silty clay loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; thin patchy grayish brown (10YR 5/2) clay films on faces of peds; common iron-manganese stains, mostly on faces of peds; neutral; clear wavy boundary.

IIB24tg—33 to 38 inches; dark brown (10YR 4/3) clay loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) mottles; weak to moderate medium subangular blocky structure; firm; thin patchy dark grayish brown (10YR 4/2) clay films on faces of peds, 6 percent small angular till pebbles; neutral; clear smooth boundary.

IIB3—38 to 41 inches; dark brown (10YR 4/3) clay loam; few medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) mottles; weak medium angular blocky structure; firm; 8 percent small angular till pebbles; few segregations of carbonates; mildly alkaline; clear irregular boundary.

IIC—41 to 62 inches; brown (10YR 5/3) light clay loam; common medium and coarse distinct grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The silt capping ranges from 20 to 40 inches in thickness. The solum typically is 36 to 46 inches thick and ranges from 36 to 60 inches in thickness.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2. An A2 horizon is present in some pedons. Reaction ranges from slightly acid to strongly acid.

The matrix of the B2 horizon has hue of 10YR, value of 4 and 5, and chroma of 2 to 4. Most horizons between the base of the A horizon and 30 inches have ped coatings of 2 or lower chroma. The upper part of the B2 horizon, which formed in loess, is silty clay loam; the lower part, which formed in glacial till, is clay loam.

The C horizon is light clay loam or loam.

Genesee series

The Genesee series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in recent alluvial material. Slope is 0 to 2 percent.

Genesee soils are commonly adjacent to Eel, Ross, and Shoals soils on the landscape. Eel soils have mottles with chroma of 2 in the A horizon, and Shoals soils are dominantly 2 in chroma below the A horizon. Ross soils have a mollic epipedon. Ross soils are slightly above Eel, Genesee, and Shoals soils on the landscape.

Typical pedon of Genesee loam, about 2.2 miles northwest of Ross, Ross Township, T. 3 N., R. 2 E., section 28, from center of section, 750 feet north and 300 feet west:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam; moderate fine and medium granular structure; friable; neutral; abrupt smooth boundary.
C1—8 to 15 inches; dark brown (10YR 4/3) loam; weak fine and medium subangular blocky structure; friable; mildly alkaline; clear smooth boundary.
C2—15 to 25 inches; dark brown (10YR 4/3) silt loam; weak medium subangular blocky structure parting to weak medium granular; friable; thin stratification of loam; moderately alkaline; gradual smooth boundary.
C3—25 to 34 inches; dark yellowish brown (10YR 4/4) loam; weak medium subangular blocky structure; friable; thin stratification of silt loam; moderately alkaline; slight effervescence; gradual wavy boundary.
C4—34 to 60 inches; yellowish brown (10YR 5/4) stratified loam; sandy loam and silt loam; massive; friable; moderately alkaline; strong effervescence.

The solum is stratified within a depth of 20 inches. Reaction ranges from neutral to moderately alkaline. Free carbonates are within the surface layer of some pedons, and some pedons have a cambic horizon.

The Ap horizon has hue of 10YR, value of 4, and chroma of 2 or 3. It is silt loam or sandy loam.

The C horizon to a depth of 40 inches has hue of 10YR, value of 4, and chroma of 3 or 4. It is loam, silt loam, or sandy loam. Below a depth of 40 inches, it has hue of 10YR and value of 4 and chroma of 3 or value of 5 and chroma of 3 or 4. Texture becomes coarser with depth.

Hennepin series

The Hennepin series consists of deep, well drained soils that have moderately slow to slow permeability. These soils formed in calcareous glacial till of Wisconsin age. Slope ranges from 18 to 50 percent.

Hennepin soils are commonly adjacent to Miamian soils or Celina soils. Hennepin soils have a thinner solum, are less than 20 inches to glacial till, and have less clay in the B horizon than these two soils.

Typical pedon of Hennepin silt loam, from an area of Hennepin-Miamian silt loams, 18 to 25 percent slopes, moderately eroded about 0.3 miles east of Maud, Union Township, R. 2, T. 3, section 24, from southeast corner, 400 feet north and 800 feet west:

A1—0 to 5 inches; dark brown (10YR 3/3) silt loam; moderate medium granular structure; 1 percent till pebbles; neutral; clear smooth boundary.
B2—5 to 17 inches; dark yellowish brown (10YR 4/4) loam; moderate medium granular structure; friable; 5 percent till pebbles; neutral; gradual wavy boundary.
C—17 to 60 inches; brown (10YR 5/3) loam; structureless, massive; friable; 5 percent rock fragments; 10 percent till pebbles; strong effervescence; moderately alkaline.

The solum ranges from 8 to 20 inches in thickness.

The A horizon commonly is silt loam, but in some places it is loam. It ranges from very dark brown (10YR 3/2) in wooded areas to brown (10YR 4/3) in cleared areas.

The B2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is light clay loam or loam. It ranges from slightly acid to moderately alkaline and commonly is calcareous in the lower part.

The C horizon is calcareous, pebbly sandy loam, loam, or light clay loam till. The control section ranges from 18 to 35 percent clay.

Henshaw series

The Henshaw series consists of deep, somewhat poorly drained soils that have moderately slow permeability. These soils formed in slackwater deposits of silt loam and silty clay loam material of Wisconsin age. They are on low stream terraces and small rises in broad, low lying lacustrine valleys. Slope is 0 to 2 percent. In Butler County, this soil has an argillic horizon that has a dominant chroma of 2 in coatings on the surface of peds. Interpretations for use and management are compatible with these properties.

Henshaw soils are commonly adjacent to high lying, moderately well drained Uniontown soils and lower lying, poorly drained Patton soils. Henshaw soils have more gray mottling in the solum than Uniontown soils and have a lighter colored A horizon than Patton soils.

Typical pedon of Henshaw silt loam, 0 to 2 percent slopes, about 1 mile southeast of Stockton, Union Township, R. 2, T. 2, section 8, from northwest corner, 2,100 feet south and 500 feet east:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; few dark iron-manganese concretions; many roots; neutral; abrupt smooth boundary.

B21t—9 to 19 inches; dark yellowish brown (10YR 4/4) light silty clay loam; many fine distinct grayish brown (10YR 5/2) mottles; moderate fine and medium angular blocky structure; friable; common roots; thin patchy clay films on surfaces of peds; few dark iron-manganese concretions; dark grayish brown (10YR 4/2) coatings; less than 1 percent fine fragments; medium acid; clear smooth boundary.

B22t—19 to 24 inches; dark yellowish brown (10YR 4/4) light silty clay loam; common fine distinct grayish brown (10YR 5/2) mottles; moderate fine and medium subangular blocky structure; friable; common roots; few fine soft dark brown iron-manganese stains; thin patchy gray clay films on surfaces of peds; dark grayish brown (10YR 4/2) coatings; less than 1 percent fine fragments; slightly acid; clear smooth boundary.

B23t—24 to 30 inches; dark yellowish brown (10YR 4/4) light silty clay loam; many medium distinct dark grayish brown (10YR 4/2) mottles; weak medium and fine subangular blocky structure; friable; few roots; common dark iron-manganese concretions; thin very patchy gray clay films on surfaces of peds; patchy dark grayish brown (10YR 4/2) coatings; less than 1 percent fragments; slightly acid; clear smooth boundary.

B31—30 to 40 inches; yellowish brown (10YR 5/4) light silty clay loam; many medium distinct grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; few dark iron-manganese concretions; less than 1 percent fragments; neutral; clear smooth boundary.

B32—40 to 50 inches; yellowish brown (10YR 5/4) light silty clay loam; many medium distinct grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; few dark iron-manganese concretions; less than 1 percent fragments; neutral; clear smooth boundary.

C1—50 to 56 inches; light olive brown (2.5Y 5/4) heavy silt loam; common medium distinct yellowish brown (10YR 5/6) and light brownish gray (2.5Y 6/2) mottles; massive; firm; common fine dark coatings; slight effervescence; mildly alkaline; clear smooth boundary.

C2—56 to 60 inches; light olive brown (2.5Y 5/4) heavy silt loam; many medium distinct light brownish gray (2.5Y 6/2) mottles; massive; very firm; slight effervescence; mildly alkaline; clear smooth boundary.

The solum ranges from 40 to 55 inches in thickness.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. It is dominantly silt loam.

The B2 horizon ranges from medium acid to slightly acid, and the B3 horizon is slightly acid to mildly alkaline. The B2 horizon has hue of 10YR, value of 4 or 5, and chroma of 4 to 6. The pH increases with depth.

The C horizon is neutral to moderately alkaline. The C horizon is stratified silt loam, silty clay loam, loam, and clay loam.

Landes series

The Landes series consists of deep, well drained, moderately rapid or rapidly permeable soils on flood plains. These soils formed in recent alluvial deposits. Slope is 0 to 2 percent.

Landes soils commonly are adjacent to Stonelick and Ross soils. Stonelick soils have a lighter colored surface layer and Ross soils are not so sandy in the solum as Landes soils.

Typical pedon of Landes sandy loam, about 1 mile southwest of New Miami, St. Clair Township, R. 3, T. 2, section 28, from northwest corner, 300 feet south and 1,550 feet east:

Ap—0 to 11 inches; very dark grayish brown (10YR 3/2) sandy loam; weak fine granular structure; friable; many fine roots; less than 2 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

B2—11 to 26 inches; dark brown (10YR 3/3) sandy loam; weak fine granular structure; friable; common roots; less than 2 percent coarse fragments; slight effervescence; mildly alkaline; abrupt wavy boundary.

C1—26 to 52 inches; dark brown (10YR 4/3) loamy fine sand and few thin lenses of fine sandy loam; single grained; very friable; few roots; 3 percent fine gravel; slight effervescence; mildly alkaline; clear wavy boundary.

C2—52 to 55 inches; brown (10YR 5/3) coarse sand; single grained; loose; 5 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

C3—55 to 67 inches; brown (10YR 5/3) coarse sand-fine gravel mixture; single grained; loose; 50 percent coarse fragments; 1 1/2-inch thick strata of dark grayish brown silt loam at a depth of 64 inches; slight effervescence; mildly alkaline.

The solum ranges from 25 to 30 inches in thickness. Reaction is neutral or mildly alkaline throughout, and some pedons contain free carbonates.

The A horizon has hue of 10YR and value of 2 or 3. It is sandy loam or fine sandy loam.

The C horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or more. It is stratified sand, loamy fine sand, sandy loam, loam, or silt loam and their gravelly analogs.

Lanier series

The Lanier series consists of deep, well drained soils on flood plains. These soils formed in recent alluvial material that overlies calcareous sandy and gravelly sediment. They have rapid or very rapid permeability. Slope ranges from 0 to 2 percent.

Lanier soils are similar to Landes soils. Landes soils do not have a rock rubble substratum.

Typical pedon of Lanier fine sandy loam, about 2 miles west of Poast Town Heights, Madison Township, T. 3 N., R. 4 E., section 33, from northeast corner, 725 feet south and 850 feet west:

Ap—0 to 8 inches; dark brown (10YR 3/3) fine sandy loam; weak fine granular structure; friable; many roots; 5 percent coarse fragments; mildly alkaline; clear smooth boundary.

A12—8 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam; weak medium granular structure; friable; 12 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

IIC—14 to 60 inches; brown (10YR 5/3) stratified very gravelly loamy sand; single grained; 60 percent coarse fragments (pebbles, channers, cobbles, and flagstones); strong effervescence; moderately alkaline.

The solum ranges from 10 to 24 inches in thickness.

The A horizon is mildly alkaline or moderately alkaline. It has hue of 10YR and value and chroma of 2 or 3. The horizon is fine sandy loam, sandy loam, or loam.

The C horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. It is stratified very gravelly loamy sand, very gravelly sand, or fine sandy loam.

Miamian series

The Miamian series consists of deep, well drained, moderately slowly permeable soils on till plains, end moraines, and till filled valleys. These soils formed in a thin layer of loess and the underlying loamy till. Slope ranges from 2 to 50 percent.

Miamian soils are commonly adjacent to Celina soils and are mapped in a complex with Hennepin and Russell soils. Celina soils have 2-chroma mottles in the upper 10 inches of the argillic horizon. Hennepin soils are shallow to till and Russell soils formed in a mantle of loess more than 18 inches thick.

Typical pedon of Miamian silt loam, 2 to 6 percent slopes, moderately eroded, about 2 miles northeast of Astoria, Madison Township, T. 3 N., R. 4 E., section 29, from southwest corner, 50 feet north and 1,500 feet east:

Ap—0 to 6 inches; brown (10YR 4/3) silt loam; weak fine granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

B1—6 to 10 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderately medium subangular blocky structure; friable; thin very patchy brown (10YR 4/3) clay films on surfaces of peds and lining voids; slightly acid; clear wavy boundary.

IIB21t—10 to 16 inches; dark yellowish brown (10YR 4/4) heavy clay loam; strong medium subangular blocky structure; firm; thin continuous brown (10YR 4/3) clay films; few roots; 2 percent coarse fragments; common iron-manganese stains on surfaces of peds; neutral; clear smooth boundary.

IIB22t—16 to 20 inches; dark yellowish brown (10YR 4/4) heavy clay loam; strong medium and coarse subangular blocky structure; firm; thin continuous brown (10YR 4/3) clay films on surfaces of peds; few roots; 3 percent coarse fragments; mildly alkaline; clear irregular boundary.

IIB3t—20 to 22 inches; dark yellowish brown (10YR 4/4) clay loam; weak coarse subangular blocky structure; firm; thin patchy brown (10YR 4/3) clay films on major vertical surfaces of peds; few roots on clay films; 5 percent coarse fragments; 3 percent highly weathered limestone fragments; mildly alkaline; slight effervescence; clear wavy boundary.

IIC1—22 to 30 inches; yellowish brown (10YR 5/4) loam; massive; friable; 10 percent coarse fragments; strong effervescence; moderately alkaline; diffuse smooth boundary.

IIC2—30 to 60 inches; yellowish brown (10YR 5/4) loam; massive; firm; 10 percent coarse fragments; strong effervescence; moderately alkaline.

The solum ranges from 20 to 35 inches in thickness. The loess mantle is less than 18 inches thick.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. It is silt loam or clay loam.

The B1 horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. It is silty clay loam or heavy silt loam.

The IIB2 and IIB3 horizons have hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. They are clay loam or clay.

The C horizon is loam or clay loam; stony analogs are in some pedons.

Ockley series

The Ockley series consists of deep, well drained soils on stream terraces and outwash plains. They formed in a mantle of loess and the underlying loamy glacial outwash over stratified, calcareous sand and gravel at a depth of 40 to 60 inches. They have moderate permeability. Slope ranges from 0 to 6 percent.

Ockley soils are similar to Princeton soils and are commonly near or adjacent to Eldean, Warsaw, and Wea soils. Princeton soils lack coarse fragments in some part of the B horizon. Ockley soils are deeper to underlying sand and gravel than either Eldean or Warsaw soils. Ockley soils have a lighter colored A horizon than Warsaw or Wea soils.

Typical pedon of Ockley silt loam, 0 to 2 percent slopes, about 1.2 miles west of Symmes Corner, Fairfield Township, R. 2, T. 1, section 10, from southeast corner, 450 feet north and 1,700 feet west:

Ap—0 to 9 inches; dark brown (10YR 4/3) silt loam; weak fine granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

B1—9 to 15 inches; dark brown (10YR 4/3) light silty clay loam; weak fine and medium subangular blocky structure; friable; common roots; medium acid; clear smooth boundary.

B21t—15 to 23 inches; dark brown (7.5YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; common roots; continuous (10YR 4/3) clay films; slightly acid; clear wavy boundary.

IIB22t—23 to 29 inches; dark brown (7.5YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; common roots; thin continuous (10YR 4/3) clay films; 3 percent coarse fragments; slightly acid; clear wavy boundary.

IIB23t—29 to 35 inches; dark brown (7.5YR 4/4) clay loam; weak coarse subangular blocky structure; friable; few roots; thin patchy dark brown (7.5YR 4/4) clay films; 3 percent coarse fragments; slightly acid; gradual wavy boundary.

IIB24t—35 to 42 inches; dark brown (7.5YR 4/4) loam; weak coarse subangular blocky structure; friable; 5 percent coarse fragments; neutral; gradual wavy boundary.

IIB25t—42 to 50 inches; dark brown (10YR 3/3) gravelly sandy clay loam; massive; friable; 20 percent coarse fragments; neutral; abrupt irregular boundary.

IIIC—50 to 60 inches; brown (10YR 5/3) very gravelly coarse sand; single grained; loose; stratified; strong effervescence; moderately alkaline.

The solum ranges from 40 to 60 inches in thickness over stratified, calcareous sand and gravel. The silt mantle ranges from 12 to 24 inches in thickness.

The B2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It ranges from medium acid to neutral.

Patton series

The Patton series consists of deep, poorly drained soils. These soils are in low basins and depressions that formerly were glacial lakes or ponded areas. The soils formed in silty sediment that settled in these ponded, slackwater lakes. They have moderate permeability. Slope is 0 to 2 percent.

Patton soils are commonly adjacent to somewhat poorly drained Henshaw soils and moderately well drained Uniontown soils that are at slightly higher elevations. Uniontown and Henshaw soils have a lighter colored A horizon.

Typical pedon of Patton silty clay loam, about 1.5 miles west of Monroe, Lemon Township, R. 3, T. 3, section 23, from southwest corner, 1,800 feet north and 1,375 feet east:

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

A12—7 to 13 inches; black (10YR 2/1) silty clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; friable; neutral; gradual smooth boundary.

B1g—13 to 19 inches; dark gray (10YR 4/1) silty clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; some very dark gray (10YR 3/1) surfaces of peds; moderate fine and medium prismatic structure parting to moderate medium subangular blocky; firm; neutral; gradual smooth boundary.

B2g—19 to 27 inches; dark gray (10YR 4/1) silty clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles and common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium prismatic structure parting to moderate fine and medium subangular blocky; firm; neutral; gradual smooth boundary.

B3g—27 to 36 inches; dark grayish brown (2.5Y 4/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium and coarse subangular blocky structure; firm; dark gray (10YR 4/1) krotovinas; mildly alkaline; gradual smooth boundary.

C1g—36 to 48 inches; dark grayish brown (10YR 4/2) stratified light silty clay loam and silt loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; dark gray (10YR 4/1) krotovinas; moderately alkaline; clear smooth boundary.

C2g—48 to 65 inches; grayish brown (10YR 5/2) stratified light silty clay loam and silt loam; common coarse distinct yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The solum typically is 30 to 40 inches thick and ranges from 24 to 42 inches in thickness. It commonly is neutral but ranges from slightly acid to mildly alkaline.

The mollic epipedon includes the A horizon and, in some pedons, the upper part of the B horizon. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It commonly is silty clay loam, but in some pedons it is heavy silt loam.

The B horizon has hue of 10YR or 5Y, value of 4 or more, and chroma of 2 or less. Mottles have hue of 10YR or 5Y, value of 4 or 5, and chroma of 3 to 6. The

B horizon commonly is silty clay loam that averages 27 to 35 percent clay.

The C horizon generally is mottled and effervescent. It generally shows evidence of stratification or water sorting by having layers of silt loam and silty clay loam. Dark colored krotovinas are common in most pedons.

Princeton series

The Princeton series consists of deep, well drained soils that have moderate permeability. They formed in thick loamy and sandy deposits, probably of wind blown origin. Slope ranges from 2 to 8 percent.

Princeton soils are similar to Ockley soils and commonly are adjacent to Eldean and Uniontown soils. Princeton soils do not have any coarse fragments in some part of the B horizon, in contrast to Ockley soils. Eldean soils have a higher clay content in the B horizon than Princeton soils. Uniontown soils formed in lacustrine material containing more clay.

Typical pedon of Princeton sandy loam, 2 to 8 percent slopes, about 2.3 miles northwest of Fairplay, Ross Township, T. 3 N., R. 2 E., section 13, from northwest corner, 2,780 feet south and 1,375 feet east:

Ap—0 to 9 inches; brown (10YR 4/3) sandy loam; weak fine granular structure; friable; slightly acid; clear smooth boundary.

B21t—9 to 18 inches; dark brown (7.5YR 4/4) heavy loam; moderate medium subangular blocky structure; firm; thin very patchy dark brown (7.5YR 4/2) clay films on some surfaces of peds; slightly acid; gradual wavy boundary.

B22t—18 to 29 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate coarse subangular blocky structure; firm; thin patchy dark brown (7.5YR 4/2) clay films on surface peds; medium acid; clear smooth boundary.

B23t—29 to 45 inches; dark brown (7.5YR 4/4) and reddish brown (5YR 4/4) heavy sandy loam; weak coarse subangular blocky structure; friable; thin patchy brown (7.5YR 4/4) clay films on surfaces of peds and bridging pores; slightly acid; clear smooth boundary.

C—45 to 72 inches; brown (10YR 5/3) stratified loamy sand and thin layers of loam; single grained and massive; very friable; slightly acid grading to moderately alkaline.

The solum ranges from 40 to 55 inches in thickness, but it is dominantly 40 to 48 inches thick.

The Ap horizon is brown (10YR 4/3 or 5/3) or dark yellowish brown (10YR 4/4).

The B2t horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 to 6; and chroma of 4 to 6. It is dominantly sandy clay loam, but subhorizons in some pedons are heavy loam or heavy sandy loam. The B horizon is slightly acid but ranges to medium acid in some thicker solums.

The C horizon generally is mildly alkaline at a depth of 50 inches. It is commonly stratified with loamy sand, fine sandy loam, loam, and coarse silt.

Ragsdale series

The Ragsdale series consists of deep, very poorly drained soils that have slow permeability. These soils formed in calcareous or neutral, silty deposits. They are in depressions on the Wisconsin glacial till plain. Slope is 0 to 2 percent.

Ragsdale soils are commonly adjacent to somewhat poorly drained Fincastle and moderately well drained Xenia soils. Ragsdale soils have a darker colored A horizon than either of these soils.

Typical pedon of Ragsdale silty clay loam, about 1.8 miles east of College Corner, Oxford Township, T. 5 N., R. 1 E., section 5, from northwest corner, 165 feet south and 1,300 feet east:

Ap—0 to 8 inches; very dark gray (10YR 3/1) light silty clay loam; few fine faint light olive brown (2.5Y 5/3) mottles; weak medium granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

A12—8 to 12 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct brown (10YR 4/3) mottles in lower part; moderate fine and medium granular structure; slightly acid; gradual wavy boundary.

B21tg—12 to 18 inches; dark gray (10YR 4/1) silty clay loam; common fine faint brown (10YR 5/3) mottles; weak fine subangular blocky structure; friable; common roots; thin very patchy dark gray (10YR 4/1) clay films on some faces of peds; slightly acid; clear wavy boundary.

B22tg—18 to 30 inches; gray (10YR 5/1) silty clay loam; many medium distinct yellowish brown (10YR 5/4) mottles; weak fine prismatic structure parting to moderate fine and medium subangular blocky; firm; few roots; thin continuous gray (10YR 5/1) clay films on faces of peds; few brown (10YR 5/3) mottles on vertical faces of peds and many brown (10YR 4/3) mottles on horizontal faces of peds; neutral; gradual wavy boundary.

B23tg—30 to 50 inches; yellowish brown (10YR 5/4) light silty clay loam; many medium distinct grayish brown (10YR 5/2) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; firm; thin very patchy gray (10YR 5/1) clay films on faces of peds; neutral; clear wavy boundary.

C1—50 to 60 inches; yellowish brown (10YR 5/4) silt loam; common coarse distinct gray (10YR 5/1) mottles; massive; friable; mildly alkaline; clear wavy boundary.

C2—60 to 72 inches; yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) silt loam; few medium distinct gray (10YR 5/1) mottles; massive; friable; mildly alkaline; clear wavy boundary.

The solum ranges from 36 to 52 inches in thickness. It is slightly acid to neutral and ranges from silt loam to silty clay loam.

The B horizon, to a depth of 30 to 40 inches, has hue of 10YR to 5Y, value of 4 or 5, and chroma of 1 or 2. Mottles have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 to 6. The lower part of the B horizon commonly has higher chroma in the matrix than the upper part ranging from brown to yellowish brown with low chroma mottles.

Raub series

The Raub series consists of deep, somewhat poorly drained soils that have slow permeability. These soils formed in a mantle of loess and in the underlying calcareous, loamy glacial till of Wisconsin age. Slope ranges from 0 to 6 percent.

Raub soils are similar to Brenton soils and are commonly adjacent to Dana and Fincastle soils. Brenton soils are similar to Raub soils, but they formed in lacustrine material. Raub soils are wetter and more mottled in the B horizon than Dana soils. They differ from Fincastle soils in having a darker colored A horizon and are better drained.

Typical pedon of Raub silt loam, 2 to 6 percent slopes, about 1.1 miles east of Le Sourdsville, Lemon Township, R. 3, T. 3, section 29, from northwest corner, 165 feet south and 1,300 feet east:

Ap—0 to 10 inches; black (10YR 2/1) silt loam; weak fine granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

A12—10 to 15 inches; very dark gray (10YR 3/2) silt loam; moderate medium granular structure; friable; many roots; slightly acid; abrupt wavy boundary.

B21t—15 to 21 inches; dark grayish brown (10YR 4/2) silty clay loam; many medium distinct brown (10YR 5/3) mottles; moderate medium subangular blocky structure; friable; common roots; thin very dark grayish brown (10YR 3/2) clay films on faces of peds; medium acid; clear wavy boundary.

B22t—21 to 37 inches; brown (10YR 5/3) silty clay loam; many medium distinct gray (10YR 5/1) mottles; moderate medium subangular blocky structure; firm; few roots; thin dark gray (10YR 4/1) clay films on faces of peds; medium acid; clear wavy boundary.

IIB3—37 to 43 inches; brown (10YR 5/3) clay loam, common medium distinct gray (10YR 5/1) mottles; weak coarse subangular blocky structure; friable; neutral; abrupt wavy boundary.

IIC—43 to 60 inches; mottled yellowish brown (10YR 5/4) and gray (10YR 6/1) loam; structureless, massive; friable; slight effervescence; mildly alkaline.

The silt mantle ranges from 22 to 42 inches in thickness, and the solum ranges from 36 to 60 inches in thickness. The mollic epipedon ranges from 11 to 18 inches in thickness. Reaction ranges from medium acid to neutral depending upon the amount of lime that has been applied.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 6. The upper part of the B horizon is silty clay loam, and the lower part is clay loam. The upper part is medium acid to strongly acid, and the lower part is neutral.

Rodman series

The Rodman series consists of deep, excessively drained soils. These soils formed in stratified, calcareous, loose gravel and sand of Wisconsin age. Slope ranges from 12 to 35 percent. Permeability is moderately rapid in the surface layer and subsoil and very rapid in the substratum.

Rodman soils generally are commonly adjacent to Casco or Eldean soils, and they lack the argillic horizon characteristic of those soils. Also, undisturbed or uneroded Rodman soils have a darker colored A horizon than Casco and Eldean soils.

Typical pedon of Rodman gravelly loam, from an area of Casco and Rodman gravelly loams, 18 to 35 percent slopes, about 2.5 miles northeast of Ross, Ross Township, T. 3 N., R. 2 E., section 23, from northwest corner, 1,000 feet south and 750 feet east:

A1—0 to 7 inches; dark brown (7.5YR 3/2) gravelly loam; weak fine granular structure; friable; mildly alkaline; clear smooth boundary.

B2—7 to 12 inches; dark yellowish brown (10YR 3/4) gravelly loam; moderate granular structure; friable; mildly alkaline; abrupt smooth boundary.

C—12 to 60 inches; dark yellowish brown (10YR 4/4) very gravelly loamy sand; single grained; loose; moderately alkaline.

The solum ranges from about 8 to 15 inches in thickness. It is neutral or mildly alkaline.

The A horizon has hue of 7.5YR, value of 3, and chroma of 1 or 2. It is gravelly loam or sandy loam.

The B horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is loam, gravelly loam, or sandy loam.

Ross series

The Ross series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in recent alluvial material. Slope is 0 to 2 percent.

Ross soils are commonly adjacent to Genesee and Landes soils. Genesee soils have an ochric epipedon.

Landes soils have a coarse-loamy control section. Both of these soils are slightly lower on the landscape and generally closer to the stream channel than Ross soils.

Typical pedon of Ross loam, about 1.5 miles northeast of Oxford, Oxford Township, T. 5 N., R. 1 E., section 14, from section center, 1,000 feet south and 50 feet east:

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam; moderate fine granular structure; friable; many roots; slightly acid; abrupt smooth boundary.

A12—7 to 11 inches; very dark brown (10YR 2/2) loam; moderate fine and medium subangular blocky structure; friable; common roots; slightly acid; clear wavy boundary.

A13—11 to 17 inches; black (10YR 2/1) silt loam; moderate medium subangular blocky structure; friable; common roots; neutral; clear wavy boundary.

B21—17 to 25 inches; very dark grayish brown (10YR 3/2) silt loam; moderate medium subangular blocky structure; friable; few roots; neutral; abrupt wavy boundary.

B22—25 to 31 inches; dark yellowish brown (10YR 4/4) loam; moderate coarse subangular blocky structure; friable; neutral; gradual wavy boundary.

B23—31 to 38 inches; dark yellowish brown (10YR 4/4) loam; weak coarse subangular blocky structure; friable; mildly alkaline; clear smooth boundary.

C1—38 to 43 inches; dark brown (10YR 4/3) sandy clay loam; massive; friable; mildly alkaline; 2 percent gravel; clear smooth boundary.

C2—43 to 60 inches; dark yellowish brown (10YR 4/4) sandy loam; single grained; friable; moderately alkaline; 5 percent gravel.

The solum and the A horizon ranges from 24 to 40 inches in thickness. Reaction ranges from slightly acid to moderately alkaline.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is loam, silt loam, or sandy loam.

The B horizon, below the mollic epipedon, has hue of 10YR, value of 4, and chroma of 3 or 4. It is silt loam or loam and is stratified in some places.

The C horizon is sandy loam or sandy clay loam. Stratified sand and gravel are at a depth of more than 40 inches in some places.

Rossmoyne series

The Rossmoyne series consists of deep, moderately well drained soils that have a fragipan and moderately slow to slow permeability. These soils formed partly in loess and partly in the underlying glacial till of Illinoian age. Slope ranges from 2 to 6 percent.

Rossmoyne soils are adjacent to well drained Cincinnati soils and somewhat poorly drained Avonburg soils. Rossmoyne soils are commonly between these soils. Avonburg soils have colors with chroma of 2 in the B horizon.

Typical pedon of Rossmoyne silt loam, 2 to 6 percent slopes, about 1 mile south of Pisgah, Union Township, R. 2, T. 3, section 14, from northeast corner, 1,450 feet south and 875 feet west:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; many roots; medium acid; abrupt smooth boundary.

A2—8 to 13 inches; brown (10YR 5/3) silt loam; weak medium platy structure parting to moderate fine subangular blocky; friable; many roots; dark grayish brown (10YR 4/2) krotovinas and wormcasts make up 8 percent of mass; medium acid; clear wavy boundary.

B1—13 to 18 inches; yellowish brown (10YR 5/4) heavy silt loam; few fine faint pale brown (10YR 6/3) and dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; friable; common roots; thin patchy light brownish gray (10YR 6/2) silt coatings on vertical faces of peds; strongly acid; clear wavy boundary.

B2t—18 to 24 inches; yellowish brown (10YR 5/4) silty clay loam; common fine distinct gray (10YR 5/1) mottles; moderate medium subangular blocky structure; firm; common roots; thin patchy brown (10YR 4/3) clay films; thin patchy grayish brown (10YR 5/2) silt coatings on vertical faces of peds; strongly acid; clear wavy boundary.

IIBx1—24 to 34 inches; yellowish brown (10YR 5/4) light clay loam; common medium distinct grayish brown (10YR 5/2) mottles; weak very coarse prismatic structure parting to moderate medium platy; firm, brittle; few small roots on prism faces; thin continuous dark yellowish brown (10YR 4/4) clay films inside prisms; gray (10YR 5/1) clay films and thin patchy pale brown (10YR 6/3) silt films on faces of prisms; 3 percent small till pebbles (chert); strongly acid; gradual wavy boundary.

IIBx2—34 to 50 inches; yellowish brown (10YR 5/4) light clay loam; weak very coarse prismatic structure parting to weak medium platy and weak medium subangular blocky; firm, brittle; thick patchy gray (10YR 5/1) and dark grayish brown (10YR 4/2) clay films on faces of prisms and in pores; thin patchy pale brown (10YR 6/3) silty films on faces of prisms; common very dark brown (10YR 2/2) iron-manganese stains and small concretions; 5 percent till pebbles; strongly acid grading to slightly acid in lower part; clear wavy boundary.

IIB3t—50 to 75 inches; dark yellowish brown (10YR 4/4) clay loam; weak coarse subangular blocky structure; firm; dark brown (10YR 2/2) iron-manganese stains; 8 percent small angular till pebbles; neutral; clear wavy boundary.

The loess mantle ranges from 18 to 40 inches in thickness. The solum ranges from 60 to 100 inches in thickness.

The B2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. A 16 to 30 inch thick fragipan is at a depth of 18 to 30 inches. The upper 20 inches of the Bt horizon ranges from silty clay loam to clay loam, and clay content typically is 25 to 34 percent. The fragipan is typically a clay loam but is heavy loam in places. The proportion of sand and small pebbles increases below the loess-till contact. The fragipan is of moderate development and has firm, brittle consistence. Dark iron-manganese concretions and stains are common in the fragipan and, in places, in the B3 horizon. Where the soil is not limed, reaction is very strongly acid to strongly acid to a depth of 40 inches.

The till or C horizon is commonly underlain by Ordovician bedrock, and the lower part of the subsoil in places is directly over the bedrock without any intervening unweathered till. The solum does not extend into residuum from the underlying bedrock.

Russell series

The Russell series consists of deep, well drained soils on uplands and in till filled valleys. These soils have moderate permeability in the upper part of the subsoil and moderately slow in the lower part of the subsoil and in the substratum. They formed in loess and in the underlying calcareous glacial till of Wisconsin age. Slope ranges from 2 to 18 percent.

These soils have a solum that is less than 40 inches thick. This is less than defined for the series, but this difference does not materially affect use or management.

Russell soils are similar to Uniontown soils and commonly are adjacent to Fincastle and Xenia soils. Uniontown soils formed in lacustrine material. Russell soils do not have mottles that are 2 in chroma as is characteristic of the Fincastle and Xenia soils.

Typical pedon of Russell silt loam, 2 to 6 percent slopes, moderately eroded, about 2 miles southeast of College Corner, Oxford Township, T. 5 N., R. 1 E., section 8, from southeast corner, 1,520 feet north and 1,920 feet west:

Ap—0 to 7 inches; dark brown (10YR 4/3) silt loam; moderate medium granular structure; friable; neutral; abrupt smooth boundary.

B1—7 to 10 inches; brown (10YR 5/3) silt loam; moderate medium subangular blocky structure; friable; slightly acid; clear wavy boundary.

B21t—10 to 22 inches; brown (7.5YR 5/4) light silty clay loam; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin patchy yellowish brown (10YR 5/4) clay films on faces of peds; medium acid; clear wavy boundary.

IIB22t—22 to 27 inches; strong brown (7.5YR 5/6) clay loam; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; thin patchy dark brown (7.5YR 4/4) clay films and pale brown (10YR 6/3) coatings on some vertical faces of peds; 2 percent till pebbles; few fine very dark brown (10YR 2/2) manganese concretions; neutral; clear wavy boundary.

IIB23t—27 to 33 inches; brown (7.5YR 5/4) clay loam; weak medium subangular blocky structure; firm; thin continuous dark brown (7.5YR 4/4) clay films on faces of peds; 4 percent till pebbles; mildly alkaline; clear smooth boundary.

IIB3—33 to 36 inches; yellowish brown (10YR 5/4) clay loam; weak medium subangular blocky structure; firm; 8 percent till pebbles; slight effervescence; mildly alkaline; clear smooth boundary.

IIC—36 to 60 inches; brown (10YR 5/3) loam; massive; firm; 10 percent till pebbles; strong effervescence; moderately alkaline.

The solum ranges from 36 to 56 inches in thickness but is commonly 36 to 46 inches thick. The loess mantle ranges from 22 to 36 inches in thickness. Thickness of the solum is generally the same as the depth to calcareous till.

The Ap horizon is dark grayish brown or dark brown. In wooded areas, there is a dark colored A1 horizon, 1 inch to 3 inches thick. The A horizon ranges from medium acid to neutral.

The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It ranges from heavy silt loam to silty clay loam.

The IIBt horizon is similar in color to the Bt horizon. It ranges from light to medium clay loam. The B horizon ranges from medium acid to mildly alkaline.

Shoals series

The Shoals series consists of deep, somewhat poorly drained soils on flood plains. These soils have moderate permeability. They formed in recent alluvial material. Slope is 0 to 2 percent.

Shoals soils are commonly adjacent to moderately well drained Eel and well drained Genesee soils. Shoals soils are generally in old sloughs, flood channels, and lower areas than Eel or Genesee soils. Shoals soils are dominantly 2 chroma in color below the A horizon. They are generally flooded sooner and more often than either Eel or Genesee soils.

Typical pedon of Shoals silt loam, about 1 mile northeast of Hamilton, St. Clair Township, T. 2 N., R. 3 E., section 27, near the southwest corner:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

C1—8 to 14 inches; dark grayish brown (10YR 4/2) silt loam; common medium distinct yellowish brown (10YR 5/4) mottles; moderate medium granular structure; friable; slight effervescence, mildly alkaline; clear smooth boundary.

C2—14 to 26 inches; dark brown (10YR 4/3) silt loam; many medium distinct brown (7.5YR 4/4) and yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; friable; few dark iron-manganese concretions; slight effervescence, mildly alkaline; gradual smooth boundary.

C3—26 to 35 inches; dark grayish brown (10YR 4/2) silt loam; many medium distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; friable; common dark iron-manganese concretions and streaks; slight effervescence, mildly alkaline; gradual wavy boundary.

C4—35 to 60 inches; grayish brown (10YR 5/2) stratified loam and silt loam and a thin (less than 1 inch) strata of sandy loam; many coarse distinct gray (10YR 6/1) mottles and common medium distinct yellowish brown (10YR 5/4, 5/6) mottles; massive; friable; slight effervescence, mildly alkaline.

The control section ranges from slightly acid to mildly alkaline; below a depth of 40 inches, the pH ranges to moderately alkaline. Free carbonates frequently are at a depth of more than 30 inches; in some pedons they are at a depth of less than 20 inches.

The Ap horizon is dark grayish brown or grayish brown. It is slightly acid or neutral.

The C horizon ranges from loam to light silty clay loam, but silt loam is most common. It commonly has thin strata of sandy loam to clay loam in the lower part. Sand and gravel are common below a depth of 50 to 60 inches. Reaction is neutral to moderately alkaline.

Sleeth series

The Sleeth series consists of deep, somewhat poorly drained, moderately permeable soils on glacial outwash terraces. These soils formed in loess mantle and the underlying loamy material over stratified sand and gravel outwash. Slope is 0 to 2 percent.

Sleeth soils are commonly adjacent to Thackery and Tippecanoe soils. Thackery soils are not dominantly 2 in chroma in the upper 10 inches of the argillic horizon. Tippecanoe soils have a mollic epipedon.

Typical pedon of Sleeth silt loam, 0 to 2 percent slopes, about 1.2 miles north of Overpeck, St. Clair Township, T. 2 N., R. 3 E., section 2, from southwest corner, 980 feet north and 875 feet east:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A2—9 to 12 inches; grayish brown (10YR 5/2) silt loam; few medium distinct yellowish brown (10YR 5/4) and dark brown (7.5YR 4/4) mottles; weak medium granular structure; friable; slightly acid; clear smooth boundary.

B1t—12 to 17 inches; brown (10YR 5/3) silty clay loam; common medium distinct grayish brown (10YR 5/2), strong brown (7.5YR 5/6), and light brownish gray (10YR 6/2) mottles; weak medium subangular blocky structure; friable; thin patchy dark grayish brown (10YR 4/2) clay films on surfaces of peds; slightly acid; clear smooth boundary.

IIB21tg—17 to 24 inches; grayish brown (10YR 5/2) light clay loam; common medium distinct yellowish brown (10YR 5/4) and dark brown (7.5YR 4/4) mottles; moderate medium subangular and angular blocky structure; firm; thin patchy dark gray (10YR 4/1) clay films on surfaces of peds; medium acid; clear wavy boundary.

IIB22tg—24 to 32 inches; dark grayish brown (10YR 4/2) clay loam; common medium distinct yellowish brown (10YR 5/6), strong brown (7.5YR 5/6), and grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; thin patchy dark gray (10YR 4/1) clay films on surfaces of peds; 8 percent fine gravel; slightly acid; clear wavy boundary.

IIB23tg—32 to 38 inches; dark grayish brown (10YR 4/2) sandy clay loam; common medium distinct yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) mottles; moderate medium and coarse subangular blocky structure; firm; thin patchy dark gray (10YR 4/1) clay films on surfaces of peds; 5 percent fine gravel; neutral; gradual wavy boundary.

IIB3t—38 to 45 inches; grayish brown (10YR 5/2) gravelly sandy clay loam; common medium distinct yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) mottles; weak medium and coarse subangular blocky structure; friable; medium patchy dark gray (10YR 4/1) clay films on pebbles and surfaces of peds; common limestone segregations and decomposed dolomite rocks; moderately alkaline; abrupt wavy boundary.

IIIC—45 to 60 inches; brown (10YR 5/3) very gravelly sand; single grained; loose; strong effervescence; mildly alkaline.

The solum commonly is 40 to 50 inches thick but ranges from 40 to 60 inches in thickness.

The Ap horizon has hue of 10YR, value of 4, and chroma of 2 or 3. It is silt loam or loam and ranges from neutral to medium acid. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 2. It is loam or silt loam.

The B2t horizon has hue of 10YR, value of 4 to 6, and chroma of 1 to 4. It ranges from medium acid to neutral. It is silty clay loam, clay loam, sandy clay loam, or gravelly clay loam. The B3t horizon is 10YR 5/2, 10YR 5/3, or 10YR 4/4. It is gravelly sandy clay loam or gravelly clay loam. It ranges from neutral to moderately alkaline.

The C horizon is stratified sand and gravel. It is mildly or moderately alkaline.

Stonelick series

The Stonelick series consists of deep, well drained soils on flood plains. These soils formed in recent alluvial material and have moderately rapid permeability. Slope is 0 to 2 percent.

Stonelick soils commonly are adjacent to Genesee and Landes soils. Genesee soils are in the fine-loamy family. Landes soils have a mollic epipedon. Both soils are on about the same position on the landscape as Stonelick soils, but Stonelick soils are generally closer to the stream channels.

Typical pedon of Stonelick fine sandy loam, about 2 miles northwest of Symmes Corner, St. Clair Township, T. 1 N., R. 3 E., section 18, from northeast corner, 100 feet south and 575 feet west:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—9 to 14 inches; dark brown (10YR 4/3) loam; single grained; loose; slight effervescence; mildly alkaline; clear wavy boundary.

C2—14 to 18 inches; brown (10YR 4/3) loamy sand; weak fine subangular blocky structure; very friable; slight effervescence; mildly alkaline; gradual wavy boundary.

C3—18 to 35 inches; brown (10YR 4/3) sandy loam that has thin strata of loam; massive; friable; slight effervescence; mildly alkaline; gradual wavy boundary.

C4—35 to 43 inches; brown (10YR 4/3) light silt loam; massive; friable; slight effervescence; mildly alkaline; gradual wavy boundary.

C5—43 to 56 inches; brown (10YR 4/3) sandy loam; massive; friable; 5 percent fine gravel; slight effervescence; mildly alkaline; gradual wavy boundary.

C6—56 to 60 inches; brown (10YR 4/3) loamy sand; single grained; very friable; slight effervescence; mildly alkaline; gradual wavy boundary.

C7—60 to 66 inches; brown (10YR 4/3) coarse sandy loam; massive; friable; slight effervescence; mildly alkaline.

The solum ranges from neutral to moderately alkaline. The surface layer is effervescent in some places. There is no cambic horizon.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 to 4. It is fine sandy loam, sandy loam, or loamy fine sand.

The C horizon has the same color as the Ap horizon. It is stratified loam, sandy loam, light silt loam, or loamy sand. The content of gravel ranges from 0 to 20 percent.

Thackery series

The Thackery series consists of deep, moderately well drained soils on glacial outwash terraces and plains. These soils formed in a thin layer of loess or silty alluvium and in loamy outwash over calcareous sand and gravel. They are moderately permeable. Slope is 0 to 2 percent.

Thackery soils commonly are adjacent to Eldean, Ockley, and Tippecanoe soils. Eldean soils are fine textured and have a solum that is less than 40 inches thick. Ockley soils do not have 2-chroma mottles in the upper 75 centimeters of the argillic horizon. Tippecanoe soils have a mollic epipedon.

Typical pedon of Thackery silt loam, 0 to 2 percent slopes, about 0.5 mile north of Overpeck, St. Clair Township, T. 2 N., R. 3 E., section 11, from northwest corner, 2,180 feet south and 250 feet east:

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) silt loam; moderate fine and medium granular structure; friable; many roots; neutral; abrupt smooth boundary.

B1t—10 to 18 inches; yellowish brown (10YR 5/4) silty clay loam; moderate medium subangular blocky structure; friable; common roots; thin patchy dark brown (10YR 4/3) clay films on vertical surfaces of peds; 1 percent coarse fragments; slightly acid; clear smooth boundary.

IIB21t—18 to 27 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; friable; common roots; thin patchy dark brown (10YR 4/3) clay films on vertical surfaces of peds; 3 percent coarse fragments; slightly acid; clear smooth boundary.

IIB22t—27 to 37 inches; yellowish brown (10YR 5/4) clay loam; many medium distinct grayish brown (10YR 5/2), yellowish brown (10YR 5/6), and dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; friable; few roots; medium patchy dark brown (10YR 4/3) clay films on vertical surfaces of peds; 6 percent coarse fragments; slightly acid; clear smooth boundary.

IIB23t—37 to 46 inches; grayish brown (10YR 5/2) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; medium coarse subangular blocky structure; friable; medium continuous dark brown (10YR 4/3) clay films on surface of peds; 8

percent coarse fragments; slightly acid; clear smooth boundary.

IIB3—46 to 52 inches; dark yellowish brown (10YR 4/4) gravelly sandy clay loam; many medium prominent dark gray (10YR 4/1) mottles; and few medium faint pale brown (10YR 6/3) and grayish brown (10YR 5/2) mottles; weak coarse subangular blocky structure; friable; 15 percent coarse fragments; neutral; clear smooth boundary.

IIIC—52 to 65 inches; dark brown (10YR 4/3) very gravelly loamy sand; common medium distinct grayish brown (10YR 5/2) and light yellowish brown (10YR 6/4) mottles; single grained; loose; 50 percent coarse fragments; strong effervescence; moderately alkaline.

The solum ranges from 40 to 60 inches in thickness. Carbonates are at a depth ranging from 32 to 55 inches.

The Ap horizon has hue of 10YR, value of 4, and chroma of 2 or 3. It is silt loam or loam. It ranges from medium acid to neutral.

The B1 and B2 horizons have hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. Chroma of 2 are in subhorizons of the B horizon but are not dominant. These horizons are silty clay loam, clay loam, or sandy clay loam. They are medium acid or slightly acid. The B3 horizon has hue of 10YR, value of 4, and chroma of 4 or 5. It is gravelly sandy clay loam or sandy loam. It ranges from slightly acid to mildly alkaline.

The C horizon is very gravelly loamy sand or stratified sand and gravel.

Tippecanoe series

The Tippecanoe series consists of deep, moderately well drained soils on glacial outwash terraces. They formed in a thin layer of loess or silty alluvium and in the underlying loamy outwash, over stratified sand and gravelly sand. These soils have moderate permeability. Slope is 0 to 2 percent.

These soils have a higher silt content than is defined for the Tippecanoe series, but this difference does not materially affect their use or management. Tippecanoe soils are commonly adjacent to Eldean, Ockley, and Warsaw soils. Eldean soils have an ochric epipedon and a solum less than 40 inches thick. Ockley soils have an ochric epipedon and do not have 2-chroma mottles in the upper 75 centimeters of the argillic horizon. Warsaw soils have a solum less than 40 inches thick.

Typical pedon of Tippecanoe silt loam, 0 to 2 percent slopes, about 1.3 miles northeast of Trenton, Madison Township, T. 2 N., R. 4 E., section 31, from northwest corner, 550 feet south and 740 feet east:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam; moderate fine granular structure; friable; neutral; clear smooth boundary.

A12—8 to 13 inches; very dark brown (10YR 2/2) heavy silt loam; moderate fine subangular blocky structure; friable; neutral; clear wavy boundary.

B21t—13 to 20 inches; brown (10YR 4/3) silty clay loam; moderate medium subangular blocky structure; firm; thin patchy clay films and silt coatings on surfaces of peds; neutral; clear wavy boundary.

B22t—20 to 27 inches; brown (10YR 4/3) silty clay loam; common fine distinct yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; very patchy organic stains and thin continuous clay films on surfaces of peds; neutral; clear smooth boundary.

B23t—27 to 38 inches; brown (10YR 4/3) silty clay loam; common medium distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; thin continuous clay films on surfaces of peds; neutral; clear smooth boundary.

IIB24t—38 to 50 inches; yellowish brown (10YR 5/4) clay loam; weak medium subangular blocky structure; firm; thin patchy clay films on vertical faces of peds; common pebbles throughout; neutral; clear wavy boundary.

IIB3—50 to 61 inches; yellowish brown (10YR 5/4) sandy clay loam; weak coarse subangular blocky structure; friable; mildly alkaline; clear wavy boundary.

IIIC—61 to 83 inches; yellowish brown (10YR 5/4) gravelly sandy loam; massive; friable; mildly alkaline.

The solum ranges from 40 to 70 inches in thickness.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 2. It is silt loam or loam.

The B horizon has hue of 10YR, value of 4 to 6, and chroma of 3 or 4. The upper part of this horizon may be mollic. The horizon is silty clay loam or heavy silt loam. The IIBt horizon has the same colors but is clay loam or sandy clay loam.

The IIIC horizon is gravelly sandy loam, gravelly loamy sand, or stratified sand and gravel.

Uniontown series

The Uniontown series consists of deep, well drained soils that have moderate to moderately slow permeability. These soils formed in medium textured and moderately fine textured sediment deposited in former glacial lakes of Wisconsin age. They are on stream terraces. Slope is 0 to 6 percent.

Uniontown soils formed in lacustrine material as did Patton and Henshaw soils. Uniontown soils commonly are adjacent to somewhat poorly drained Henshaw soils and poorly drained Patton soils. Uniontown soils have a light colored surface layer in contrast to the dark colored surface layer of Patton soils. They are less gray and less mottled in the subsoil than Henshaw soils.

Typical pedon of Uniontown silt loam, 0 to 2 percent slopes, about 0.5 mile east of Shandon, Morgan Township, T. 3 N., R. 1 E., section 25, from northeast corner, 2,500 feet south and 50 feet west:

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; many roots; neutral; abrupt smooth boundary.

B1—10 to 14 inches; brown (10YR 4/4) heavy silt loam; weak medium subangular blocky structure; friable; common roots; slightly acid; clear smooth boundary.

B21t—14 to 20 inches; yellowish brown (10YR 5/4) silty clay loam; moderate medium subangular blocky structure; firm; few roots; thin patchy brown (10YR 4/3) clay films on faces of peds; medium acid; clear smooth boundary.

B22t—20 to 32 inches; yellowish brown (10YR 5/4) silty clay loam; many medium faint yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; few roots; thin continuous brown (10YR 4/3) clay films on faces of peds; few black iron-manganese concretions; slightly acid; gradual smooth boundary.

B23t—32 to 39 inches; yellowish brown (10YR 5/4) silty clay loam; many coarse prominent grayish brown (10YR 5/2) mottles; moderate coarse subangular blocky structure; firm; few roots; thin patchy brown (10YR 5/3) clay films on faces of peds; neutral; clear smooth boundary.

B3—39 to 49 inches; grayish brown (10YR 5/2) light silty clay loam; many coarse prominent yellowish brown (10YR 5/4) mottles; moderate coarse subangular blocky structure; firm; few roots; thin patchy brown (10YR 5/3) clay films on faces of peds; neutral; clear smooth boundary.

C—49 to 66 inches; grayish brown (2.5Y 5/2) silt loam; common medium distinct yellowish brown (10YR 5/4) mottles; massive; friable; few 1 to 2 millimeter calcium carbonate segregations; few thin (3 to 6 millimeter) strata of sandy loam and loam; slight effervescence; mildly alkaline.

The solum ranges from 36 to 60 inches in thickness. It is normally neutral or calcareous within a depth of 42 inches.

The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3.

The B2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is mainly silty clay loam but ranges to silt loam.

Warsaw series

The Warsaw series consists of deep, well drained soils that have moderate permeability. These soils have formed in medium textured outwash overlying stratified calcareous sand and gravel at depth of 24 to 40 inches. They are on terraces. Slope is 0 to 3 percent.

Warsaw soils are commonly adjacent to Eldean and Wea soils that are in similar positions on the landscape. Warsaw soils have a darker colored A horizon and coarser textured B horizon than Eldean soils. Warsaw soils have a thinner solum than Wea soils.

Typical pedon of Warsaw loam, 0 to 3 percent slopes, about 2 miles south of Trenton, Madison Township, T. 1 N., R. 4 E., section 8, from southeast corner, 488 feet north and 2,380 feet west:

Ap—0 to 9 inches; very dark brown (10YR 2/2) loam; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A12—9 to 17 inches; very dark brown (10YR 2/2) loam; weak fine and medium granular structure; friable; neutral; clear wavy boundary.

B21t—17 to 23 inches; brown (7.5YR 4/4) light sandy clay loam; moderate medium subangular blocky structure; firm; thin patchy dark brown (7.5YR 3/2) clay films on faces of most peds; 10 percent fine gravel; neutral; clear wavy boundary.

B22—23 to 29 inches; brown (7.5YR 4/4) sandy clay loam; moderate medium subangular blocky structure; firm; thin patchy dark brown (7.5YR 3/2) clay films of faces of some peds and lining some voids; 10 percent fine gravel; neutral; clear irregular boundary.

B3—29 to 32 inches; dark brown (7.5YR 3/2) gravelly sandy clay loam; weak medium subangular blocky structure; friable; thin black (10YR 2/1) organic and clay films on faces of peds, lining voids, and on surfaces of pebbles; common very pale brown (10YR 7/3) limestone pebbles; slight effervescence; mildly alkaline; abrupt wavy boundary.

IIC—32 to 60 inches; brown (10YR 4/3) very gravelly loamy sand; single grained; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 40 inches, and it commonly is the same as the depth to sand and gravel. Gravel commonly is less than 10 percent, by volume, of the A horizon and upper part of the B horizon. In some pedons, a silt layer as much as 24 inches thick is on the surface.

The mollic epipedon ranges from 12 to 20 inches in thickness. The Ap and/or A1 horizons are very dark grayish brown (10YR 3/2), dark brown (7.5YR 3/2), or very dark brown (10YR 2/2). The A horizon is generally loam but ranges to silt loam.

The B2t horizon has hue of 10YR or 7.5YR, value of 3 to 5, and dominant chroma of 3 or 4. It is typically sandy clay loam or gravelly clay loam but individual horizons range from sandy loam to silty clay loam. The B2t horizon ranges from medium acid to neutral. The B3 horizon overlying the calcareous gravel ranges from neutral to moderately alkaline. In some pedons, a strongly illuviated horizon of clay and organic matter is at the contact of the calcareous sand and gravel. It normally has a darker color than the overlying B horizon. The dolomite pebbles in this layer show evidence of weathering.

The underlying C horizon ranges considerably in proportion of sand and gravel and in the degree of stratification.

Wea series

The Wea series consists of deep, well drained soils on glacial outwash terraces and plains. These soils formed in a mantle of loess in the underlying loamy outwash over sand and gravel. Slope is 0 to 6 percent.

These soils have a higher silt content than is defined as the range for the Wea series, but this difference does not materially effect their use or management.

Wea soils are similar to Tippecanoe soils and commonly are adjacent to Ockley, Tippecanoe, and Warsaw soils. Tippecanoe soils have 2-chroma mottles in the upper 75 centimeters of the argillic horizon. Ockley soils have a ochric epipedon and are in a fine-loamy family. Warsaw soils are in a fine-loamy family and have a solum that is less than 40 inches thick.

Typical pedon of Wea silt loam, 0 to 2 percent slopes, about 0.5 mile southwest of Symmes Corner, Fairfield Township, R. 2, T. 1, section 3, from northeast corner, 1,315 feet south and 1,980 feet west:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 3/3) rubbed; weak fine granular structure; friable; medium acid; abrupt smooth boundary.

A12—9 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 3/3) rubbed; moderate fine and medium subangular blocky structure; friable; slightly acid; clear wavy boundary.

B1—14 to 19 inches; dark yellowish brown (10YR 4/4) dark brown (10YR 3/3) heavy silt loam; moderate fine and medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21t—19 to 25 inches; dark yellowish brown (10YR 4/4) silty clay loam; dark brown (10YR 3/3) organic coatings on faces of peds; moderate medium subangular blocky structure; firm; thin patchy clay films on faces of peds; slightly acid; clear wavy boundary.

B22t—25 to 30 inches; dark yellowish brown (10YR 4/4) silty clay loam; strong medium subangular blocky structure; firm; thin patchy dark brown (10YR 3/3) clay films on vertical and horizontal faces of peds; slightly acid; clear wavy boundary.

B23t—30 to 35 inches; dark yellowish brown (10YR 4/4) silty clay loam; strong medium subangular blocky structure; firm; thin patchy dark brown (10YR 3/3) clay films on vertical and horizontal faces of peds; slightly acid; clear wavy boundary.

IIB24t—35 to 41 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium and coarse subangular blocky structure; firm; thin patchy brown (10YR 4/3) clay films on vertical faces of peds; 2 percent rounded, 2 to 5 millimeter pebbles; 2 percent white chert fragments; slightly acid; clear wavy boundary.

IIB25t—41 to 48 inches; dark yellowish brown (10YR 4/4) clay loam; weak coarse subangular blocky structure; firm; thin patchy brown (10YR 4/3) clay films on few vertical faces of peds; 3 percent rounded, 2 to 5 millimeter pebbles; slightly acid; clear wavy boundary.

IIB3—48 to 56 inches; dark brown (7.5YR 3/2) clay loam; weak coarse subangular blocky structure; firm; 5 percent 2 to 5 millimeter pebbles; neutral; clear irregular boundary.

IIIC1—56 to 65 inches; yellowish brown (10YR 5/4) and brown (10YR 5/3) stratified gravelly loamy sand; single grained; loose; strong effervescence; moderately alkaline.

The solum ranges from 40 to 70 inches in thickness.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 2. It is silt loam or loam. The A12 horizon, where present, is the same color and texture.

The B1 horizon has hue of 10YR, value of 3 to 5, and chroma of 3 or 4. It is silt loam or light silty clay loam. The B2t horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. It is silt loam or silty clay loam. The IIB horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 to 4. It is clay loam or loam.

The IIIC horizon is gravelly loamy sand or stratified sand and gravel.

Wynn series

The Wynn series consists of moderately deep, well drained soils on uplands. These soils have moderately slow or slow permeability. They formed in a thin layer of loess, in glacial till, and the underlying residuum from calcareous clay shale and limestone bedrock. Slope is 2 to 18 percent.

Wynn soils are commonly adjacent to Eden soils. Wynn soils differ from Eden soils because part or all of the B horizon of Wynn soils developed in glacial till and the B horizon of Eden soils developed in residuum of clay shale and limestone. Wynn soils are also commonly adjacent to Miamian-Russell, bedrock substratum, soils on similar positions on the landscape. Wynn soils have bedrock at a depth of 20 to 40 inches; the latter soils are more than 40 inches to stony till over bedrock. In addition, Miamian and Russell soils commonly have a thicker mantle of loess.

Typical pedon of Wynn silt loam, 6 to 12 percent slopes, moderately eroded, about 0.8 mile southeast of Somerville, Milford Township, T. 5 N., R. 2 E., section 2, from southwest corner, 1,580 feet north and 1,075 feet east:

Ap—0 to 8 inches; brown (10YR 4/3) silt loam; weak fine granular structure; friable; many roots; neutral; abrupt smooth boundary.

B1—8 to 12 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine and medium subangular blocky structure; friable; common roots; slightly acid; clear smooth boundary.

B21t—12 to 16 inches; brown (7.5YR 4/4) heavy silty clay loam; moderate medium subangular blocky structure; firm; common roots; thin patchy dark brown (7.5YR 4/2) clay films; 2 percent fine till pebbles; slightly acid; clear wavy boundary.

IIB22t—16 to 21 inches; dark reddish brown (5YR 3/4) clay; moderate coarse subangular blocky structure; firm; common small roots; thin very patchy dark brown (7.5YR 4/2) clay films; fine root channels and voids lined with dark brown (7.5YR 4/2) coatings; 8 percent coarse fragments including 3 percent limestone fragments; neutral; clear wavy boundary.

IIB23t—21 to 26 inches; dark reddish brown (5YR 3/4) clay; moderate coarse subangular blocky structure; firm; few roots; thin very patchy dark brown (7.5YR 4/2) clay films; 10 percent coarse fragments including 4 percent limestone fragments; neutral; clear wavy boundary.

IIB3—26 to 29 inches; 70 percent dark reddish brown (5YR 3/4) and 30 percent light olive brown (2.5Y 5/4) clay; weak coarse subangular blocky structure; firm; few roots; 10 percent coarse fragments including 4 percent limestone fragments; neutral; clear smooth boundary.

IIIC—29 to 33 inches; 65 percent olive brown (2.5Y 4/4) clay and 35 percent dark reddish brown (5YR 3/4) heavy clay loam; massive; firm; olive brown material has strong effervescence, dark reddish brown material has slight effervescence; 10 percent thin limestone fragments; abrupt smooth boundary.

IIICr—33 to 45 inches; interbedded calcareous olive brown (2.5Y 4/4) clay shale and dark gray (10YR 4/1) thin bedded strata of limestone that is jointed, fossiliferous, and of Ordovician age.

The solum ranges from 20 to 40 inches in thickness; a paralithic contact is within a depth of 40 inches. The upper part of the solum formed in a thin loess mantle that ranges from 10 to 22 inches in thickness, the most common thickness is about 12 to 18 inches. There are no coarse fragments in the upper part of the solum that formed in loess, and coarse fragments range from 2 to 15 percent in the horizons formed in till. The Bt horizon formed principally from glacial till containing a component of local limestone and shale. The upper part of the solum is strongly acid to neutral, and the lower part is neutral to moderately alkaline.

The Ap horizon is dark brown (10YR 4/3) or dark grayish brown (10YR 4/2). Undisturbed areas have an A1 horizon that is 2 to 5 inches thick and is very dark grayish brown (10YR 3/2) or very dark brown (10YR 2/2); these areas also have an A2 horizon that is 3 to 6 inches thick, brown (10YR 5/3) or pale brown (10YR 6/3), and has weak platy structure. The A horizon is commonly silt loam; in moderately eroded areas it is silty clay loam and in severely eroded areas it is clay loam.

The B horizon ranges from dark yellowish brown (10YR 4/4) to dark reddish brown (5YR 3/4). Coatings have hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 to 4. Texture of the B2 and B3 horizons is heavy clay loam, heavy silty clay loam, silty clay or clay. The B3 horizon extends into calcareous till or residuum from Ordovician material.

The C horizon typically is calcareous clay residuum from shale but is calcareous clay loam till in places. Skeletal material of limestone fragments or till pebbles make up as much as 50 percent of volume. The Cr horizon consists of interbedded calcareous shale on thin jointed strata of limestone with the shale predominating.

Xenia series

The Xenia series consists of deep, moderately well drained soils on glacial till plains and in till filled valleys. These soils formed in a mantle of loess and the underlying calcareous glacial till over Ordovician bedrock in many areas. They have moderately slow permeability. Slope is 0 to 6 percent.

Xenia soils are commonly adjacent to Fincastle and Russell soils. Fincastle soils are dominantly 2 in chroma below the Ap horizon and Russell soils lack 2-chroma mottles in the upper 10 inches of the argillic horizon.

Typical pedon of Xenia silt loam, 2 to 6 percent slopes, about 3 miles south of Monroe, Liberty Township, R. 3, T. 3, section 9, from southwest corner, 430 feet north and 2,190 feet east:

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; neutral; clear smooth boundary.

B&A—6 to 10 inches; brown (10YR 5/3) (B, 60 percent) and grayish brown (10YR 5/2) (A, 40 percent) heavy silt loam; weak fine and medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

B21t—10 to 14 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine and medium subangular blocky structure; friable; thin patchy grayish brown (10YR 5/2) clay films on surfaces of peds; medium acid; clear smooth boundary.

B22t—14 to 20 inches; dark yellowish brown (10YR 4/4) silty clay loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; thin patchy grayish brown (10YR 5/2) clay films on surfaces of peds; medium acid; clear wavy boundary.

B23t—20 to 25 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) silty clay loam; common fine distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; thin patchy grayish brown (10YR 5/2) clay films on surfaces of peds; common small very dark brown (10YR 2/2) iron-manganese concretions; medium acid; clear wavy boundary.

IIB24t—25 to 31 inches; yellowish brown (10YR 5/4 and 5/6) silty clay loam; few fine faint grayish brown (10YR 5/2) mottles; moderate coarse subangular blocky structure; firm; thin very patchy grayish brown (10YR 5/2) clay films on surfaces of peds; few fine very dark brown (10YR 2/2) iron-manganese concretions; 2 percent fine angular till pebbles; neutral; clear smooth boundary.

IIB3—31 to 37 inches; dark yellowish brown (10YR 4/4) clay loam; few medium distinct yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; weak coarse subangular blocky structure; firm; 5 percent fine angular till pebbles in upper part and limestone segregations in lower part of horizon; mildly alkaline; abrupt irregular boundary.

IIC—37 to 72 inches; olive brown (2.5YR 4/4) light clay loam; many medium distinct grayish brown (2.5YR 5/2) mottles; massive; firm; 8 percent angular till pebbles; strong effervescence; moderately alkaline.

The thickness of the solum and depth to carbonates ranges from 36 to 50 inches. The loess cap ranges from 22 to 36 inches in thickness.

The Ap horizon is 10YR 4/2 or 10YR 3/4. It ranges from medium acid to neutral. It is silt loam.

The B2 horizon is 10YR 4/4, 10YR 5/4, or 10YR 4/3. It is silty clay loam. The IIB2 horizon and IIB3 horizons formed in till and are similar to the B2 horizon in color, but are clay loam.

The C horizon is clay loam or loam till.

Formation of the soils

This section has two main parts. First, the important factors of soil formation are discussed as they relate to the formation of soils in Butler County. Next, the processes of formation of soil horizons are described.

Factors of soil formation

The important factors in soil formation are parent material, climate, living organisms, topography, and time.

Climate and living organisms, particularly vegetation, are the active factors in soil formation. Their effect on the parent material is modified by topography and by the length of time the parent material has been acted upon. The relative importance of each factor differs from place to place. In some places, one factor dominates and is responsible for most of the soil properties, but normally, the interaction of all five factors determines the kind of soil that forms in any given place.

Parent material

Most soils in Butler County formed in glacial materials of Wisconsin age or Illinoian age. These materials consist of glacial till, outwash material, loess, and silty and clayey lacustrine material.

Some soils formed in alluvial material washed from uplands. The Eden soils formed in residuum weathered from interbedded shale and limestone. They commonly contain many limestone flagstones and have the steeper slopes (*5*).

The Miamian, Russell, Xenia, and Fincastle soils formed in Wisconsin age glacial till covered with loess of variable thickness. These soils are deep because they formed in thick soil materials. The Miamian soils generally are only moderately deep to carbonates because they lack a thick loess cap. Russell, Xenia, and Fincastle soils are deeper to carbonates than Miamian soils and have a thicker loess cap. The underlying glacial till is 20 to 40 percent calcium carbonate, a relatively high percentage. Uniontown, Patton, and Henshaw soils have a high content of silt because they formed in silty sediments deposited in areas that ponded in postglacial time. Warsaw and Eldean soils are moderately deep over calcareous sand and gravel because they formed in Wisconsin age outwash materials. Ockley and Wea soils formed in thicker materials similar to that underlying the Warsaw and Eldean soils. The Avonburg and Rossmoyne soils are weathered to greater depths, because they formed in older Illinoian age glacial materials.

Some soils in the county formed in material that washed from other soils and was deposited on bottom lands. Because this material is continually deposited, soils on bottom lands show little or no profile development. Ross, Genesee, Eel, and Shoals soils formed on bottom lands in thick silty and loamy deposits. They are nearly neutral in reaction because their parent material washed from calcareous till. The sandy Stonelick and Landes soils formed in coarser textured sediments than Ross, Genesee, and similar soils.

Climate

Climate affects the development of soils in several ways in Butler County. Rainfall and temperature have favored plant growth, and most of the soils have a surface layer than contains significant amounts of organic matter. The surface layer of Ragsdale, Brookston, Patton, and other soils is dark colored because it has a large accumulation of organic matter as is characteristic in a local wet microclimate. Most of the parent materia in the county is weathered to a moderate depth. Weathering is shallow in soils that have strong slopes and a high calcium carbonate equivalent. In this county, frequent rain and snow have supplied ample moisture for weathering the Miamian, Russell, Wynn, and other soils, and the water has leached soluble carbonates to a moderate depth. The water from frequent rains have moved the clay from the surface layer to the subsoil. Evidence of such movement is the clay films in the subsoil of Eldean, Fincastle, and Wea soils. In this county the structure of most soils is at least partly the result of freezing and thawing.

Living organisms

In addition to climate, organisms—plants, animals, insects, and man—are active factors of soil formation. Hardwood trees have been the dominant native vegetation in Butler County for a long time. Russell, Fincastle, Xenia, and most other soils on uplands have a light-colored surface layer and are acid because they formed under hardwood trees. The dark-colored Dana and Wea soils formed in small areas under mixed prairie vegetation and trees. The dark-colored Raub, Patton, Ragsdale, and similar soils formed in marshy swales and flats where excessive water has slowed the oxidation of organic matter.

By their channeling activities, insects, worms, tree roots, and small animals make the soils more permeable. Worms, ants, and other insects mix the soil material considerably. Crayfish, whose burrows frequently extend to a depth of 4 or 5 feet, mix much of the material in the Patton and Avonburg soils.

Man also influences soils. Construction work and soil tillage drastically alter the surface layer. When man drains, irrigates, and fertilizes the soils, the natural chemical and climatic soil regime is greatly affected. Man's activity also causes accelerated erosion and loss of organic matter, plant nutrients, and soil material.

Topography

Some differences in the soils of this county are caused by relief or topography. The Russell, Xenia, Fincastle, and Ragsdale soils formed under similar conditions except for natural drainage, which depends largely on topography. The gently sloping to sloping Russell soils have good surface and internal drainage. Xenia soils are nearly level to sloping and moderately well drained. They are in convex positions where the water table is high for relatively short but significant periods. The Fincastle soils are somewhat poorly drained. They are nearly level and generally occur on slight rises where surface runoff is mostly slow and the water table is seasonally high for long periods. Water tends to accumulate on the nearly level to depressional, very poorly drained Ragsdale soils.

Because of the differences in drainage, there are other differences in the soils. For example, mottles are nearer the surface in the Fincastle soils than in Xenia or Russell soils. The Fincastle soils are grayer than the Xenia or Russell soils because they have been saturated for longer periods.

The poorly drained or very poorly drained soils in this county are nearly level or depressional. They occur where surface runoff is slow to ponded and where silty and clayey materials tend to accumulate. The very poorly drained Patton and Ragsdale soils have a thick, dark-colored surface layer because organic matter decomposes slowly in wet soils.

Sloping soils in a given series, in most places, are thinner than less sloping soils in the same series. For example, the Wynn soils, 6 to 12 percent slopes, moderately eroded, have thinner horizons and a thinner solum (A and B horizons) than Wynn silt loam, 2 to 6 percent slopes. The Hennepin soils are generally thinner than less steep soils, partly because erosion removes soil material from steeper soils faster than from less steep soils.

Time

Important in soil development is the time that parent material has been in place and exposed to the active factors of climate and vegetation. In Butler County, glacial materials of Illinoian age have been exposed for roughly 100,000 to 300,000 years (*4*), and those of Wisconsin age are much younger, ranging from 10,000 to 20,000 years. Time has permitted the soils that formed in Illinoian material to be leached to a greater depth than the soils that formed in Wisconsin age materials. The depth to carbonates ranges roughly from 2 to 4 feet in the Miamian, Eldean, and similar soils that formed in glacial till or outwash of Wisconsin age; it ranges from 6 to 10 feet or more in the Cincinnati, Rossmoyne, and similar soils that formed in glacial till of outwash or Illinoian age. Rocks and minerals in Illinoian-age till are weathered more than those in Wisconsin-age till.

Eel, Ross, Genesee, and other soils on bottom lands formed in recently deposited material and continue to receive new material from periodic floods. In these soils, profile development starts with the accumulation of organic matter in the surface layer. Because this accumulation is interrupted by successive alluvial deposits of varying amounts, these soils have a variable content of organic matter.

Processes of soil formation

The soil-forming processes of addition, loss, transfer, and alteration of soil material and its components are controlled or influenced by the factors of soil formation discussed in the foregoing section. Some of these processes promote differences in a soil; other retard or prevent differences.

In Butler County the most evident soil-forming process is the addition of organic matter to the surface layer. Soils that formed under deep-rooted grasses or where a high water table has restricted decomposition of organic matter, have a deep, dark-colored surface layer as in the Warsaw or Ragsdale soils. These soils have a high content of organic matter, good structure, and a base saturation of more than 50 percent. Some organic matter accumulates as a thin surface mat in most of the soils. This accumulation is generally mixed with other soil material by cultivation, however, and evidence of the dark layer is obliterated.

Bases are also added to the soils in the organic matter and in seepage water, in depositions of eroded material, and in additions of lime and fertilizer. Plant nutrients move in a cycle from soil to plants and then back to soil again in the form of litter or other organic material. The Patton, Ragsdale, and Raub soils are seasonally waterlogged and continually accumulate bases through additions from seepage water. In these soils additions of bases are commonly greater than losses. Floodwaters periodically supply additions of alluvium to Genesee, Ross, Shoals, and Lanier soils. When lime and fertilizer are added to cultivated soils, the added plant nutrients counteract, or may even exceed, the amount normally lost when crops are harvested.

In some soils, however, bases are removed by leaching and soil material is lost through erosion. Among the most significant in Butler County are losses through leaching of carbonates. Carbonates were removed to a depth of 2 to 10 feet or more in the Miamian, Xenia, Russell, Cincinnati, and most other soils on the glaciated uplands in the county, where the original soil material was 20 to 40 percent calcium carbonate. Removal is slower from the Eldean, Warsaw, and similar soils, which have a much higher content of calcium in the underlying sand and gravel than does glacial till. In these soils, the calcium carbonate equivalent ranges from 40 to 60 percent in the sand and gravel particles less than 2 millimeters in size. The content of limestone gravel is about 75 to 85 percent.

Other minerals in the soil break down and are lost by leaching, but at a slower rate than the carbonates. After carbonates are leached, alteration of minerals, such as biotite and feldspars, produces changes of color within the profile. Free iron oxides are produced when some minerals are altered in the Princeton, Eldean, and similar soils, and fairly bright reddish or brownish colors appear. Because of the recurrent high water table in Ragsdale, Patton, and similar soils, iron oxides are reduced and then lost through leaching. This changes the soil color to gray. The mottling in all except the well drained soils is caused by the reduction and resegregation of the iron oxides that occur when the water table fluctuates. If ground water is not within the profile, brownish colors of stronger chroma or redder hue than those of the C horizon will develop.

Seasonal wetting and drying appear to be largely responsible for the transfer of clay from the A horizon to the ped surfaces in the B horizon. The fine clay becomes suspended in percolating water that moves through the surface layer and is carried to the subsoil where it is deposited on the ped surfaces by drying or by precipitation caused by free carbonates. The transfer of fine clay accounts for the nearly continuous clay coatings on ped surfaces in the B horizon of the Russell and Ockley soils.

Transformations of mineral compounds occur in most soils. The results are most apparent if the development of horizons is not affected by rapid erosion or by accumulation of material at the surface. The primary silicate minerals are weathered chemically to produce secondary minerals, mainly silicate clays. Most of the clays remain in the soil profile, but clay from the A horizon is transferred to deeper horizons. In the Miamian soils, illite is the most common clay mineral in the loamy glacial till. Because it is altered by weathering, only a minor amount of illite remains in the surface layer where vermiculite is the dominant mineral. Montmorillonite, vermiculite, and illite are about equal in the B horizon, where a large amount of clay has accumulated. Kaolinite, a clay mineral that indicates fairly intense weathering, is present only in minor amounts in the Miamian soils and in most other soils of the county.

The soils that make up most of the acreage in Butler County have rather strongly developed profiles. The processes of soil formation have produced distinct changes in the parent material. These well developed soils are level to very steep, and they formed in deposits of glacial till and in terraces of glacial outwash along the major valleys. In a small part of the county, parent materials have been only slightly modified by the processes of soil formation. Some of these soils are on flood plains and some are steep.

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) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(3) 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.

(4) Fenneman, Nevin M. 1916. Geology of Cincinnati and vicinity. Geol. Surv. of Ohio. Bull. 19, pp. 20, 21.

(5) Flint, Richard Foster. 1955. Pleistocene geology of eastern South Dakota. U.S. Geol. Surv., Prof. Pap. 262, 173 pp., illus.

(6) Ohio Soil and Water Conservation Needs Committee. 1971. Ohio soil and water conservation needs inventory. Spons. U.S. Dep. Agric., 131 pp.

(7) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. of Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(8) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(9) United States Department of Agriculture. 1975. Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys. Agric. Handb. 436, 754 pp., illus.

Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

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.

California bearing ratio (CBR). The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

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.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. Mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

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.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 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 arresting grazing for a prescribed period.

Depth to rock. Bedrock is too near the surface for the specified use. In this survey the depth to rock is defined as follows: shallow, 10 to 20 inches; moderately deep, 20 to 40 inches; deep, over 40 inches.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess alkali (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

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.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

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 melt water. Many deposits are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

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.

Haylage. Silage consisting of chopped up grass.

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 upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil*

Survey Manual. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock 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.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.5 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 areas. Areas that have little or no natural soil and support little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

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).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, 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 0.20 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, differences in 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. 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 outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

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.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

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.

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. In this survey the root zone is defined as follows: shallow, less than 10 inches; moderately deep, 20 to 40 inches; deep, 40 to 60 inches.

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 groundwater 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.

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.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (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 (7.5 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 mm 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 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.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or " very fine."

Thin layer (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.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the low lands along streams.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded 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.

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.