SOIL SURVEY OF

MILWAUKEE AND WAUKESHA COUNTIES WISCONSIN

U. S. Department of Agriculture
Soil Conservation Service
In cooperation with
University of Wisconsin
Wisconsin Geological and Natural History Survey
Soils Department and
Wisconsin Agricultural Experiment Station

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Major fieldwork for this soil survey was done in the period 1963-65. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1965. This survey was made cooperatively by the Soil Conservation Service and the Wisconsin Geological and Natural History Survey, Soils Department, and the Wisconsin Agricultural Experiment Station, University of Wisconsin, as part of the assistance furnished to the Waukesha and Milwaukee Soil and Water Conservation Districts.

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Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Milwaukee and Waukesha Counties contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, or other structures; and in judging the suitability of tracts of land for farming, industry, wildlife, or recreation.

Locating Soils

All the soils of this survey area are shown on the detailed map at the back of this publication. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all of the soils of the two counties in alphabetic order by map symbol. It shows the page where each kind of soil is described and also the capability unit and the woodland, wildlife, recreation, and shrub and vine groups in which the soil has been placed.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text and tables. Interpretations not included in the text or in tables can be developed by grouping the soils according to their suitability or limitations for the desired purpose. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils by reading descriptions of the soils and the discussions of the capability units.

Foresters and others can refer to the subsection "Woodland and Community Planting," where the soils of the area are grouped according to their suitability for forest trees and for trees in various kinds of plantings.

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the subsection "Wildlife Uses of Soils."

Developers of campgrounds and other recreational facilities can refer to the subsection "Recreational Uses of Soils" to find limitations of soils for various types of recreational use.

Engineers and builders will find, under "Engineering Uses of Soils," tables that give test data and estimated properties of soils that affect engineering practices and structures.

Community planners and others concerned with suburban development can read about the properties that affect the choice of homesites, industrial sites, schools, and parks in the subsections "Engineering Interpretations" and "Recreational Uses of Soils."

Soil scientists and others can read about how the soils were formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Milwaukee and Waukesha Counties may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Facts About Milwaukee and Waukesha Counties," which gives additional information about the survey area.

Cover picture: A soil scientist sketching soil boundaries in a rural-fringe area of Waukesha County.

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SOIL SURVEY OF MILWAUKEE AND WAUKESHA COUNTIES, WISCONSIN

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UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY, SOILS DEPARTMENT, AND THE WISCONSIN AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF WISCONSIN

MILWAUKEE AND WAUKESHA COUNTIES are in the southeastern part of Wisconsin (fig. 1). Milwaukee

Figure 1.--Location of Milwaukee and Waukesha Counties in Wisconsin.

County is bordered on the east by Lake Michigan, and on the west, by Waukesha County. It has a total land area of 152,960 acres. Of this total acreage, about 58,350 acres within the city limits of Milwaukee was excluded from the survey, because the soils in that area had been disturbed too extensively for a detailed survey to be practical. Waukesha County has a total land area of 355,840 acres, all of which is in the survey area. The city of Milwaukee is the county seat of Milwaukee County, and the city of Waukesha is the county seat of Waukesha County.

Commerce and industry are important occupations in the east-central part of Milwaukee County. They are increasingly important in other parts of that county and in the eastern part of Waukesha County. Farming is still the leading occupation in the western two-thirds of Waukesha County, and dairying is the main farm enterprise in that area. Corn, small grains, and forage crops are grown extensively on the farms, and they provide feed for the dairy cattle, as well as some cash income. The largest tracts of woodland are also in the western two-thirds of Waukesha County, but smaller tracts are scattered throughout the rest of the survey area. These tracts supply wood products needed on the farms, and they provide some cash income from the sale of wood products. The wooded tracts and the many lakes are becoming increasingly important as recreational areas. They are also highly desirable as homesites for the expanding populations of southeastern Wisconsin and northeastern Illinois.

Although the importance of farming as an occupation has diminished in Milwaukee County and in the eastern part of Waukesha County, farm products are still highly important to the economy of the city of Milwaukee and surrounding areas. The processing and the shipping of grain, grain products, and other farm products provide employment for thousands of persons in this area. More than 1 million tons of farm products were moved through the port of Milwaukee (3) 1/ in 1963. Several million tons of products of various kinds are now moved through this port each year.

Soils in the survey area have formed mainly in material that was laid down through glaciation. Those in the eastern part have a rather high content of clay. They warm up slowly in spring, are easily compacted, and are likely to puddle if worked when wet. Most of the soils in the central and western parts tend to be droughty, and the sandy ones are subject to blowing. Soils in low areas are generally wet.

1/ Underscored numbers in parentheses refer to Literature Cited, p. 174.

HOW THIS SURVEY WAS MADE

Soil scientists made this survey to learn what kinds of soils are in Milwaukee and Waukesha Counties, where they are located, and how they can be used. The soil scientists went into the area knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the area, they observed steepness, length, and shape of slopes; size and speed of streams; extent of the flood plains and high watermarks; kinds of native plants or crops; kinds of rock and depth to bedrock; and many facts about the soils. They dug or bored many holes to expose soil profiles, and they also examined road cuts, trenches, gravel pits, newly dug basements; and the like, where soil profiles could be examined and studied. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this survey efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Kewaunee and Theresa, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Fox sandy loam and Fox silt loam are two soil types in the Fox series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Fox sandy loam, 0 to 2 percent slopes, is one of several phases of Fox sandy loam, a soil type that ranges from nearly level to sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew boundaries of the individual soils on aerial photographs. These photographs show woodland, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this survey was prepared from the aerial photographs. Generally speaking, the soils in rural areas have not been greatly disturbed by man, except for cultivation, and their boundaries could be plotted in detail with greater accuracy than those in cities and towns. Within cities and towns, where little open space remains, and where hills have been leveled, low areas filled in, and the natural soils greatly disturbed, the boundaries cannot be recognized or plotted easily. For this reason, an arbitrary boundary was drawn around the city of Milwaukee and its environs. Within this boundary, a detailed soil survey was not feasible, and that area was excluded from the soil survey.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed and occur in areas so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Casco-Rodman complex, 6 to 12 percent slopes, eroded. Also on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be classified by soil series. These areas are shown on the map like other mapping units, but they are given descriptive names, such as Alluvial land or Rough broken land, and are called land types.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are

similar in suitability for each specified use is the method of organization commonly used in soil surveys. On the basis of the yield and practice tables and other data, the soil scientists set up trial groups, and then test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

GENERAL SOIL MAP

The general soil map at the back of this survey shows, in color, the soil associations in Milwaukee and Waukesha Counties. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern and proportion.

A map showing soil associations is useful to people who want a general idea of the soils in a county or larger tract, who want to compare different parts of such a tract, or who want to know the location of large areas suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, or for choosing the site for a building or other structure, because the soils in any one association ordinarily are different in slope, depth, stoniness, drainage, and other characteristics that affect management.

The soil associations of Milwaukee and Waukesha Counties are described in the pages that follow and are shown on the colored map at the back of this survey.

1. Houghton-Palms-Adrian Association

Very poorly drained organic soils in depressions on old lakebeds and on flood plains

This association occurs throughout most of the survey area. The soils are mainly in marshy depressions and on the very gently sloping floors of stream valleys, where they have formed from dead and decaying remains of plants. In a few places, the soils occupy hanging bogs on seepy slopes adjacent to better drained soils of uplands. The association makes up about 5 percent of the survey area.

The major soils in this association are the Houghton, Palms, and Adrian. Houghton soils make up 65 percent of the total acreage; Palms soils, 15 percent; Adrian soils, 15 percent; and minor soils, 5 percent.

The Houghton soils have formed in a layer, more than 5 feet thick, of the remains of sedges, reeds, and other water-tolerant plants. The Palms and the Adrian soils are underlain by sand and by loamy material, respectively, at a depth of less than 40 inches.

A minor part of this association consists of organic soils that are underlain by marl or sedimentary peat at a depth of less than 40 inches. Another minor acreage consists of soils that occur at the edges of peat bogs and that have formed in silty alluvium over deposits of organic material. A small acreage is occupied by poorly drained mineral soils.

Much of this association is used to grow potatoes, onions, mint, sod, and other specialty crops. Where drainage is adequate, most of the soils are well suited to these crops. All of the major soils receive overwash or are subject to flooding, however, and drainage is needed for crops to grow well. Organic soils that are drained tend to shrink, and they are subject to subsidence and to damage from fire and soil blowing. The undrained areas are used for limited pasture, serve as wildlife habitat, and provide local reservoirs for runoff water that accumulates during wet periods.

These organic soils generally have severe limitations to use for housing developments and as sites for industries, commercial establishments, and roads. They can be used as mulch, topdressing, and potting soil for plants.

2. Fox-Casco Association

Well-drained soils that have a subsoil of clay loam; moderately deep to shallow over sand and gravel, on outwash plains and stream terraces

This association is mainly on sandy and gravelly outwash plains. Mostly it is in the northwestern part of Waukesha County, but it also occupies small areas on stream terraces in the valleys of the Fox, Root, Menomonee, and Milwaukee Rivers. Most of the association is covered by a thin layer of silt. The soils range from nearly level to steep, and they contain numerous ponds and lakes in kettleholes or steep-sided depressions of the outwash plains. These are loamy soils over stratified sand and gravel. The association occupies about 15 percent of the survey area.

Dominant in this association are well-drained Fox and Casco soils on uplands and on the higher terraces bordering the major streams. Fox soils occupy 60 percent of the total acreage; Casco soils, 30 percent; and minor soils, 10 percent.

The Fox soils have formed where the mantle of silt is generally 10 to 30 inches thick over glacial outwash. The Casco soils have formed where the mantle of silt is less than 10 inches thick.

A minor part of this association consists of soils that have formed in a mantle of silt that is 30 to 50 inches thick. Another minor part consists of soils that are very shallow over gravelly till.

Other small acreages are occupied by somewhat poorly drained and poorly drained soils that have formed in the same kinds of material as the Fox and Casco soils.

If management is good, nearly all of the acreage is suited to crops. Not well suited are some small areas of gravelly or droughty soils and areas where the content of plant nutrients is low. The Casco and Fox soils are somewhat droughty. Sandy areas of these soils are subject to blowing.

Most of this association is used for dairy farming. For many years areas adjacent to the lakes have been used as sites for resorts and summer homes. The Fox and Casco soils are well suited to use for housing developments, industrial and commercial establishments, and transportation systems. They are also a major source of sand and gravel (pl. I).

The many kinds of crops and native plants, the mixture of well-drained and poorly drained soils, and the many ponds and lakes make this association well suited to wildlife. Songbirds, upland game animals and game birds, migratory waterfowl, and small fur-bearing animals are the main kinds of wildlife.

3. Warsaw-Lorenzo Association

Well-drained soils that have a subsoil of clay loam; moderately deep over sand and gravel, on outwash plains and river terraces

This association is on sandy and gravelly outwash plains and on river terraces where the soils are underlain by stratified sand and gravel. Parts of the association are covered by a thin layer of silt. The largest areas are near the city of Waukesha and between the villages of Eagle and North Prairie in the southwestern part of Waukesha County (pl. I). The soils are mainly nearly level or gently sloping, but some areas are sloping and a few areas on terrace escarpments are steep. The association occupies about 3 percent of the survey area.

The major soils are the Warsaw and Lorenzo. Of the total acreage, Warsaw soils make up 70 percent; Lorenzo soils, 20 percent; and minor soils, 10 percent.

The Warsaw soils are nearly level or gently sloping, and the Lorenzo soils are gently sloping or sloping. In places the Warsaw soils have a mantle of silt 10 to 20 inches thick and the Lorenzo soils have a mantle of silt 3 to 10 inches thick over glacial outwash.

A minor part of this association is occupied by Rodman and other gravelly, excessively drained soils. These gravelly soils are on knolls and terrace escarpments where the layer of silt is thin or absent. Other minor acreages are occupied by soils on low stream terraces and in depressions where the water table is high most of the year.

All of the soils except the Rodman are suitable for cultivated crops. The Warsaw and Lorenzo soils are somewhat droughty, but they can be made more suitable for crops through proper management.

This association is used mainly for general dairy farming. A large part of the acreage is planted to corn that provides some feed for the dairy cattle. The Warsaw and Lorenzo soils have few limitations to use for industrial and housing developments, and they are suited to most engineering purposes. The more sloping areas and the somewhat poorly drained and poorly drained soils that occupy minor acreages have more severe limitations to use as sites for industrial and housing developments, or for engineering purposes, than the nearly level or gently sloping areas of Warsaw and Lorenzo soils.

This association is suitable for pheasant and other birds and for animals that require open spaces for their habitat.

4. Boyer-Oshtemo Association

Well-drained soils that have a subsoil of sandy loam and sandy clay loam; underlain by sandy material, on outwash plains

This association is on sandy, rather low, nearly level or gently sloping outwash plains locally known as Sandy Island. It is in the southwestern part of Waukesha County, south of the village of Dousman. The association occupies about 1 percent of the survey area.

The major soils are the Boyer and Oshtemo. Boyer soils make up 70 percent of the association; Oshtemo soils, 20 percent; and minor soils, 10 percent.

The Boyer and Oshtemo soils occupy the higher parts of the outwash plain. These soils are droughty, have low natural fertility, and are subject to blowing.

Minor soils in this association are the somewhat poorly drained Wasepi and poorly drained Granby. These soils are in swales on the lower slopes bordering areas of the sandy plains. Shallow organic soils underlain by sand are in the depressions. If the minor soils are drained, they can be used for corn grown for silage.

The Boyer and Oshtemo soils are used mainly for cultivated crops, but dairy farming is the main farm enterprise. Some areas are planted to conifers to be sold as Christmas trees and nursery stock. The demand for Christmas trees and nursery stock will likely increase as cities and towns take over more of the farmland.

5. Rodman-Casco Association

Excessively drained to well-drained soils that have a subsoil of gravelly sandy loam and clay loam; shallow over gravel and sand, on the Kettle Moraine

This association is made up mainly of kames, eskers, and kettleholes or potholes. The topography

is complex (pl. II), and the soils are generally too steep for crops that require cultivation. The soils are mainly droughty, medium textured, shallow over gravel and sand, and rather low in fertility. The association extends in a general north-south direction from the Walworth County line through the villages of Eagle, Wales, and Delafield, where it is intersected by the valley of the Bark River. Beyond this valley, it extends northward from the edge of Pine Lake through the village of North Lake and into Washington County. In some places the elevations are the highest of any in Milwaukee and Waukesha Counties. These high points were formed during the last glacial period, when the Green Bay and Lake Michigan lobes of the continental ice sheet joined and deposited glacial material. The association occupies about 5 percent of the survey area.

The major soils are those of the Rodman and Casco series. The Rodman soils occupy 45 percent of the association; the Casco soils, 30 percent; and minor soils, 25 percent.

The Rodman soils are excessively drained, and they occur on the steepest parts of the kames and eskers, where the mantle of silt is very thin or is absent. In most places the Rodman soils are intermingled with Casco soils, which are less sloping and are well drained.

A minor part of the association consists of Chelsea, Boyer, Fox, Lorenzo, and Houghton soils. The Houghton soils occupy foot slopes and potholes of steep-sided moraines. All the minor soils, except the Houghton, are droughty. Throughout the association, the sloping soils are subject to erosion and the soils that have a surface layer of sandy loam are subject to soil blowing.

Most of this association is occupied by native woodland or has been planted to conifers in recent years (pl. II). The association is generally well suited to use for recreational purposes and wildlife habitat. The high hills provide places for viewing the scenic countryside. Pasch, prairie smokeflower, birdsfoot violet, big bluestem, and many other plants native to dry prairies are abundant.

6. Ozaukee-Morley-Mequon Association

Well-drained to somewhat poorly drained soils that have a subsoil of silty clay loam and silty clay; formed in thin loess and silty clay loam glacial till, on moraines

This association is in glaciated uplands where the soils formed in a thin layer of loess and the underlying glacial till. The association extends westward from Lake Michigan. It consists of a narrow sand beach and intermittent "clay" bluffs and of gently sloping to rolling morainic ridges that roughly parallel the shoreline. The ridges rise progressively higher toward the western edge of the association. The association occupies about 37 percent of the survey area.

The major soils are the Ozaukee, Morley, and Mequon. Ozaukee soils make up 20 percent of the association; Morley soils, 18 percent; Mequon soils, 11 percent; and minor soils, 51 percent.

The Ozaukee and Morley soils are gently sloping, and they occupy ridges and convex side slopes of glacial moraines. The Mequon soils, also gently sloping, are in drainageways or old lake basins.

Minor soils in this association are the Blount, Markham, and Elliott. The Blount soils occur in drainageways or old lake basins. The Markham and Elliott soils are in slight depressions, mostly in the southern part of the association near the Racine County line.

Most of this association is within the corporate limits of villages and cities, and the rest is being built up rapidly (pl. III). On the few farms remaining, hay, flowers, truck crops, and nursery stock are grown extensively, and, to a lesser extent, corn, soybeans, and winter wheat.

Most of the association is well suited to farming, but erosion control is needed on the sloping soils, and drainage and protection from flooding are needed for the soils in the low areas. In general, the soils are not well suited to use as sites for disposal of effluent from septic tanks. If used for foundations or roads, some of the soils would require costly preparation.

7. Montgomery-Martinton-Hebron-Saylesville Association

Poorly drained to well-drained soils that have a subsoil of clay to clay loam; formed in silty clay or silty clay loam sediments, in old lakebeds

This association consists of nearly level, wet soils that lie on flats and in depressions and are intermingled with better drained soils in slightly higher areas. Some of the soils are dark colored, and others are light colored. They formed mainly from sandy, silty, or clayey lacustrine deposits that accumulated on the bottoms of temporary lakes or was deposited by very slowly moving glacial melt water. The association occupies about 4 percent of the survey area and is in scattered areas throughout the southeastern part.

The major soils are the Montgomery, Martinton, Hebron, and Saylesville, but the Navan soils are also fairly extensive. Montgomery soils occupy 20 percent of the association; Martinton soils, 15 percent; Hebron soils, 10 percent; and Saylesville soils, 10 percent. In addition, Navan soils make up 10 percent, and other minor soils, 35 percent.

The Montgomery soils are poorly drained, and they are in swales and on wet flats. The Martinton soils, which are somewhat poorly drained and the Saylesville, which are well drained or moderately well drained, are at a slightly higher elevation than the Montgomery soils. The Hebron soils, in old glacial lake basins and on river benches, are well drained or moderately well drained, and the Navan soils are poorly drained.

A minor part of the association is occupied by small areas of soils underlain by sandy and gravelly

outwash, and by areas of soils underlain by silty and clayey lacustrine deposits. Organic soils in small depressions occupy other minor acreages.

Soils of this association that have not been drained and improved are used as permanent pasture or as wildlife habitat. Many areas have been drained and are used for general farming or to grow truck crops and specialty crops. In general, the soils are not well suited to use as sites for housing developments, industrial developments, or roads.

8. Kewaunee-Manawa Association

Well-drained to somewhat poorly drained soils that have a subsoil of clay and silty clay; formed in thin loess and silty clay glacial till, on moraines and in depressed areas

This soil association, commonly called the red clay area, occupies glaciated areas between Lake Michigan and the valley of the Milwaukee River in the northeastern part of Milwaukee County. The soils are mainly gently sloping to rolling, but some of them on the sides of ravines and on lake bluffs bordering Lake Michigan are steep. This soil association occupies about 2 percent of the survey area.

The major soils are those of the Kewaunee and Manawa series. The Kewaunee soils make up 80 percent of the association; the Manawa soils, 15 percent; and minor soils, 5 percent.

Kewaunee and Manawa soils have formed in a thin layer of silt and in the underlying reddish-brown or light reddish-brown silty clay glacial till. The Kewaunee soils are on the convex side slopes of glacial moraines, and they are well drained or moderately well drained. The Manawa soils are in shallow swales or depressions, in nearly level areas, and on the side slopes of drainageways, and they are somewhat poorly drained.

Minor soils are the Fox, Casco, and Matherton, which are along drainageways that lead to the Milwaukee River. In addition, Sandy lake beaches occupy a narrow strip between the shoreline of Lake Michigan and the base of the bluffs.

Soils of this association are well suited to farming, but practically the entire area has been subdivided or is being subdivided for housing and other development. The soils in swales and drainageways are saturated with water during wet seasons, and they are not suitable as sites for disposal of effluent from septic tanks. If used for foundations or roads, some of the soils would require costly preparation.

9. Hochheim-Theresa Association

Well-drained soils that have a subsoil of clay loam and silty clay loam; formed in thin loess and loam glacial till, on ground moraines

This association consists of nearly level to steep soils, mostly on drumlins that extend in a northeast-southwest direction through the eastern and central parts of Waukesha County and in a northwest-southeast direction in the western part of that county (pl. III). In most places the soils have formed in a thin mantle of windblown silt and in the underlying loam and sandy loam glacial till. This till is 5 to 15 feet thick, and it is underlain by stratified sand and gravel. The association occupies about 27 percent of the survey area.

The major soils are those of the Hochheim and Theresa series, but Miami soils and Pella soils are also extensive. Hochheim soils make up about 35 percent of the association; Theresa soils, 10 percent; Miami soils, 5 percent; and Pella soils, 10 percent. In addition, about 35 percent of the association is occupied by poorly drained and somewhat poorly drained soils in depressions, drainageways, and other low places.

The Hochheim soils are sloping to steep. They are on the convex side slopes of drumlins and on ground moraines, where they have formed in a mantle of silt less than 12 inches thick over loam glacial till. The Theresa soils, which are nearly level or gently sloping, occur throughout the association on the side slopes of ground moraines. They have formed in a layer of silt that is 12 to 20 inches thick over till. The Miami soils are sloping to steep, and they occur on the side slopes of moraines and drumlins in the southern and western parts of Waukesha County. The Miami soils lack a mantle of silt, and they have formed directly in glacial till.

The major soils of this association are well drained, and they are well suited to farming. The nearly level or gently sloping soils are well suited to use for roads and as sites for housing developments and industrial developments, but the steeper areas are less well suited to these purposes.

The somewhat poorly drained and poorly drained soils that occupy minor acreages in low areas are also suitable for farming if they are adequately drained and are protected from flooding. Generally, however, they have severe limitations to use for roads or as sites for housing developments or industrial developments (pl. IV).

This soil association is used mainly for dairy farming, but the growing of cash crops is increasing. Areas along the eastern edge of Waukesha County are also being used for housing developments. Because of the wide variety of soils and drainage patterns, and the diversified types of farming in the area, this association provides abundant food and water, escape routes, and nesting sites for songbirds, upland game birds, and small fur-bearing animals.

10. Pella, moderately shallow variant-Knowles Association

Poorly drained and well-drained soils that have a subsoil of silty clay loam or clay loam; moderately shallow over dolomite bedrock

The largest area of this association is in the northeastern part of Waukesha County near the

villages of Sussex and Lannon. Other areas, some too small to be shown on the general soil map, are scattered throughout the survey area. The soils have formed in a thin deposit of loess and in the underlying glacial till. In most places the till is underlain at a depth of less than 40 inches by dolomite bedrock, but bedrock is at a depth of more than 5 feet in some small areas. Bedrock crops out in many places, and flagstones or slabs of dolomite are scattered on the surface in some areas. The association occupies about 1 percent of the survey area.

A major part of the association consists of soils of the Pella series, moderately shallow variant, and of soils of the Knowles series. The Pella soils, moderately shallow variant, occupy 50 percent of the total acreage; the Knowles soils, 40 percent; and minor soils, 10 percent.

Soils of the Pella series, moderately shallow variant, occur on flats and in swales between low glacial ridgetops and convex side slopes that are occupied by Knowles soils. The Pella soils are poorly drained, and the Knowles soils are well drained.

Only a small part of this association is used for crops, and the rest is mainly used for permanent pasture or as habitat for wildlife. The moderately shallow bedrock underlying the Pella soils makes drainage difficult. Where bedrock is at a great enough depth so that the soils can be tilled, and where the slabs of dolomite do not interfere with tillage, the Knowles soils are fairly well suited to crops. Shallow or rocky spots within cultivated fields are generally not disturbed. Some of these spots are used for pasture. Others are planted to trees and shrubs that furnish cover and nesting sites for wildlife.

Many quarries are located in this association (pl. IV). Limestone is removed and is used for building stone, as a source of agricultural lime and crushed rock, and for other related uses.

The moderately shallow bedrock limits use of these soils for residential developments and industrial and commercial establishments where excavation into the bedrock is necessary. Use of these soils as sites for disposal of effluent from septic tanks can contaminate the ground water because the effluent can seep through cracks in the fissured bedrock.

DESCRIPTIONS OF THE SOILS

This section describes the soil series and mapping units of Milwaukee and Waukesha Counties in alphabetical order. The procedure is first to describe the soil series, and then the mapping units in that series. Thus, to get full information on any mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs.

Each series contains a short nontechnical description of a typical soil profile and a much more detailed description of the same profile that scientists, engineers, and others can use in making highly technical interpretations. This profile is considered typical for all the soils of the series. If a profile for a given mapping unit differs from this typical profile, the differences are stated in the description of the mapping unit, unless the differences are apparent in the name of the mapping unit. The included soils named in the descriptions of the mapping units do not necessarily occur in all areas of the mapping unit, but they do occur in some areas.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Alluvial land, for example, does not belong to a soil series, but, nevertheless, it is listed in alphabetical order along with the soil series.

In describing the typical profile, the color of each horizon is described in words, such as yellowish brown, but it can also be indicated by symbols for the hue, value, and chroma, such as 10YR 5/4. These symbols, called Munsell color notations (6), are used by soil scientists to evaluate the color of the soil precisely. For the profiles described, the names of the colors and the color symbols are for a moist soil unless stated otherwise.

Following the name of each mapping unit, there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit, woodland group, wildlife group, recreation group, and shrub and vine group in which the mapping unit has been placed. The page on which each group is described can be found by referring to the "Guide to Mapping Units" at the back of this survey. Many terms in the soil descriptions and in other parts of the survey are defined in the Glossary. The acreage and proportionate extent of the mapping units are shown in table 1. The location of the soils in Milwaukee and Waukesha Counties are shown on the detailed map at the back of this survey.

Adrian Series

The Adrian series consists of very poorly drained soils that have formed in deposits of organic material over sand. These soils occupy fairly large areas of irregular shape in old glacial lakebeds and river basins. The native vegetation was mainly reeds and sedges.

In a typical profile, the surface layer is black muck that is neutral in reaction and is about 9 inches thick. Immediately beneath the surface layer is a layer of dark olive-gray, disintegrated mucky peat about 12 inches thick. This mucky peat is underlain by a layer, about 3 inches thick, of black muck that breaks down readily when rubbed between the fingers. Next is a layer of very dark gray muck that has a large content of sand. The substratum is at a depth of about 27 inches and is grayish-brown

TABLE 1.--APPROXIMATE ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Mapping unit	Milwaukee County 1/		Waukesha County		Total survey area	
	Acres	Percent	Acres	Percent	Acres	Percent
Adrian muck	20	(2/)	3,680	1.0	3,700	0.8
Alluvial land	150	0.1	260	.1	410	.1
Ashkum silty clay loam, 0 to 3 percent slopes	4,012	4.2	5,266	1.5	9,278	2.1
Aztalan loam, 0 to 2 percent slopes	225	.2	987	.3	1,212	.3
Aztalan loam, 2 to 6 percent slopes	440	.5	671	.2	1,111	.2
Blount silt loam, 1 to 3 percent slopes	11,860	12.6	3,395	1.0	15,255	3.5
Boyer loamy sand, 1 to 6 percent slopes	20	(2/)	2,897	.8	2,917	.6
Boyer loamy sand, 6 to 12 percent slopes, eroded	-----	-----	245	.1	245	.1
Boyer sandy loam, 1 to 6 percent slopes	30	(2/)	817	.2	847	.2
Brookston silt loam, 0 to 3 percent slopes	-----	-----	5,734	1.6	5,734	1.3
Casco sandy loam, 2 to 6 percent slopes	39	(2/)	490	.1	529	.1
Casco sandy loam, 6 to 12 percent slopes, eroded	10	(2/)	519	.1	529	.1
Casco sandy loam, 12 to 20 percent slopes, eroded	-----	-----	1,597	.4	1,597	.3
Casco loam, 2 to 6 percent slopes	365	.4	6,316	1.8	6,681	1.5
Casco loam, 6 to 12 percent slopes, eroded	85	.1	7,053	2.0	7,138	1.6
Casco loam, 12 to 20 percent slopes, eroded	20	(2/)	3,216	.9	3,236	.7
Casco soils, 6 to 12 percent slopes, severely eroded	-----	-----	277	.1	277	.1
Casco-Rodman complex, 6 to 12 percent slopes, eroded	-----	-----	413	.1	413	.1
Casco-Rodman complex, 12 to 20 percent slopes	-----	-----	5,293	1.5	5,293	1.2
Casco-Rodman complex, 20 to 30 percent slopes	16	(2/)	9,168	2.6	9,184	2.0
Casco-Rodman complex, 30 to 45 percent slopes	-----	-----	4,110	1.2	4,110	.9
Chelsea fine sand, 1 to 6 percent slopes	-----	-----	596	.2	596	.1
Chelsea fine sand, 6 to 20 percent slopes	-----	-----	387	.1	387	.1
Clayey land	6,960	7.5	1,323	.4	8,283	1.8
Colwood silt loam	248	.3	1,708	.5	1,956	.4
Dodge silt loam, 0 to 2 percent slopes	-----	-----	394	.1	394	.1
Dodge silt loam, 2 to 6 percent slopes	-----	-----	729	.2	729	.2
Drummer silt loam, gravelly substratum	805	.9	1,230	.3	2,035	.5
Elliott silt loam, 1 to 3 percent slopes	615	.7	775	.2	1,390	.3
Fabius loam, 1 to 3 percent slopes	-----	-----	317	.1	317	.1
Fox sandy loam, 0 to 2 percent slopes	-----	-----	2,477	.7	2,477	.5
Fox sandy loam, 2 to 6 percent slopes	21	(2/)	4,283	1.2	4,304	1.0
Fox sandy loam, 6 to 12 percent slopes, eroded	15	(2/)	983	.3	998	.2
Fox sandy loam, loamy substratum, 2 to 6 percent slopes	25	(2/)	191	.1	216	(2/)
Fox loam, 0 to 2 percent slopes	304	.3	3,780	1.1	4,084	.9
Fox loam, 2 to 6 percent slopes	448	.5	6,503	1.8	6,951	1.5
Fox loam, 6 to 12 percent slopes, eroded	132	.1	1,069	.3	1,201	.3
Fox silt loam, 0 to 2 percent slopes	92	.1	12,131	3.4	12,223	2.7
Fox silt loam, 2 to 6 percent slopes	344	.4	13,338	3.7	13,682	3.1
Fox silt loam, 6 to 12 percent slopes, eroded	24	(2/)	4,613	1.3	4,637	1.0
Fox silt loam, loamy substratum, 2 to 6 percent slopes	189	.2	107	(2/)	296	.1
Gilford loam	-----	-----	575	.2	575	.1

See footnotes at end of table

TABLE 1.--APPROXIMATE ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Mapping unit	Milwaukee County 1/		Waukesha County		Total survey area	
	Acres	Percent	Acres	Percent	Acres	Percent
Granby fine sandy loam	-----	-----	277	0.1	277	0.1
Grays silt loam, 0 to 2 percent slopes	132	0.1	77	(2/)	209	(2/)
Grays silt loam, 2 to 6 percent slopes	337	.3	497	.1	834	.2
Griswold silt loam, 2 to 6 percent slopes	-----	-----	659	.2	659	.1
Griswold silt loam, 6 to 12 percent slopes, eroded	-----	-----	299	.1	299	.1
Griswold silt loam, mottled subsoil variant, 2 to 6 percent slopes	-----	-----	563	.1	563	.1
Hebron loam, 0 to 2 percent slopes	135	.1	343	.1	478	.1
Hebron loam, 2 to 6 percent slopes	371	.4	695	.2	1,066	.2
Hebron loam, 6 to 12 percent slopes, eroded	71	.1	176	(2/)	247	.1
Hochheim loam, 2 to 6 percent slopes	60	.1	8,962	2.5	9,022	2.1
Hochheim loam, 2 to 6 percent slopes, eroded	20	(2/)	12,379	3.5	12,399	2.8
Hochheim loam, 6 to 12 percent slopes, eroded	120	.1	17,892	5.0	18,012	4.1
Hochheim loam, 12 to 20 percent slopes, eroded	-----	-----	8,249	2.3	8,249	1.8
Hochheim loam, 20 to 30 percent slopes, eroded	-----	-----	2,017	.6	2,017	.4
Hochheim soils, 6 to 12 percent slopes, severely eroded	-----	-----	312	.1	312	.1
Hochheim soils, 12 to 20 percent slopes, severely eroded	-----	-----	1,101	.3	1,101	.2
Hochheim soils, 20 to 30 percent slopes, severely eroded	-----	-----	203	.1	203	(2/)
Houghton muck, 0 to 2 percent slopes	722	.8	23,330	6.7	24,052	5.4
Houghton muck, 2 to 6 percent slopes	-----	-----	538	.1	538	.1
Juneau silt loam, 1 to 3 percent slopes	40	(2/)	804	.2	844	.2
Kane silt loam, 1 to 3 percent slopes	40	(2/)	593	.2	633	.1
Kendall silt loam, 1 to 3 percent slopes	-----	-----	1,250	.4	1,250	.3
Kewaunee silt loam, 2 to 6 percent slopes	7,206	7.6	-----	-----	7,206	1.6
Kewaunee silt loam, 6 to 12 percent slopes, eroded	296	.3	-----	-----	296	.1
Knowles silt loam, 0 to 2 percent slopes	46	(2/)	517	.1	563	.1
Knowles silt loam, 2 to 6 percent slopes	90	.1	1,450	.4	1,540	.3
Lamartine silt loam, 1 to 4 percent slopes	35	(2/)	8,355	2.3	8,390	1.9
Lawson silt loam	368	.4	116	(2/)	484	.1
Loamy land	2,229	2.4	2,597	.7	4,826	1.1
Lorenzo loam, 2 to 6 percent slopes, eroded	20	(2/)	1,871	.5	1,891	.4
Lorenzo loam, 6 to 12 percent slopes, eroded	-----	-----	685	.2	685	.1
Lorenzo loam, 12 to 20 percent slopes, eroded	-----	-----	337	.1	337	.1
Manawa silt loam, 1 to 3 percent slopes	1,664	1.8	-----	-----	1,664	.4
Markham silt loam, 2 to 6 percent slopes	469	.5	60	(2/)	529	.1
Marsh	40	(2/)	1,592	.4	1,632	.4
Martinton silt loam, 1 to 3 percent slopes	1,382	1.5	2,307	.6	3,689	.8
Matherton sandy loam, 1 to 3 percent slopes	-----	-----	1,135	.3	1,135	.2
Matherton silt loam, 1 to 3 percent slopes	1,698	1.8	5,695	1.6	7,393	1.6
Mayville silt loam, 0 to 2 percent slopes	-----	-----	587	.2	587	.1
Mayville silt loam, 2 to 6 percent slopes	16	(2/)	3,170	.9	3,186	.7
Mequon silt loam, 1 to 3 percent slopes	7,229	7.7	9,388	2.6	16,617	3.7
Miami sandy loam, sandy loam substratum, 2 to 6 percent slopes	-----	-----	3,217	.9	3,217	.7
Miami sandy loam, sandy loam substratum, 6 to 12 percent slopes, eroded	-----	-----	2,123	.6	2,123	.5

See footnotes at end of table

TABLE 1.--APPROXIMATE ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Mapping unit	Milwaukee County 1/		Waukesha County		Total survey area	
	Acres	Percent	Acres	Percent	Acres	Percent
Miami loam, sandy loam substratum, 2 to 6 percent slopes	-----	-----	2,473	0.7	2,473	0.5
Miami loam, sandy loam substratum, 6 to 12 percent slopes, eroded	-----	-----	561	.1	561	.1
Miami loam, sandy loam substratum, 12 to 20 percent slopes, eroded	-----	-----	1,695	.5	1,695	.4
Miami loam, sandy loam substratum, 20 to 30 percent slopes	-----	-----	302	.1	302	.1
Montgomery silty clay loam	1,056	1.1	2,596	.7	3,652	.8
Morley silt loam, 2 to 6 percent slopes	9,845	10.5	3,052	.9	12,897	2.9
Morley silt loam, 2 to 6 percent slopes, eroded	8,189	8.8	1,970	.6	10,159	2.3
Morley silt loam, 6 to 12 percent slopes, eroded	1,973	2.1	1,474	.4	3,447	.8
Morley silt loam, 12 to 20 percent slopes, eroded	334	.3	316	.1	650	.1
Mundelein silt loam, 1 to 3 percent slopes	855	.9	1,154	.3	2,009	.4
Muskego muck	29	(2/)	159	.1	188	(2/)
Mussey loam	2	(2/)	772	.2	774	.2
Navan silt loam	626	.7	1,973	.6	2,599	.6
Ogden muck	503	.5	4,502	1.3	5,005	1.1
Oshtemo loamy sand, 1 to 6 percent slopes	-----	-----	438	.1	438	.1
Oshtemo sandy loam, 1 to 6 percent slopes	-----	-----	501	.1	501	.1
Ozaukee silt loam, 2 to 6 percent slopes	6,174	6.5	7,109	2.0	13,283	2.9
Ozaukee silt loam, 2 to 6 percent slopes, eroded	5,329	5.7	6,907	1.9	12,236	2.7
Ozaukee silt loam, 6 to 12 percent slopes, eroded	2,071	2.2	4,196	1.2	6,267	1.4
Ozaukee silt loam, 12 to 20 percent slopes, eroded	692	.7	387	.1	1,079	.2
Palms muck	50	.1	3,887	1.1	3,937	.9
Pella silt loam	296	.3	8,213	2.3	8,509	1.9
Pella silt loam, moderately shallow variant	16	(2/)	611	.2	627	.1
Pistakee silt loam, 1 to 3 percent slopes	40	(2/)	1,611	.5	1,651	.4
Ritchey silt loam, 1 to 6 percent slopes	70	.1	873	.2	943	.2
Ritchey silt loam, 6 to 12 percent slopes, eroded	15	(2/)	262	.1	277	.1
Ritchey silt loam, 12 to 30 percent slopes	-----	-----	190	.1	190	(2/)
Ritchey silt loam, mottled subsoil variant, 1 to 3 percent slopes	50	.1	995	.3	1,045	.2
Rollin muck, deep	-----	-----	348	.1	348	.1
Rollin muck, shallow	-----	-----	306	.1	306	.1
Rough broken land	550	.6	-----	-----	550	.1
St. Charles sandy loam, gravelly substratum, 1 to 3 percent slopes	-----	-----	467	.1	467	.1
St. Charles silt loam, 0 to 2 percent slopes	-----	-----	426	.1	426	.1
St. Charles silt loam, 2 to 6 percent slopes	-----	-----	1,148	.3	1,148	.2
St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes	3	(2/)	3,999	1.1	4,002	.9
St. Charles silt loam, gravelly substratum, 2 to 6 percent slopes	25	(2/)	888	.2	913	.2
Sandy and gravelly land	78	.1	705	.2	783	.2
Sandy lake beaches	98	.1	-----	-----	98	(2/)
Sawmill silt loam, calcareous variant	256	.3	556	.1	812	.2
Saylesville silt loam, 0 to 2 percent slopes	-----	-----	290	.1	290	.1

See footnotes at end of table

TABLE 1.--APPROXIMATE ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Mapping unit	Milwaukee County 1/		Waukesha County		Total survey area	
	Acres	Percent	Acres	Percent	Acres	Percent
Saylesville silt loam, 2 to 6 percent slopes	524	0.5	1,023	0.3	1,547	0.3
Saylesville silt loam, 2 to 6 percent slopes, eroded	171	.2	259	.1	430	.1
Saylesville silt loam, 6 to 12 percent slopes, eroded	45	(2/)	305	.1	350	.1
Sebewa silt loam	996	1.1	7,180	2.0	8,176	1.8
Theresa silt loam, 0 to 2 percent slopes	-----	-----	1,681	.5	1,681	.4
Theresa silt loam, 2 to 6 percent slopes	-----	-----	11,097	3.2	11,097	2.6
Theresa silt loam, 2 to 6 percent slopes, eroded	-----	-----	3,385	1.0	3,385	.8
Theresa silt loam, 6 to 12 percent slopes, eroded	-----	-----	930	.3	930	.2
Virgil silt loam, gravelly substratum, 0 to 3 percent slopes	25	(2/)	483	.1	508	.1
Wallkill silt loam	144	.1	815	.2	959	.2
Warsaw sandy loam, 2 to 6 percent slopes	-----	-----	435	.1	435	.1
Warsaw loam, 0 to 2 percent slopes	20	(2/)	7,104	2.0	7,124	1.6
Warsaw loam, 2 to 6 percent slopes	-----	-----	1,698	.5	1,698	.4
Warsaw loam, 6 to 12 percent slopes, eroded	-----	-----	178	.1	178	(2/)
Warsaw silt loam, 0 to 2 percent slopes	-----	-----	2,514	.7	2,514	.5
Wasepi sandy loam, 1 to 3 percent slopes	10	(2/)	705	.2	715	.1
Wet alluvial land	1,100	1.2	1,405	.4	2,505	.5
Total	94,610	100.0	355,840	100.0	450,450	100.0

1/ Survey does not include area within Milwaukee city limits.

2/ Less than 0.05 percent.

and gray medium to coarse sand. Except for the surface layer, the layers above the substratum are slightly acid. The substratum is moderately alkaline and is slightly calcareous.

The Adrian soils have moderately rapid permeability and high available water capacity. Ground water is at or near the surface throughout most of the year. Natural fertility is low.

Typical profile of Adrian muck (0 to 2 percent slopes) (NW1/4 NE1/4 sec. 8, T. 6 N., R. 17 E.):

1--0 to 9 inches, black (N 2/0) muck; weak, coarse, subangular blocky structure breaking to weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.
2--9 to 21 inches, dark olive-gray (5Y 3/2), disintegrated mucky peat containing some remains of sedges, grasses, and forbs; weak, thick, platy structure; friable; slightly acid; abrupt, smooth boundary.
3--21 to 24 inches, black (10YR 2/1) muck that contains some remains of sedges, grasses, and forbs and breaks down easily when rubbed between the fingers; massive; friable; slightly acid; abrupt, wavy boundary.
4--24 to 27 inches, very dark gray (10YR 3/1) muck that has a high content of sand; weak, coarse, subangular blocky structure; very friable; slightly acid; clear, wavy boundary.
IIC1--27 to 42 inches, grayish-brown (10YR 5/2) medium sand; single grain; loose; moderately alkaline; gradual, wavy boundary.
IIC2--42 to 62 inches, gray (5Y 5/1) coarse sand; single grain; loose; slightly calcareous.

Thickness of the organic material ranges from 12 to 40 inches. In some places all of the organic material is muck, and in others it is peat. The organic material contains small snail shells in places. It is generally slightly acid or neutral in reaction.

The Adrian soils have formed in a thinner deposit of organic material than the Houghton soils. They lack the sedimentary peat that is typical in the lower part of the Muskego profile. Unlike the Palms and Ogden soils, the Adrian soils are underlain by sand.

Adrian muck (0 to 2 percent slopes) (Ac).--This is the only soil of the Adrian series mapped in the survey area. It is subject to subsidence and soil blowing where drainage has been installed and cultivated crops are grown.

Included with this soil in mapping were small areas of Palms muck and of Houghton muck, 0 to 2 percent slopes.

Wetness is the major limitation to use of this Adrian soil for crops, and removing the excess water by installing tile drains is difficult in some places. Only a small part of the acreage has been cultivated, and this acreage is mainly in corn, vegetables, and sod. This soil is suitable for crops, however, if it is drained, if soil blowing and subsidence are controlled, and if fertility is maintained. (Capability unit IVw-7; woodland group 10; wildlife group 6; recreation group 9; shrub and vine group 3)

Alluvial Land

Alluvial land (0 to 2 percent slopes) (Am) consists of a mixture of light-colored and dark-colored sediment deposited by streams. It is on flood plains and on the bottoms of narrow valleys through the survey area, but is mainly along the major streams and their larger tributaries. Alluvial land occurs with Lawson, Pistakee, and Sawmill soils, but it is deeper than those soils and is more variable in texture.

Because the soil material was deposited as the result of flooding, it mostly is layered, and it is variable in texture. The material ranges from silt loam to sandy loam in texture, but it is generally loam. In some places sand or gravel is on the surface or is in thin layers beneath the surface. Drainage is generally good or moderately good, but it is somewhat poor in some small depressional areas. Permeability and the available water capacity are both moderate.

Alluvial land that is protected from flooding is suited to corn, small grains, grasses, and legumes. Where flooding is frequent or cannot be controlled, the areas are suitable for forage, trees, or use for wildlife habitat. (Capability unit IIIw-12; woodland group 1; wildlife group 7; recreation group 6; shrub and vine group 3)

Ashkum Series

In the Ashkum series are poorly drained, silty soils underlain by calcareous silty clay loam glacial till in drainageways and depressions. These soils are on ground moraines in Milwaukee County and the eastern part of Waukesha County. The native vegetation was a deciduous forest consisting mainly of elm.

In a typical profile, the surface layer is black silty clay loam that is neutral in reaction and is about 11 inches thick. The subsoil is about 18 inches thick. The upper part of the subsoil is dark-gray silty clay that contains distinct mottles and is neutral and mildly alkaline in reaction. The lower part is gray, strongly calcareous silty clay loam that contains mottles and a few pebbles. The substratum is gray, strongly calcareous silty clay loam glacial till that contains many mottles and a few pebbles and fragments of shale.

The Ashkum soils have moderately slow permeability and high available water capacity. Natural fertility is high. Ground water is at or near the surface throughout most of the year.

Typical profile of Ashkum silty clay loam, 0 to 3 percent slopes (SW1/4 SE1/4 sec. 36, T. 5 N., R. 20 E.):

Ap--0 to 8 inches, black (10YR 2/1) silty clay loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A1--8 to 11 inches, black (10YR 2/1) silty clay loam; weak, fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

B1g--11 to 16 inches, dark-gray (5Y 4/1) silty clay; common, medium, distinct, olive (5Y 5/3) mottles; weak, coarse, prismatic structure parting to moderate, fine, angular blocky structure; firm; neutral; gradual, wavy boundary.

B2tg--16 to 23 inches, dark-gray (5Y 4/1) silty clay; common, coarse, prominent, olive (5Y 5/6) mottles; moderate, coarse, prismatic structure parting to strong, fine, angular blocky structure; thick, continuous clay films; very firm; few pebbles of dolomite and fragments of shale; mildly alkaline; gradual, wavy boundary.

B3g--23 to 29 inches, gray (5Y 5/1) heavy silty clay loam; common, coarse, prominent, olive (5Y 5/6) and light olive-brown (2.5Y 5/6) mottles; weak, coarse, prismatic structure parting to moderate, medium, angular blocky structure; very firm; few pebbles of dolomite; strongly calcareous; gradual, wavy boundary.

C--29 to 64 inches, gray (5Y 5/1) silty clay loam; many, coarse, prominent, yellowish-brown (10YR 5/6) mottles; weak, coarse, prismatic structure to massive; firm; segregations of free lime; few pebbles of dolomite and fragments of shale; strongly calcareous.

The A horizon is black (10YR 2/1) to very dark gray (10YR 3/1), and it ranges from 10 to 15 inches in thickness. The B horizon is commonly silty clay and silty clay loam, and the C horizon is generally silty clay loam. In many places pebbles of dolomite and small fragments of shale are common throughout the B and C horizons. Thickness of the solum and depth to free carbonates is 22 to 36 inches.

The Ashkum soils occur with well drained or moderately well drained Morley and Ozaukee soils and with somewhat poorly drained Blount and Mequon soils. They contain more sand and fine gravel than the Montgomery soils, and unlike the Montgomery soils, they have formed in glacial till. The Ashkum soils lack the moderately coarse textured material in the upper part of their profile that is typical in the Navan soils.

Ashkum silty clay loam, 0 to 3 percent slopes (AsA).--This is the only soil of the Ashkum series mapped in the survey area. It is on the bottoms of drainageways and in depressions. Runoff is slow, and flooding and ponding are hazards in spring and during periods of heavy rainfall. Erosion is not a hazard or is only a slight hazard.

Included with this soil in mapping were small areas where the slopes are steeper than 3 percent. Also included were small areas of Blount silt loam, Mequon silt loam, and Montgomery silty clay loam.

Where this Ashkum soil is adequately drained, it is suited to the crops commonly grown in the survey area. (Capability unit IIw-1; woodland group 7; wildlife group 5; recreation group 7; shrub and vine group 3)

Aztalan Series

The Aztalan series consists of somewhat poorly drained soils that are nearly level or gently sloping. These soils are on low stream terraces or beach lines of basins formerly occupied by glacial lakes. They consist of a thin layer of loamy outwash underlain by lacustrine sediment. The native vegetation was water-tolerant grasses and scattered elm and oak trees.

In a typical profile, the surface layer is black, mildly alkaline loam about 11 inches thick. The subsoil is about 24 inches thick. The upper part of the subsoil is very dark grayish-brown, mildly alkaline heavy loam that contains a few fine mottles. The middle part is yellowish-brown, mildly alkaline loam that contains many mottles. The lower part is light brownish-gray, slightly calcareous silty clay loam that contains many mottles. The substratum is light brownish-gray, calcareous silty clay loam that contains many mottles and light-gray coatings of lime.

The Aztalan soils have moderately slow permeability and high available water capacity. Ground water is less than 3 feet below the surface during wet periods. Natural fertility is high.

Typical profile of Aztalan loam, 0 to 2 percent slopes (NE1/4 SE1/4 sec. 30, T. 5 N., R. 19 E.):

Ap--0 to 7 inches, black (10YR 2/1) loam; moderate, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

A1--7 to 11 inches, black (10YR 2/1) loam; weak, coarse, subangular blocky structure parting to moderate, medium, granular structure; friable; mildly alkaline; clear, wavy boundary.

B1--11 to 17 inches, very dark grayish-brown (10YR 3/2) heavy loam; few, fine, faint, grayish-brown (10YR 5/2) and distinct, yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure; friable; mildly alkaline; gradual, wavy boundary.

B21t--17 to 27 inches, yellowish-brown (10YR 5/4) heavy loam; many, medium, faint, mottles of light olive brown (2.5Y 5/4), distinct mottles of light grayish brown (10YR 6/2), and prominent mottles of yellowish brown (10YR 5/8); moderate, medium, subangular blocky structure; friable; thin, patchy clay films; mildly alkaline; gradual, wavy boundary.

IIB22t--27 to 35 inches, light brownish-gray (10YR 6/2) silty clay loam; many, medium, distinct mottles of light olive brown (2.5Y 5/4) and prominent mottles of yellowish brown (10YR 5/8); moderate, medium, subangular blocky structure; continuous clay films on ped faces; firm; slightly calcareous; gradual, wavy boundary.

IIC--35 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam; many, medium, prominent, yellowish-brown (10YR 5/8) mottles; massive; light-gray (10YR 7/2), soft, segregated lime coatings on ped faces; firm; calcareous.

The A horizon is black (10YR 2/1) to very dark brown (10YR 2/2), and it ranges from 10 to 12 inches in thickness. The total thickness of the layers of loam in the A horizon and the upper part of the B horizon ranges from 15 to 35 inches. The A horizon and the upper part of the B horizon are loamy outwash material, and the lower part of the B horizon is lacustrine material. In places a layer of loose sandy material, 2 to 6 inches thick, separates the B21t horizon from the IIB22t horizon. Color of the IIB22t horizon and of the IIC horizon ranges from yellowish brown (10YR 5/4) and light brownish gray (10YR 6/2) to reddish brown (5YR 5/4). In many places the IIC horizon is laminated silty clay to silty clay loam, and this horizon contains thin seams of silt and fine sand in places.

The Aztalan soils occur with poorly drained Navan soils. The upper part of their solum is coarser textured than that of the Martinton soils.

Aztalan loam, 0 to 2 percent slopes (AzA).--This soil is on concave slopes in small drainageways, along the edges of large drainageways, and on slight rises within depressional areas occupied by poorly drained Navan and Montgomery soils. The profile is the one described as representative of the Aztalan series. Runoff is slow, and erosion is only a slight hazard or is not a hazard. Ponded water is a hazard to crops in spring and during periods of heavy rainfall.

Included with this soil in mapping were small areas of a Navan soil having a loam surface layer, and fairly large areas of a Fabius loam that is underlain by clay. Also included were places in which the surface layer is silt loam or sandy loam, and some areas where the surface layer is lighter colored than typical for Aztalan soils.

Where drainage is adequate, this Aztalan soil is suited to the crops commonly grown in the survey area. It is intensively used for crops. (Capability unit IIw-2; woodland group 12; wildlife group 5; recreation group 6; shrub and vine group 3)

Aztalan loam, 2 to 6 percent slopes (AzB).--This soil is on concave slopes in drainageways and along the edges of broad depressions occupied by poorly drained soils. It receives runoff from higher areas, and it is rather wet. Runoff is slow to medium, and erosion is a slight hazard.

Included with this soil in mapping were small areas of a nearly level Aztalan loam, and fairly large areas in which the surface layer is silt loam or sandy loam. Also included were small areas of a Navan loam and a Fabius loam that are underlain by clay.

This Aztalan soil is suited to the crops commonly grown in the survey area, and it is farmed intensively in many places. Wetness is the major limitation to use for crops. Well-maintained grassed waterways help to control erosion in the intensively cultivated areas, especially in the more sloping places. (Capability unit IIw-2; woodland group 12; wildlife group 5; recreation group 6; shrub and vine group 3)

Blount Series

Somewhat poorly drained, nearly level soils are in the Blount series. These soils have formed in a thin layer of silt and in calcareous silty clay loam glacial till. They occur in drainageways and in slight depressions in the southern part of Milwaukee County and in the southeastern part of Waukesha County. The native vegetation was a deciduous forest consisting mainly of oak, hickory, and elm.

In a typical profile, the surface layer is very dark grayish-brown silt loam that is about 3 inches thick and is neutral in reaction. The subsurface layer is about 5 inches thick and is brown silt loam that contains a few mottles and is slightly acid. The subsoil is about 26 inches thick. The upper part of the subsoil is dark-brown silty clay loam that contains fine mottles and is medium acid. The middle part of the subsoil is dark-brown silty clay that contains mottles and is strongly acid and slightly acid. The lower part is dark-brown silty clay loam that contains many mottles and is slightly calcareous. The substratum is brown, firm silty clay loam glacial till that contains many mottles and is highly calcareous.

Blount soils have moderately slow permeability and high available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is moderate.

Typical profile of Blount silt loam, 1 to 3 percent slopes (NE1/4 SW1/4 sec. 12, T. 5 N., R. 21 E.):

Ap--0 to 3 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, medium, granular structure; friable; neutral; clear, wavy boundary.

A2--3 to 8 inches, brown (10YR 5/3) silt loam; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, platy structure; friable; slightly acid; clear, wavy boundary.

B1--8 to 11 inches, dark-brown (10YR 4/3) silty clay loam; common, fine, distinct, grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/8) mottles; moderate, medium, subangular blocky structure; firm; medium acid; clear, wavy boundary.

IIB21t--11 to 19 inches, dark-brown (10YR 4/3) silty clay; common, fine, faint, grayish-brown (10YR 5/2) and distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; thick, continuous clay films; firm; few pebbles of dolomite; strongly acid; gradual, wavy boundary.

IIB22t--19 to 28 inches, dark-brown (10YR 4/3) silty clay; common, medium, faint, grayish-brown (10YR 5/2) and distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, prismatic structure breaking to strong, medium, subangular blocky structure; thick, continuous clay films; firm; very dark grayish-brown (10YR 3/2) stains of organic matter; few pebbles of dolomite and fragments of shale; slightly acid; gradual, wavy boundary.

IIB3--28 to 34 inches, dark-brown (10YR 4/3) silty clay loam; many, medium, distinct, light brownish-gray (10YR 6/2) and yellowish-brown (10YR 5/6 and 5/8) mottles; weak, medium, prismatic structure breaking to weak, medium, subangular blocky structure; firm; small patches of segregated free lime; slightly calcareous; gradual, wavy boundary.

IIC--34 to 60 inches, brown (10YR 5/3) silty clay loam; many, medium, faint, light brownish-gray (10YR 6/2) and prominent, yellowish-brown (10YR 5/6 and 5/8) mottles; massive; firm; few pebbles of dolomite; highly calcareous.

In areas that have not been disturbed, the A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and ranges from 3 to 5 inches in thickness. The A2 horizon ranges from 4 to 6 inches in thickness. Most of the solum has formed in glacial till. The layer of silt is 10 to 14 inches thick in most places, but it is only 4 to 5 inches thick in some areas. The IIC horizon is generally silty clay loam, but it contains pockets or lenses of silt and loam in places. Reaction of the solum is medium acid or strongly acid in areas that have not been disturbed, but the reaction ranges to mildly alkaline in areas that have been intensively limed and cultivated.

The Blount soils occur with well drained and moderately well drained Morley soils and with poorly drained Ashkum soils. They have a browner hue than the Mequon soils, and they have a thinner, lighter colored A horizon than the Martinton soils.

Blount silt loam, 1 to 3 percent slopes (B1A).--This is the only soil of the Blount series mapped in the survey area. It occupies concave slopes in small drainageways and slight depressions. Runoff

is slow, and ponding is a hazard to crops in spring and during periods of heavy rainfall. Erosion is not a hazard or is only a slight hazard.

Included with this soil in mapping were small areas in which slopes are steeper than 3 percent. Also included were small areas of Ashkum silty clay loam and of Martinton silt loam.

Where this Blount soil is adequately drained, it is suited to all the crops commonly grown in the survey area. It is intensively used for crops. (Capability unit IIw-2; woodland group 7; wildlife group 5; recreation group 6; shrub and vine group 3)

Boyer Series

The Boyer series consists of well-drained, loamy sand and sandy loam soils over sandy glacial outwash. These soils are on outwash plains in the southwestern part of Waukesha County. The areas have an irregular shape, and some of them are rather large. The native vegetation was a deciduous forest consisting mainly of oak and hickory.

In a typical profile, the surface layer is brown loamy sand that is about 8 inches thick and is neutral in reaction. The subsurface layer is about 7 inches thick, and it is also brown loamy sand that is neutral in reaction. The subsoil is about 23 inches thick. The upper part of the subsoil is brown to strong-brown sandy loam that is neutral in reaction. The middle part of the subsoil is dark-brown sandy clay loam that is medium acid. The lower part is brownish-yellow, loose, slightly calcareous sand. Very pale brown, loose, slightly calcareous sand makes up the substratum.

The Boyer soils have moderately rapid permeability and low available water capacity. They are subject to soil blowing when the surface is bare and is exposed to wind. Natural fertility is low.

Typical profile of Boyer loamy sand, 1 to 6 percent slopes (NE1/4 SW1/4 sec. 18, T. 6 N., R. 17 E.):

Ap--0 to 8 inches, brown (10YR 4/3) loamy sand; weak, fine, granular structure breaking to single grain; very friable; neutral; abrupt, smooth boundary.

A2--8 to 15 inches, brown (7.5YR 5/4) loamy sand; weak, medium, subangular blocky structure; very friable; neutral; gradual, wavy boundary.

B1--15 to 30 inches, brown (7.5YR 5/4) to strong-brown (7.5YR 5/6) sandy loam; weak, medium, subangular blocky structure; very friable; neutral; clear, wavy boundary.

B2t--30 to 36 inches, dark-brown (7.5YR 4/4) sandy clay loam; moderate, medium, subangular blocky structure; thin, discontinuous clay films; friable; medium acid; clear, wavy boundary.

B3--36 to 38 inches, brownish-yellow (10YR 6/6) sand; single grain; loose; slightly calcareous; clear, wavy boundary.

C--38 to 64 inches, very pale brown (10YR 7/4) sand; single grain; loose; slightly calcareous.

In areas that have not been cultivated, the A1 horizon is dark grayish brown (10YR 4/2) to very dark grayish brown (10YR 3/2) and ranges from 2 to 4 inches in thickness. In places the texture of the A horizon is sandy loam. The texture of the B2t horizon ranges from sandy loam to sandy clay loam. Where the B2t horizon is sandy clay loam, that horizon is less than 10 inches thick. The solum ranges from 24 to 42 inches in thickness, but it is commonly 30 to 38 inches thick. In areas that have not been cultivated, the solum is medium acid or slightly acid.

The Boyer soils occur with somewhat poorly drained Wasepi soils. They have a thinner solum than the Oshtemo soils and a thicker solum than the Casco soils. The Boyer soils are coarser textured and have thinner horizons in which clay has accumulated than the Fox soils.

Boyer loamy sand, 1 to 6 percent slopes (BmB).--This soil has the profile described as representative of the Boyer series. It is droughty and is moderately susceptible to soil blowing. Runoff is very slow. Erosion is not a hazard or is only a slight hazard.

Included with this soil in mapping were small areas of Oshtemo loamy sand, 1 to 6 percent slopes, and Boyer sandy loam, 1 to 6 percent slopes. Also included were a few fairly large areas of a moderately well drained soil that has mottling in the lower part of the subsoil.

This Boyer soil is used mostly for the crops commonly grown in the area, but a considerable acreage is in pasture or trees. (Capability unit IIIs-4; woodland group 4; wildlife group 1; recreation group 4; shrub and vine group 2)

Boyer loamy sand, 6 to 12 percent slopes, eroded (BmC2).--This soil is droughty and is subject to blowing. It has lost part of the original surface layer through erosion, and the present surface layer contains some material from the subsoil. Further erosion is a moderate hazard.

Included with this soil in mapping were small areas in which the surface layer is sandy loam, and other areas where little or no erosion has taken place.

Formerly, most areas of this Boyer soil were used for crops. Now, much of the acreage is in pasture or trees. (Capability unit IIIe-7; woodland group 4; wildlife group 1; recreation group 4; shrub and vine group 2)

Boyer sandy loam, 1 to 6 percent slopes (BnB).--This soil is droughty, and it is slightly susceptible to soil blowing. Runoff is slow, and little or no erosion has taken place.

Included with this soil in mapping were small areas of Oshtemo sandy loam, 1 to 6 percent slopes; Boyer loamy sand, 1 to 6 percent slopes; and Fox sandy loam, 0 to 2 percent slopes. Also included were a few fairly large areas in which the surface layer is darker colored than typical for the Boyer soils.

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This Boyer soil is used mainly for the crops commonly grown in the survey area. Part of the acreage is in pasture or trees. (Capability unit IIIs-4; woodland group 3; wildlife group 1; recreation group 2; shrub and vine group 2)

Brookston Series

The Brookston series consists of poorly drained soils in depressions and in broad drainageways in morainic areas. These soils are made up of a thin layer of silt loam over calcareous loam glacial till. The native vegetation was a deciduous forest consisting mainly of elm and basswood.

In a typical profile, the surface layer is black silt loam that is about 11 inches thick and is neutral in reaction. The subsoil is about 18 inches thick. The upper part of the subsoil is olive-gray heavy silt loam that contains streaks of very dark grayish brown and is neutral in reaction. The middle part of the subsoil is grayish-brown heavy loam that is slightly calcareous and contains mottles and a few pebbles. The lower part is brown loam that is strongly calcareous and contains mottles and many pebbles. The substratum is grayish-brown and yellowish-brown gravelly loam that is very friable and is strongly calcareous.

The Brookston soils are moderately permeable and have high available water capacity. Ground water is at or near the surface most of the year. Natural fertility is high.

Typical profile of Brookston silt loam, 0 to 3 percent slopes (SW1/4 SW1/4 sec. 17, T. 7 N., R. 20 E.):

Ap--0 to 8 inches, black (10YR 2/1) silt loam; weak, fine, subangular blocky structure parting to moderate, medium, granular structure; friable; neutral; abrupt, smooth boundary.

A1--8 to 11 inches, black (10YR 2/1) silt loam; weak, fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

B1g--11 to 15 inches, olive-gray (5Y 4/2) heavy silt loam; moderate, medium, subangular blocky structure; friable; contains streaks of very dark grayish brown (10YR 3/2); neutral; clear, wavy boundary.

IIB2g--15 to 23 inches, grayish-brown (10YR 5/2) heavy loam; common, medium, faint, gray (10YR 5/1) and prominent, yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; discontinuous clay films; firm; few pebbles of dolomite; slightly calcareous; gradual, wavy boundary.

IIB3--23 to 29 inches, grayish-brown (10YR 5/2) loam; moderate, medium, faint, gray (10YR 5/1) and prominent, yellowish-brown (10YR 5/6) mottles; weak, coarse, subangular blocky structure; friable; many pebbles of dolomite; strongly calcareous; gradual, wavy boundary.

IIC--29 to 60 inches, grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/6) gravelly loam; massive; very friable; few cobblestones; strongly calcareous.

The A horizon is black (10YR 2/1) to very dark brown (10YR 2/2), and it ranges from 10 to 15 inches in thickness. The mantle of silt is 10 to 20 inches thick. That part of the B horizon that formed in silt is generally silt loam or silty clay loam. The part that formed in loam till is generally loam. The IIC horizon is typically light loam, and in places it contains many cobblestones and pebbles of dolomite. The solum is commonly 24 to 36 inches thick, and it ranges from mildly alkaline to slightly acid in reaction. The Brookston soils in this survey area have a thinner solum, are shallower over free carbonates, and have slightly coarser textured B horizons than is typical for the Brookston series.

The Brookston soils occur with well-drained Theresa and Hochheim soils. They have formed in coarser textured glacial till than the Ashkum soils, and they lack the substratum of stratified sand and gravel that is typical in the profile of the Sebewa soils.

Brookston silt loam, 0 to 3 percent slopes (BsA).--This soil is on the bottoms of broad drainageways and in depressions. It is the only soil of the Brookston series mapped in the survey area. Runoff is slow, and ponding is a hazard in spring and during periods of heavy rainfall. Erosion is not a hazard or is only a slight hazard.

Included with this soil in mapping were sloping areas in which erosion is a hazard. Also included were small areas where stones and boulders are on the surface, and other small areas of Pella silt loam, Lamartine silt loam, and Sebewa silt loam.

Where this Brookston soil is adequately drained, it is suited to the crops commonly grown in the survey area. Most of the acreage is in pasture. (Capability unit IIw-1; woodland group 7; wildlife group 5; recreation group 7; shrub and vine group 3)

Casco Series

The Casco series consists of well-drained, loamy soils that have formed over calcareous sand and gravel outwash. These soils are on plains underlain by glacial outwash. The native vegetation was a deciduous forest consisting mainly of oak and hickory.

In a typical profile, the surface layer is dark grayish-brown, mildly alkaline loam about 7 inches thick. The subsoil is about 12 inches thick. The main part of the subsoil is dark-brown, mildly alkaline clay loam that contains many pebbles. The lower 2 inches of the subsoil is dark-brown, mildly alkaline sandy loam that contains very dark grayish-brown stains of organic matter and many pebbles. The substratum is pale-brown, loose, calcareous, stratified sand and gravel.

The Casco soils are moderately permeable and have low available water capacity. Natural fertility is moderate to low.

Typical profile of Casco loam, 2 to 6 percent slopes (NE1/4 NE1/4 sec. 2, T. 6 N., R. 17 E.):

Ap--0 to 7 inches, dark grayish-brown (10YR 4/2) loam; moderate, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

B2t--7 to 17 inches, dark-brown (7.5YR 4/4) clay loam; moderate, medium, subangular blocky structure; thick, continuous clay films; firm; many pebbles as much as three-fourths inch in diameter; mildly alkaline; clear, wavy boundary.

B3--17 to 19 inches, dark-brown (7.5YR 4/4) heavy sandy loam; weak, medium, subangular blocky structure; friable; many pebbles; a few very dark grayish-brown (10YR 3/2) stains of organic matter; mildly alkaline; clear, abrupt boundary.

IIC--19 to 60 inches, pale-brown (10YR 6/3), stratified sand and gravel; single grain; loose; calcareous.

In areas that have not been cultivated, the A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2), and it ranges from 2 to 4 inches in thickness. The A2 horizon in those areas is brown (10YR 5/3) and ranges from 3 to 6 inches in thickness. Most of the B horizon has formed in outwash, even where these soils are covered by a thin mantle of silt. In places the B horizon has a hue of 10YR. The C horizon generally is stratified sand and gravel, but the entire horizon is gravel mixed with many cobblestones in some places.

The Casco soils occur with poorly drained Mussey soils. They have a lighter colored surface layer than the Lorenzo soils and a thinner solum than the Fox soils.

Casco sandy loam, 2 to 6 percent slopes (CcB).--This soil is generally more droughty and less well suited to crops than the Casco soils that have a surface layer of loam or silt loam. It is slightly susceptible to soil blowing and water erosion. Runoff is medium.

Included with this soil in mapping were small areas of Fox sandy loam, 2 to 6 percent slopes, and Boyer sandy loam, 2 to 6 percent slopes.

This Casco soil is used mostly for pasture or as woodland. A small part of the acreage is cropped. (Capability unit IIIe-4; woodland group 5; wildlife group 1; recreation group 2; shrub and vine group 2)

Casco sandy loam, 6 to 12 percent slopes, eroded (CcC2).--The plow layer of this soil contains a moderate amount of dark-brown material from the subsoil that was mixed with the remaining original surface soil during tillage. Runoff is medium, and water erosion and soil blowing are moderate hazards. This soil is more droughty and is generally less well suited to crops than the Casco soils that have a surface layer of loam or silt loam.

Included with this soil in mapping were small areas of Casco loam, 6 to 12 percent slopes, and a few areas that are not eroded or are only slightly eroded.

Nearly all of the acreage is in the crops commonly grown in the survey area. A small acreage is used for pasture. (Capability unit IVe-3; woodland group 5; wildlife group 1; recreation group 2; shrub and vine group 2)

Casco sandy loam, 12 to 20 percent slopes, eroded (CcD2).--This soil is on escarpments and dissected outwash plains. Where it has been cultivated, it has a moderate amount of dark-brown material from the subsoil mixed with the remaining original surface soil. In areas that have not been cultivated, most of the original surface layer remains. Runoff is rapid, and soil blowing and further water erosion are severe hazards. In addition, this soil is droughty.

Most of the acreage is used for crops. The rest is in pasture or is used as woodland. (Capability unit VIe-4; woodland group 5; wildlife group 1; recreation group 2; shrub and vine group 2)

Casco loam, 2 to 6 percent slopes (CeB).--This soil is droughty. Runoff is medium, and water erosion is a slight hazard. The profile is the one described as representative of the Casco series.

Included with this soil in mapping were areas in which the surface layer is silt loam. Also included were small areas of a Fox loam; Casco loam, 2 to 6 percent slopes, moderately eroded; and Casco loam, 6 to 12 percent slopes.

Most of the acreage is used for the crops commonly grown in the survey area. A small acreage is in trees or pasture. (Capability unit IIIe-4; woodland group 5; wildlife group 1; recreation group 2; shrub and vine group 2)

Casco loam, 6 to 12 percent slopes, eroded (CeC2).--This soil has lost part of its original surface layer through erosion. The plow layer contains a moderate amount of dark-brown material from the subsoil that was mixed with the remaining original surface soil during tillage. Further erosion is a moderate hazard because of the medium runoff. This soil is also droughty and is slightly susceptible to soil blowing.

Included with this soil in mapping were small areas of Casco loam, 2 to 6 percent slopes; Casco loam, 12 to 20 percent slopes, moderately eroded; and Fox loam, 6 to 12 percent slopes.

Nearly all of the acreage is in the crops commonly grown in the survey area. A small acreage is in permanent pasture. Because the plow layer contains some moderately fine textured material from the subsoil, maintaining good tilth and a desirable rate of water infiltration is more important than for the Casco soils that are not eroded or that are only slightly eroded. (Capability unit IVe-4; woodland group 5; wildlife group 1; recreation group 2; shrub and vine group 2)

Casco loam, 12 to 20 percent slopes, eroded (CeD2).--This soil is on escarpments and dissected outwash plains. Where it has been cultivated, it has a moderate amount of dark-brown material from the subsoil mixed with the remaining original surface soil in the plow layer. In areas that have not been cultivated, most of the original surface layer has been lost through erosion. Runoff is rapid, and further erosion is a severe hazard. This soil is also droughty, and it is slightly susceptible to soil blowing.

Included with this soil in mapping were small areas of a Fox loam; Casco loam, 6 to 12 percent slopes, eroded; and Rodman gravelly loam, 12 to 20 percent slopes. Also included were a few fairly large areas that are only slightly eroded.

Nearly all of the acreage of this Casco soil is now in permanent pasture or trees. A small acreage is used to grow forage crops. (Capability unit VIe-4; woodland group 5; wildlife group 1; recreation group 2; shrub and vine group 2)

Casco soils, 6 to 12 percent slopes, severely eroded (CfC3).--Soils of this complex have lost all of their original surface layer and part or all of their subsoil through erosion. Where part of the subsoil remains, the present plow layer is clay loam. Texture of the plow layer ranges to sandy loam, however, where erosion has removed all of the subsoil. These soils are droughty. Runoff is medium, and further erosion is a severe hazard. Most of the areas are small.

Included with these soils in mapping were small areas of Casco loam, 6 to 12 percent slopes, moderately eroded, and small areas of a Rodman loam.

These Casco soils are used mostly for crops. A small acreage is used for permanent pasture. (Capability unit VIe-4; woodland group 6; wildlife group 1; recreation group 5; shrub and vine group 2)

Casco-Rodman complex, 6 to 12 percent slopes, eroded (CrC2).--Soils of this complex are on undulating outwash plains. The complex consists of areas of Casco and Rodman soils that are too small and too closely intermingled to be mapped separately. Casco loam, 6 to 12 percent slopes, eroded, makes up about 80 percent of the complex, and it is generally on the lower concave slopes. A Rodman gravelly loam, on the convex hilltops, makes up the remaining 20 percent. A typical profile of a Rodman soil is described under the Rodman series. The Rodman soil of this complex is less sloping, however, than the soil for which a profile is described as representative of the Rodman series, and the hazard of erosion is moderate rather than severe.

Included with these soils in mapping were small areas of Fox loam, 6 to 12 percent slopes, and fairly large areas of soils in a Casco-Rodman complex that are not eroded or are only slightly eroded.

Most of the acreage is in pasture or trees. The soils are droughty and are generally poorly suited to crops. Practices that help to control erosion are needed if these soils are used intensively. (Capability unit IVe-4; woodland group 5; wildlife group 3; recreation group 2; shrub and vine group 2)

Casco-Rodman complex, 12 to 20 percent slopes (CrD).--This complex is on rolling outwash plains. Casco loam, 12 to 20 percent slopes, makes up about 70 percent of the acreage, and a Rodman gravelly loam, the remaining 30 percent. The Casco soil generally is on the lower concave side slopes, and the Rodman soil is on the convex hilltops. The profile of the Rodman soil is the one described as representative of the Rodman series. Soils of this complex are droughty, and they are susceptible to severe erosion.

Included with these soils in mapping were small areas of Fox loam, 6 to 12 percent slopes. Also included were fairly large areas that are moderately eroded or severely eroded.

Soils of this complex are not suited to crops, and they are mostly in pasture or trees. Practices that help to control erosion are needed if these soils are used intensively. (Capability unit VIe-4; woodland group 5; wildlife group 3; recreation group 2; shrub and vine group 2)

Casco-Rodman complex, 20 to 30 percent slopes (CrE).--This mapping unit consists of areas of Casco and Rodman soils that are too small and too closely intermingled to be mapped separately. Casco loam, 20 to 30 percent slopes, makes up about 60 percent of the acreage, and a Rodman gravelly loam, about 40 percent. The Casco soil is generally on the lower concave side slopes, and the Rodman soil is on the convex ridgetops. A profile typical of the Rodman soil is described under the Rodman series. Soils of this mapping unit are on rolling outwash plains. The drainage is not well defined, because many of the slopes are complex. The soils are not well suited to farming, for they are droughty and susceptible to very severe erosion.

Included with these soils in mapping were small areas of a Lorenzo loam and places where the surface layer is silt loam or sandy loam. Also included were fairly large areas that are moderately eroded.

Most of the acreage has remained in trees or has been cleared and is used for pasture. If the soils are used intensively, practices are needed that help to control erosion. (Capability unit VIIe-4; woodland group 5; wildlife group 3; recreation group 2; shrub and vine group 2)

Casco-Rodman complex, 30 to 45 percent slopes (CrF).--Soils of this mapping unit are on rolling outwash plains. About 60 percent of the acreage is Casco loam, 30 to 45 percent slopes, and this soil is on the lower concave side slopes. About 40 percent is Rodman gravelly loam, 30 to 45 percent slopes, on the convex ridgetops. Soils of this mapping unit are droughty, and they are susceptible to very severe erosion. They are not suited to use for cultivated crops.

Included with these soils in mapping were small areas of a Lorenzo loam, and areas that are moderately eroded.

Nearly all of the acreage is in pasture or trees. If these soils are used intensively, practices are needed that help to control erosion. (Capability unit VIIe-4; woodland group 6; wildlife group 3; recreation group 5; shrub and vine group 2)

Chelsea Series

In the Chelsea series are excessively drained, sandy soils that are underlain by calcareous sand. These soils occupy glacial outwash plains in the western part of Waukesha County. The native vegetation was a deciduous forest consisting mainly of scrub oak and hickory.

In a typical profile, the surface layer is very dark gray, strongly acid fine sand about 2 inches thick. The subsurface layer is dark grayish-brown, medium acid fine sand, also about 2 inches thick. The subsoil is about 56 inches thick. The upper part of the subsoil is strong-brown, medium acid fine sand. The lower part is yellowish-brown, slightly acid fine sand that contains bands of strong-brown loamy fine sand less than one-fourth of an inch thick. The substratum is pale-brown, loose, slightly calcareous fine sand.

The Chelsea soils are very rapidly permeable and have low available water capacity. Natural fertility is very low.

Typical profile of Chelsea fine sand, 1 to 6 percent slopes (NE1/4 SW1/4 sec. 29, T. 5 N., R. 17 E.):

A1--0 to 2 inches, very dark gray (10YR 3/1) fine sand; weak, fine, granular structure; very friable; strongly acid; clear, wavy boundary.
A2--2 to 4 inches, dark grayish-brown (10YR 4/2) fine sand; weak, fine, granular structure; very friable; medium acid; clear, wavy boundary.
B1--4 to 42 inches, strong-brown (7.5YR 5/6) fine sand; weak, medium, subangular blocky structure; very friable; medium acid; gradual, wavy boundary.
B2--42 to 60 inches, yellowish-brown (10YR 5/8) fine sand; weak, medium, subangular blocky structure; very friable; contains bands of strong-brown (7.5YR 5/6) loamy fine sand that are less than one-fourth inch thick and are 1 to 2 inches apart; slightly acid; abrupt, wavy boundary.
C--60 to 72 inches, pale-brown (10YR 6/3) fine sand; single grain; loose; slightly calcareous.

The A1 horizon ranges from 1 to 3 inches in thickness, and the A2 horizon ranges from 2 to 4 inches in thickness. The B2 horizon is generally about 18 inches thick. The thin bands of loamy fine sand in the B2 horizon are commonly 1/8 to 3/8 inch thick and are 1 to 6 inches apart. The solum generally is about 60 inches thick. In some places the entire solum and the C horizon have a few pebbles throughout. Reaction of the subsurface layer and the subsoil is medium acid or slightly acid.

The Chelsea soils have a coarser textured subsoil than the Oshtemo and Boyer soils.

Chelsea fine sand, 1 to 6 percent slopes (CtB).--This soil is very droughty, and it is susceptible to severe damage from soil blowing. The profile is the one described as representative of the Chelsea series.

Included with this soil in mapping were small areas of Oshtemo loamy sand, 2 to 6 percent slopes, and a few moderately eroded areas.

This Chelsea soil is better suited to trees and to use as wildlife habitat than to field crops or pasture. Most of the acreage is wooded, and only a small acreage is in field crops or pasture. (Capability unit VIIs-9; woodland group 4; wildlife group 3; recreation group 5; shrub and vine group 2)

Chelsea fine sand, 6 to 20 percent slopes (CtD).--This soil is very droughty. Soil blowing is a severe hazard, and erosion caused by runoff is a moderate hazard.

Included with this soil in mapping were small areas of an Oshtemo loamy sand having slopes of 6 to 12 percent, and a few fairly large areas that are moderately eroded.

This Chelsea soil is better suited as woodland or wildlife habitat than to field crops or pasture. Most of the acreage is used as woodland or has been recently replanted to trees. A small acreage is in pasture. (Capability unit VIIs-9; woodland group 4; wildlife group 3; recreation group 5; shrub and vine group 2)

Clayey Land

Clayey land (Cv) is a miscellaneous land type that consists of fill areas and of cut or borrow areas. It is mainly within or near cities or towns and areas used for housing developments or related purposes.

In the cut or borrow areas, the entire solum of the soil has been removed by man, and the raw underlying material is exposed. These areas differ from gravel pits in that the side slopes of the adjacent banks have been graded and sloped so that they blend with adjacent less disturbed areas that are accessible for building sites or roads.

The fill areas consists of a layer of fill material, about 1 to 5 feet thick, that is deposited over a mineral soil that is generally somewhat poorly drained to very poorly drained. In some places the fill material covers a well-drained mineral soil, and in others it covers an organic soil.

The material in this land type is mainly clay to clay loam. In cut areas, where the original soils have been removed, the material is generally silty clay loam glacial till that contains pockets of loamy or silty material. In fill areas the material is more variable in texture, and it contains debris, such as rocks, bricks, and fragments of paving material, as well as some loamy or gravelly material.

The surface of this land type is generally compacted. Much of the water from rainfall runs off, and the soil material is unfavorable for the growth of plants. The hazards and limitations for engineering uses are so variable that they can be determined only by onsite investigation. (Capability unit VIIIs-10; woodland group 11; wildlife group 2; recreation group 10; shrub and vine group 4)

Colwood Series

In the Colwood series are poorly drained, silty soils underlain by stratified lacustrine silt and very fine sand. These soils occupy areas on river bottoms and in the basins of old glacial lakes. The native vegetation was water-tolerant grasses and a forest of deciduous trees, mainly elms.

In a typical profile, the surface layer is black, mildly alkaline silt loam about 7 inches thick. The subsurface layer is very dark gray, mildly alkaline silty clay loam about 3 inches thick. The subsoil is about 15 inches thick. The upper part of the subsoil is grayish-brown and light yellowish-brown, mildly alkaline silt loam that contains a few mottles. The lower part is light brownish-gray, slightly calcareous silty clay loam that contains common mottles. The substratum is light brownish-gray, friable, stratified silt and very fine sand that are strongly calcareous.

Colwood soils are moderately permeable and have high available water capacity. Ground water is at or near the surface throughout most of the year. Draining these soils is generally difficult. Natural fertility is moderate.

Typical profile of Colwood silt loam (0 to 2 percent slopes) (SW1/4 NE1/4 sec. 32, T. 6 N., R. 17 E.):

Ap--0 to 7 inches, black (10YR 2/1) silt loam; moderate, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

A3--7 to 10 inches, very dark gray (10YR 3/1) light silty clay loam; weak, medium, subangular blocky structure breaking to moderate, medium, granular structure; friable; mildly alkaline; clear, wavy boundary.

B11g--10 to 14 inches, grayish-brown (2.5Y 5/2) heavy silt loam; few, fine, distinct, light yellowish-brown (2.5Y 6/4) mottles; weak, medium, subangular blocky structure; friable; mildly alkaline; gradual, wavy boundary.

B12g--14 to 18 inches, light yellowish-brown (2.5Y 6/4) silt loam; few, fine, distinct, grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/6) mottles; weak, medium, subangular blocky structure; friable; mildly alkaline; clear, wavy boundary.

B2g--18 to 25 inches, light brownish-gray (2.5Y 6/2) light silty clay loam; common, fine, prominent, light olive-brown (2.5Y 5/6) mottles; weak, medium, subangular blocky structure; friable; slightly calcareous; gradual, wavy boundary.

C--25 to 62 inches, light brownish-gray (10YR 6/2), weakly stratified silt and very fine sand; massive; friable; strongly calcareous.

The A horizon is black (10YR 2/1) to very dark brown (10YR 2/2), and it ranges from 10 to 15 inches in thickness. In most places the B horizon is heavy silt loam or light silty clay loam, and depth to free carbonates is commonly 18 to 30 inches. The C horizon is generally stratified silt and very fine sand, but it contains thin layers of clay in some places. In places the C horizon is mostly silt. In other places the proportions of silt and very fine sand are nearly equal. The Colwood soils in this survey area have a higher content of silt than is modal for the series.

The Colwood soils occur with well-drained Grays and somewhat poorly drained Mundelein soils. They have a slightly coarser textured solum than the Pella and Montgomery soils.

Colwood silt loam (0 to 2 percent slopes) (Cw).--This is the only soil of the Colwood series mapped in the survey area. It is subject to ponding in spring and during periods of heavy rainfall. Draining this soil is difficult because the silt and fine sand tend to flow easily when the soil is saturated.

Included with this soil in mapping were small areas of a Mundelein silt loam having slopes of 0 to 2 percent, and a few fairly large areas in which the surface layer is sandy loam.

This Colwood soil is used mainly as pasture or woodland. It can be used for the crops commonly grown in the survey area if it is adequately drained. (Capability unit IIw-1; woodland group 7; wildlife group 5; recreation group 7; shrub and vine group 3)

Dodge Series

The Dodge series consists of well-drained, silty soils that are underlain by calcareous loam till. These soils occupy areas on the convex side slopes of ground moraines and drumlins. The native vegetation was a deciduous forest consisting mainly of maple, basswood, oak, and hickory.

In a typical profile, the surface layer is dark grayish-brown, mildly alkaline silt loam about 9 inches thick. The subsurface layer is dark grayish-brown silt loam that is neutral in reaction and is about 3 inches thick. The subsoil is about 25 inches thick. The upper part of the subsoil is dark-brown silt loam that is neutral in reaction. The middle part of the subsoil is dark yellowish-brown and dark-brown silty clay loam that is slightly acid. The lower part is dark yellowish-brown loam that contains a few pebbles and is mildly alkaline. Underlying the subsoil is a substratum of yellowish-brown, strongly calcareous loam glacial till.

The Dodge soils are moderately permeable and have high available water capacity. Natural fertility is high.

Typical profile of Dodge silt loam, 2 to 6 percent slopes (SW1/4 SE1/4 sec. 35, T. 5 N., R. 18 E.):

Ap--0 to 9 inches, dark grayish-brown (10YR 4/2) silt loam; weak, medium, subangular blocky structure parting to moderate, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.
A2--9 to 12 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, medium, platy structure parting to moderate, very fine, subangular blocky structure; friable; neutral; clear, wavy boundary.
B1--12 to 16 inches, dark-brown (10YR 4/3) silt loam; moderate, medium, subangular blocky structure; friable; neutral; clear, wavy boundary.
B21t--16 to 25 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; moderate, fine, subangular blocky structure; discontinuous clay films; firm; slightly acid; gradual, wavy boundary.
IIB22t--25 to 33 inches, dark-brown (7.5YR 4/4) silty clay loam; moderate, medium, subangular blocky structure; continuous clay films; firm; few pebbles of dolomite; slightly acid; clear, wavy boundary.
IIB3--33 to 37 inches, dark yellowish-brown (10YR 4/4) loam; weak, coarse, subangular blocky structure; friable; few pebbles of dolomite; mildly alkaline; clear, wavy boundary.
IIC--37 to 60 inches, yellowish-brown (10YR 5/4) light loam; massive; very friable; many pebbles and cobblestones of dolomite; strongly calcareous.

In some places the Ap horizon is very dark grayish brown (10YR 3/2). In areas that have not been cultivated the A1 horizon is generally 3 to 5 inches thick. The IIB22t horizon has a hue of 10YR in places. The mantle of silt ranges from 20 to 36 inches in thickness, but it is most commonly 24 to 30 inches thick. The A horizon and approximately the uppermost two-thirds of the B horizon have formed in silt. The IIC horizon is typically loam, but it is sandy loam in some places. In areas that have not been cultivated, reaction of the solum ranges from medium acid to strongly acid. Thickness of the solum ranges from 30 to 40 inches.

The Dodge soils occur with moderately well drained Mayville, somewhat poorly drained Lamartine, and poorly drained Pella soils. They have formed in a thicker mantle of silt and they have a thicker solum than the Theresa and Hochheim soils.

Dodge silt loam, 0 to 2 percent slopes (DdA).--Because runoff is slow, this soil is not susceptible to erosion or is only slightly susceptible. Included with it in mapping were small areas of Theresa silt loam, 0 to 2 percent slopes, and Mayville silt loam, 0 to 2 percent slopes.

If this Dodge soil is well managed, it can be cropped intensively. Nearly all of the acreage is used for the crops commonly grown in the survey area. A small acreage is in trees. (Capability unit I-1; woodland group 1; wildlife group 1; recreation group 1; shrub and vine group 1)

Dodge silt loam, 2 to 6 percent slopes (DdB).--This soil has the profile described as representative of the Dodge series. Runoff is medium, and erosion is only a slight hazard.

Included with this soil in mapping were small areas of Theresa silt loam, 2 to 6 percent slopes, and Mayville silt loam, 2 to 6 percent slopes.

Nearly all of the acreage is used for the crops commonly grown in the survey area. A small acreage is in pasture or trees. (Capability unit IIe-1; woodland group 1; wildlife group 1; recreation group 1; shrub and vine group 1)

Drummer Series

The Drummer series consists of soils that are poorly drained. These soils lie in drainageways and in low, nearly level places on glacial outwash plains and river terraces. In this survey area, these soils are silty over loamy soils that are underlain by calcareous, stratified sand and gravel. Typically, Drummer soils are loamy and are over loamy glacial till. The native vegetation was water-tolerant grasses and a forest of deciduous trees, mainly elms.

In a typical profile, the upper part of the surface layer is black, mildly alkaline silt loam about 10 inches thick. The lower part of the surface layer is very dark gray, mildly alkaline silt loam about 5 inches thick. The subsoil is about 31 inches thick. The upper part of the subsoil is gray, mildly alkaline silty clay loam. The lower part is light olive-gray, mildly alkaline and slightly calcareous, mottled clay loam and loam. The substratum is light olive-brown, loose, calcareous sand and gravel.

The Drummer soils are moderately permeable and have high available water capacity. Ground water is at or near the surface throughout most of the year. Natural fertility is high.

Typical profile of Drummer silt loam, gravelly substratum (NE1/4 SW1/4 sec. 4, T. 5 N., R. 21 E.):

A11--0 to 10 inches, black (10YR 2/1) silt loam; moderate, medium, granular structure; friable; mildly alkaline; gradual, smooth boundary.
A12--10 to 15 inches, very dark gray (5Y 3/1) heavy silt loam; moderate, medium, granular structure; friable when moist, slightly sticky when wet; mildly alkaline; clear, wavy boundary.
B1g--15 to 24 inches, gray (5Y 5/1) silty clay loam; weak, coarse, prismatic structure parting to

moderate, medium, subangular blocky structure; firm; mildly alkaline; clear, wavy boundary.

IIB2g--24 to 40 inches, light olive-gray (5Y 6/2) clay loam; many, medium, prominent, brownish-yellow (10YR 6/6 and 6/8) mottles; weak, coarse, prismatic structure parting to moderate, medium, angular blocky structure; firm; few, thin, discontinuous clay films on the vertical faces of peds; few dolomite pebbles; mildly alkaline; clear, wavy boundary.

IIB3g--40 to 46 inches, light olive-gray (5Y 6/2) loam; weak, medium, subangular blocky structure; friable; slightly calcareous; clear, wavy boundary.

IIC--46 to 60 inches, light olive-brown (2.5Y 5/4) sand and gravel; single grain; loose; calcareous.

The A horizon ranges from 10 to 15 inches in thickness. In places it is covered by a layer of muck that is a few inches thick. The solum is generally 40 to 54 inches thick, and it ranges from mildly alkaline to medium acid in reaction. In some places the IIC horizon is mostly sand, and in others it is mostly gravel.

The Drummer soils occur with well-drained St. Charles and somewhat poorly drained Virgil soils. The Drummer soils of this survey area have a thicker solum than the Sebewa soils.

Drummer silt loam, gravelly substratum (0 to 3 percent slopes) (Dt).--This is the only soil of the Drummer series mapped in the survey area. It is subject to ponding and flooding in spring and during periods of heavy rainfall. Runoff is very slow, and erosion is not a hazard or is only a slight hazard.

Included with this soil in mapping were small areas of Sebewa silt loam and a Virgil silt loam having slopes of 0 to 2 percent.

Wetness is the major limitation to the use of this Drummer soil for crops. This soil can be used for crops, however, if adequate artificial drainage is established and maintained. If management is good, cropping can be intensive. (Capability unit IIw-1; woodland group 7; wildlife group 5; recreation group 7; shrub and vine group 3)

Elliott Series

In the Elliott series are somewhat poorly drained, silty soils that have a silty clay subsoil underlain by calcareous silty clay loam glacial till. These soils occupy the concave side slopes of small drainageways, slight depressions, and glacial ground moraines in the southern part of Milwaukee County and the southeastern part of Waukesha County. The areas are long and narrow or are of irregular shape. The native vegetation was mainly water-tolerant grasses.

In a typical profile, the surface layer is black and very dark brown, slightly acid silt loam about 11 inches thick. The subsurface layer is very dark brown, slightly acid silt loam that has a few mottles and is about 2 inches thick. The subsoil is about 17 inches thick. The main part of the subsoil is dark yellowish-brown and dark-brown, mottled silty clay that is neutral and mildly alkaline in reaction. The lower 4 inches of the subsoil is brown, mottled silty clay loam that is strongly calcareous. The substratum is brown, firm, mottled silty clay loam glacial till that is strongly calcareous.

The Elliott soils have moderately slow permeability and high available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is high.

Typical profile of Elliott silt loam, 1 to 3 percent slopes (SE1/4 SE1/4 sec. 28, T. 5 W., R. 21 E.):

Ap--0 to 9 inches, black (10YR 2/1) silt loam; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A1--9 to 11 inches, very dark brown (10YR 2/2) silt loam; weak, fine, granular structure; friable; slightly acid; clear, wavy boundary.

A3--11 to 13 inches, very dark brown (10YR 2/2) heavy silt loam; few, fine, distinct, dark grayish-brown (10YR 4/2) mottles; moderate, medium, granular structure; friable; slightly acid; clear, wavy boundary.

B21t--13 to 16 inches, dark yellowish-brown (10YR 4/4) silty clay; few, fine, faint, yellowish-brown (10YR 5/4) and distinct, grayish-brown (10YR 5/2) mottles; weak, coarse, prismatic structure parting to moderate, fine, angular blocky structure; continuous clay films; firm; few small pebbles of dolomite; neutral; clear, wavy boundary.

B22t--16 to 26 inches, dark-brown (10YR 4/3) silty clay; common, fine, faint, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/6) mottles; moderate, coarse, prismatic structure parting to moderate, fine, angular blocky structure; continuous clay films; firm; few pebbles of dolomite; mildly alkaline; slightly calcareous in lower part of horizon; gradual, wavy boundary.

B3--26 to 30 inches, brown (10YR 5/3) silty clay loam; common, medium, prominent, yellowish-brown (10YR 5/6) mottles; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky structure; firm; strongly calcareous; clear, wavy boundary.

C--30 to 62 inches, brown (10YR 5/3) silty clay loam; common, medium, faint, dark yellowish-brown (10YR 4/4) and prominent, yellowish-brown (10YR 5/6) mottles; massive; firm; few pebbles of dolomite; strongly calcareous.

The A horizon is generally black (10YR 2/1) or very dark brown (10YR 2/2), and it ranges from 10 to 15 inches in thickness. The B2 horizons have formed in till, and they have a texture of silty clay loam in places. The C horizon contains pockets

or lenses of silt loam or clay loam material in places. The solum ranges from 24 to 36 inches in thickness and from strongly acid to moderately alkaline in reaction.

The Elliott soils occur with poorly drained Ashkum soils. They have a thicker, darker colored A horizon than the Blount, Mequon, and Manawa soils.

Elliott silt loam, 1 to 3 percent slopes (EsA).--This is the only soil of the Elliott series mapped in the survey area. It receives runoff from the slopes above, and it is subject to ponding in spring and during periods of heavy rainfall. Runoff is slow to medium. Erosion is not a hazard in the nearly level areas, but it is a slight hazard in the more sloping places.

Included with this soil in mapping were small areas of Blount silt loam, Markham silt loam, and Ashkum silty clay loam. Also included were areas where a thin, light-colored subsurface layer is between the surface layer and the subsoil.

If this Elliott soil is adequately drained, it is suited to the crops commonly grown in the survey area. Where cropping is intensive, grassed waterways and practices that help to control erosion are needed in the more sloping areas. (Capability unit IIw-2; woodland group 12; wildlife group 5; recreation group 6; shrub and vine group 3)

Fabius Series

The Fabius series consists of somewhat poorly drained, loamy soils over calcareous sand and gravel outwash. These soils are on low outwash plains and stream terraces. The native vegetation consisted mainly of water-tolerant grasses and a few scattered oaks and elm trees.

In a typical profile, the surface layer is black loam that is neutral in reaction and is about 7 inches thick. Just beneath the surface layer is a layer of very dark brown and yellowish-brown loam that is also neutral in reaction and is about 3 inches thick. The subsoil is about 7 inches thick. The upper part of the subsoil is yellowish-brown loam that contains a few mottles and is neutral in reaction. The lower part is light brownish-gray gravelly sandy loam that also contains a few mottles and is slightly calcareous. The substratum is very pale brown, loose, stratified sand and gravel that are calcareous.

The Fabius soils have moderate permeability and moderate available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is moderate.

Typical profile of Fabius loam, 1 to 3 percent slopes, where the slope is about 1 percent (SE1/4 SE1/4 sec. 7, T. 5 N., R. 17 E.):

Ap--0 to 7 inches, black (10YR 2/1) loam; moderate, medium, granular structure; friable; neutral; abrupt, smooth boundary.

AB--7 to 10 inches, very dark brown (10YR 2/2) and yellowish-brown (10YR 5/4) loam; weak, medium, subangular blocky structure parting to moderate, medium, granular structure; few pebbles 1/4 to 1/2 inch in diameter; friable; neutral; clear, wavy boundary.

B2t--10 to 15 inches, yellowish-brown (10YR 5/4) heavy loam; few, fine, distinct mottles of grayish brown (10YR 5/2) and prominent mottles of yellowish brown (10YR 5/8); moderate, medium, subangular blocky structure; few, thin, patchy clay films; friable; few pebbles 1/4 to 1/2 inch in diameter; neutral; abrupt, smooth boundary.

B3--15 to 17 inches, light brownish-gray (10YR 6/2) gravelly sandy loam; few, fine, prominent mottles of yellowish brown (10YR 5/8); weak, medium, subangular blocky structure; very friable; few pebbles; slightly calcareous; clear, wavy boundary.

C--17 to 50 inches, very pale brown (10YR 7/3), stratified medium sand and gravel; single grain; loose; calcareous.

The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2), and in some places it has a texture of silt loam. Thickness of the solum ranges from 12 to 20 inches. Pebbles generally are larger and more numerous in the lower part of the solum than in the upper part.

The Fabius soils occur with well-drained Lorenzo and poorly drained Mussey soils. They have a thinner solum than the Kane soils.

Fabius loam, 1 to 3 percent slopes (FaA).--This is the only soil of the Fabius series mapped in the survey area. It is subject to ponding in spring and during periods of heavy rainfall. Runoff is slow, and little or no erosion has taken place.

Included with this soil in mapping were small areas of Warsaw loam, 0 to 2 percent slopes, and a Matherton loam having slopes of 0 to 2 percent.

Wetness is the major limitation to use of this Fabius soil for crops. Where this soil has been overdrained, however, it is droughty. Most of the acreage is used for the crops commonly grown in the survey area, but a small acreage is in pasture. (Capability unit IIw-5; woodland group 12; wildlife group 5; recreation group 6; shrub and vine group 3)

Fox Series

The Fox series consists of well-drained, loamy soils over calcareous sand and gravel outwash. These soils occur on glacial outwash plains. The native vegetation was a deciduous forest consisting mainly of hardwoods.

In a typical profile, the surface layer is dark grayish-brown or very dark grayish-brown loam that is neutral in reaction and is about 8 inches thick. The subsoil is about 25 inches thick. It is dark yellowish-brown, slightly acid clay loam in the upper part; dark yellowish-brown, strongly acid gritty clay loam in the middle part; and dark yellowish-brown, slightly acid sandy clay loam in the lower

part. The lower part contains dark-brown stains of organic matter and many small pebbles. The substratum is pale-brown, slightly calcareous, stratified sand and gravel.

The Fox soils are moderately permeable, have moderate natural fertility, and have moderate available water capacity. The Fox sandy loams are slightly more permeable than the Fox silt loams and Fox loams.

Typical profile of Fox loam, 2 to 6 percent slopes (NE1/4 SE1/4 sec. 35, T. 7 N., R. 17 E.):

Ap--0 to 8 inches, dark grayish-brown (10YR 4/2) to very dark grayish-brown (10YR 3/2) loam, light brownish gray (10YR 6/2) when dry; weak, medium, subangular blocky structure parting to moderate, medium, granular structure; friable; neutral; abrupt, smooth boundary.

B1t--8 to 14 inches, dark yellowish-brown (10YR 4/4) clay loam; moderate, medium, subangular blocky structure; friable; discontinuous clay films; slightly acid; gradual, wavy boundary.

B2t--14 to 28 inches, dark yellowish-brown (10YR 4/4) gritty clay loam; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; continuous clay films; firm; few small pebbles; strongly acid; gradual, wavy boundary.

B3t--28 to 33 inches, dark yellowish-brown (10YR 4/4) sandy clay loam; weak, medium, subangular blocky structure; friable; dark-brown (10YR 3/3) stains of organic matter; many small pebbles; slightly acid; clear, wavy boundary.

IIC--33 to 62 inches, pale-brown (10YR 6/3), stratified sand and gravel; single grain; loose; slightly calcareous.

The solum ranges from 20 to 40 inches in thickness, but it is generally 24 to 36 inches thick. Where a layer of silt covers the outwash, the A horizon is silt loam, but where the mantle of silt is lacking, the A horizon is loam or sandy loam. In areas that have not been cultivated, the A1 horizon is commonly 3 to 5 inches thick. In some cultivated areas, the Ap horizon is very dark grayish brown (10YR 3/2) and the solum ranges from strongly acid to neutral in reaction. Where the A horizon is silt loam, the upper part of the B2t horizon is generally silty clay loam and the lower part is clay loam. Where the A horizon is sandy loam, the B2t horizon is commonly sandy clay loam. Where the A horizon is loam, the B2t horizon is commonly clay loam. In some places the C horizon is mostly sand, and in others it is mostly gravel. Where the A horizon is sandy loam, the solum generally has fewer pebbles throughout than where the A horizon is loam or silt loam.

The Fox soils occur with somewhat poorly drained Matherton and poorly drained Sebewa soils. They have a lighter colored surface layer than the Warsaw soils and a thinner solum than the St. Charles soils that have a gravelly substratum. The Fox soils have a thicker solum than the Casco soils and a finer textured subsoil than the Boyer soils.

Fox sandy loam, 0 to 2 percent slopes (FmA).--The surface layer of this soil is slightly coarser textured than the one in the profile described as representative of the Fox series. This soil also has lower available water capacity and is thus more droughty than the soil for which a profile is described. Runoff is slow, and erosion is not a hazard or is only a slight hazard.

Included with this soil in mapping were small areas of Fox loam, 0 to 2 percent slopes, and a Boyer sandy loam that has slopes of 0 to 2 percent. Also included were small areas of soils that are similar to the Fox soils but have a mottled subsoil.

This Fox soil is used mostly for crops. A small acreage is in trees or pasture. (Capability unit IIIs-4; woodland group 3; wildlife group 1; recreation group 2; shrub and vine group 2)

Fox sandy loam, 2 to 6 percent slopes (FmB).--This soil is more droughty and has lower available water capacity than the soil for which a profile is described as representative of the Fox series. It is moderately susceptible to soil blowing. Runoff is medium. Little or no erosion has taken place, but erosion is a slight hazard.

Included with this soil in mapping were small areas of Fox loam, 2 to 6 percent slopes; small areas of a Boyer sandy loam that has slopes of 2 to 6 percent; and areas that are moderately eroded.

The acreage is used mainly for the crops commonly grown in the survey area. A small acreage is in pasture or trees. (Capability unit IIIs-4; woodland group 3; wildlife group 1; recreation group 2; shrub and vine group 2)

Fox sandy loam, 6 to 12 percent slopes, eroded (FmC2).--This soil has lost part of its original surface layer through moderate erosion. The present plow layer consists partly of the remaining original surface soil and partly of dark yellowish-brown clay loam from the subsoil. Runoff is medium. Soil blowing and further erosion are moderate hazards.

Included with this soil in mapping were small areas of Casco sandy loam, 6 to 12 percent slopes, eroded; a few areas that are not eroded or that are only slightly eroded; and some areas that are steeper than 12 percent.

Nearly all of the acreage is used for the crops commonly grown in the survey area. A small acreage is in pasture. (Capability unit IIIe-2; woodland group 3; wildlife group 1; recreation group 2; shrub and vine group 2)

Fox sandy loam, loamy substratum, 2 to 6 percent slopes (FnB).--This soil has a profile similar to the one described as representative of the Fox series, except that the surface layer has a coarser texture and the substratum is loamy and has sand and gravel only in the upper part. The loamy part of the substratum has higher available water

capacity and is more easily compacted than the sand and gravel in the typical profile. Runoff is medium, and this soil is slightly susceptible to erosion. This soil is also slightly droughty, and it is moderately susceptible to soil blowing.

Included with this soil in mapping were small areas of Fox sandy loam, 2 to 6 percent slopes.

Most of the acreage is used for the crops commonly grown in the survey area. (Capability unit IIIs-4; woodland group 3; wildlife group 1; recreation group 2; shrub and vine group 2)

Fox loam, 0 to 2 percent slopes (FoA).--This soil occurs in rather large areas. It is slightly droughty. The profile is similar to the one described as representative of the Fox series, except that it contains a subsurface layer that is lighter colored than the surface layer. Runoff is slow. Erosion is not a hazard or is only a slight hazard.

Included with this soil in mapping were small areas of Fox silt loam, 0 to 2 percent slopes, and Fox loam, 2 to 6 percent slopes. Also included were small areas of soils that are similar to Fox soils but have a mottled subsoil.

Most of the acreage is used for field crops, but some of it is in pasture or trees. This Fox soil can be cropped intensively if it is properly managed. (Capability unit IIs-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Fox loam, 2 to 6 percent slopes (FoB).--This soil has the profile described as representative of the Fox series. It is slighty droughty. Runoff is medium, and erosion is a slight hazard.

Included with this soil in mapping were small areas of Fox silt loam, 2 to 6 percent slopes, and small areas of soils that are similar to Fox soils but have a mottled subsoil. Also included were small moderately eroded areas.

Most of the acreage is in field crops. A small acreage is in pasture or trees. (Capability unit IIe-2; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Fox loam, 6 to 12 percent slopes, eroded (FoC2).--This soil has lost part of its original surface layer through erosion, and dark yellowish-brown clay loam from the subsoil is mixed with the remaining original surface soil. As a result, the present surface layer has a slightly finer texture than the one in the profile described as typical of the Fox series. Runoff is medium, and further erosion is a moderate hazard. This soil is slightly droughty.

Included with this soil in mapping were areas that are slightly steeper than 12 percent; small areas of Fox silt loam, 6 to 12 percent slopes, eroded; and uncultivated areas that are not eroded or that are only slightly eroded.

Nearly all of the acreage is used for the crops commonly grown in the survey area. (Capability unit IIIe-2; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Fox silt loam, 0 to 2 percent slopes (FsA).--This soil occurs in rather large areas. It has a profile similar to the one described as representative of the Fox series, except that the surface layer is silt loam and the upper part of the subsoil is heavy silt loam. Runoff is slow, and little or no erosion has taken place. This soil is slightly droughty.

Included with this soil in mapping were small areas of Fox loam, 0 to 2 percent slopes; St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes; and a soil that is similar to Fox soils but has a mottled subsoil.

Most of the acreage is used for the crops commonly grown in the survey area, but a small acreage is in pasture or trees. If properly managed, this Fox soil can be cropped intensively. (Capability unit IIs-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Fox silt loam, 2 to 6 percent slopes (FsB).--This soil has a profile similar to the one described as representative of the Fox series, except that the surface layer is silt loam and the upper part of the subsoil is heavy silt loam. In much of the acreage, little or no erosion has taken place, but runoff is medium, and erosion is a slight hazard. This soil is slightly droughty.

Included with this soil in mapping were small areas of Fox silt loam, 0 to 2 percent slopes, and St. Charles silt loam, gravelly substratum, 2 to 6 percent slopes. Also included were some moderately eroded areas.

Most of the acreage is used for the crop commonly grown in the survey area, but a small acreage is in pasture or trees. If properly managed, this Fox soil can be cropped intensively. (Capability unit IIe-2; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Fox silt loam, 6 to 12 percent slopes, eroded (FsC2).--This soil has lost part of its original surface layer through erosion. The present plow layer contains some dark yellowish-brown clay loam that is mixed with the remaining surface soil. In some places the present plow layer is light silty clay loam. This soil is slightly droughty. Runoff is medium, and further erosion is a moderate hazard.

Included with this soil in mapping were small areas of a Fox loam. Also included were a few fairly large areas that are not eroded or that are only slightly eroded because they have remained in trees or have been cleared and used for permanent pasture.

Nearly all of the acreage is used for the crops commonly grown in the survey area. A small acreage is in trees or pasture. (Capability unit IIIe-2; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Fox silt loam, loamy substratum, 2 to 6 percent slopes (FtB).--This soil has a profile similar to the one described as representative of the Fox

series, except that the surface layer is silt loam and the substratum is loamy and has sand and gravel only in the upper part. The loamy material in the substratum has higher available water capacity and is generally more easily compacted than the sand and gravel in the substratum of the soil described in the typical profile. Runoff is medium, and erosion is a slight hazard. This soil is slighty droughty.

Included with this soil in mapping were small areas of Fox silt loam, 2 to 6 percent slopes; a few fairly large areas in which the surface layer is loam; and areas where little or no erosion has taken place. Also included were eroded areas in which dark yellowish-brown clay loam from the subsoil is mixed with the remaining original surface soil in the plow layer.

Nearly all of the acreage is used for the crops commonly grown in the survey area, but a small acreage is in trees. If management is good, cropping can be intensive. (Capability unit IIe-2; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Gilford Series

In the Gilford series are poorly drained, loamy soils that are underlain by calcareous sand. These soils are on low, broad flats and in depressions of glacial outwash plains, mainly in the southwestern part of Waukesha County. The native vegetation was water-tolerant grasses and a deciduous forest consisting mostly of elm and elder.

In a typical profile, the surface layer is black, mildly alkaline loam about 10 inches thick. The subsurface layer is dark grayish-brown, mildly alkaline, mottled sandy loam about 2 inches thick. The subsoil is about 18 inches thick. The upper part of the subsoil is grayish-brown, mildly alkaline, mottled sandy loam. The middle part of the subsoil is gray, mildly alkaline, mottled sandy clay loam. The lower part is dark-gray, slightly calcareous, mottled sandy loam. A substratum of grayish-brown, loose, slightly calcareous, stratified sand underlies the subsoil.

The Gilford soils have moderate available water capacity and moderate permeability. Ground water is at or near the surface throughout most of the year. Natural fertility is moderate.

Typical profile of Gilford loam (0 to 2 percent slopes) (NE1/4 SW1/4 sec. 21, T. 6 N., R. 17 E.):

Ap--0 to 10 inches, black (10YR 2/1) loam; moderate, fine, granular structure; friable; mildly alkaline; clear, wavy boundary.

A3--10 to 12 inches, dark grayish-brown (2.5Y 4/2) sandy loam; few, fine, prominent, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; friable; mildly alkaline; clear, wavy boundary.

B1g--12 to 16 inches, grayish-brown (2.5Y 5/2) sandy loam; common, medium, prominent, strong-brown (7.5YR 5/8) mottles; weak, medium, subangular blocky structure; friable; mildly alkaline; clear, wavy boundary.

B2g--16 to 24 inches, gray (5Y 5/1) sandy clay loam; many, medium, prominent, yellowish-red (5YR 4/8) mottles; moderate, medium, subangular blocky structure; friable; mildly alkaline; clear, wavy boundary.

B3g--24 to 30 inches, dark-gray (5Y 4/1) sandy loam; few, fine, prominent, yellowish-red (5YR 5/8) mottles; weak, medium, subangular blocky structure; friable; slightly calcareous; clear, wavy boundary.

IIC--30 to 60 inches, grayish-brown (2.5Y 5/2) sand; weakly stratified; single grain; loose; slightly calcareous.

In areas that have not been cultivated, the A1 horizon is black (N 2/0) to very dark brown (10YR 2/2) loam or mucky loam, and it ranges from 10 to 15 inches in thickness. Texture of the B horizon ranges from sandy loam to sandy clay loam. Reaction of the solum ranges from moderately alkaline to medium acid.

The Gilford soils occur with well-drained Boyer and somewhat poorly drained Wasepi soils. They have a slightly finer textured solum than the Granby soils, and they have a coarser textured solum than the Sebewa soils.

Gilford loam (0 to 2 percent slopes) (Gd).--This is the only soil of the Gilford series mapped in the survey area. Runoff is very slow, and little or no erosion has taken place.

Included with this soil in mapping were small areas of Mussey loam, and of a Wasepi sandy loam having slopes of 0 to 2 percent.

If this Gilford soil is adequately drained, preferably by means of open ditches, it can be used for crops. Only a small acreage is presently used for crops, and the rest is wooded, in pasture, or used as wildlife habitat. (Capability unit IIIw-5; woodland group 7; wildlife group 5; recreation group 7; shrub and vine group 3)

Granby Series

The Granby series consists of poorly drained, loamy soils underlain by deep, sandy, calcareous outwash. These soils are on the bottoms of depressions and in low, broad, nearly level areas on glacial outwash plains in the western part of Waukesha County. The native vegetation was sedges, water-tolerant grasses, and a deciduous forest consisting mainly of elm.

In a typical profile, the surface layer is black to very dark gray sandy loam that is neutral in reaction and is about 11 inches thick. The surface layer is covered by a layer, about 4 inches thick, of sedge leaves and stems that are in various stages of decomposition and are neutral in reaction. The

subsoil is about 24 inches thick. It consists of mottled light brownish-gray sand that is also neutral in reaction. The substratum is gray, loose, moderately alkaline and slightly calcareous sand.

The Granby soils have low available water capacity and moderately rapid permeability. Ground water is at or near the surface throughout most of the year. Natural fertility is low.

Typical profile of Granby fine sandy loam (0 to 2 percent slopes) (SW1/4 SE1/4 sec. 9, T. 6 N., R. 17 E.):

O1--4 to 3 inches, dark-brown (7.5YR 3/3) mat of sedge leaves and stems; neutral; abrupt, smooth boundary.
O2--3 inches to 0, very dark brown (10YR 2/2), disintegrated sedge peat; moderate, medium, granular structure; neutral; abrupt, smooth boundary.
A1--0 to 8 inches, black (10YR 2/1) fine sandy loam; high content of organic matter; moderate, medium, granular structure; very friable; neutral; clear, wavy boundary.
A3g--8 to 11 inches, very dark gray (10YR 3/1) sandy loam; moderate, medium, subangular blocky structure; very friable; neutral; clear, wavy boundary.
B--11 to 35 inches, light brownish-gray (2.5Y 6/2) fine and medium sand; few, medium, distinct mottles of dark brown (7.5YR 4/4) and prominent mottles of strong brown (7.5YR 5/6); single grain; loose; neutral; clear, wavy boundary.
Cg--35 to 62 inches, gray (5Y 6/1) fine and medium sand; single grain; loose; moderately alkaline and slightly calcareous.

Cultivated areas and some areas that have not been cultivated lack an accumulation of organic material above the A1 horizon. The A horizon is black (10YR 2/1) to very dark brown (10YR 2/2) or very dark gray (10YR 3/1), and it ranges from 10 to 15 inches in thickness. In places the B horizon is calcareous. These soils have a few pebbles throughout all horizons in some areas. Reaction throughout the profile ranges from neutral to moderately alkaline.

The Granby soils lack the subsoil of sandy clay loam that is typical of the Mussey and Gilford soils.

Granby fine sandy loam (0 to 2 percent slopes) (Gf).--This is the only soil of the Granby series mapped in the survey area. It is not eroded or is only slightly eroded. Runoff is very slow, and flooding and ponding are hazards in spring and during periods of heavy rainfall.

Included with this soil in mapping were small areas of Wasepi sandy loam. Also included were a few fairly large areas in which the surface layer is loam.

Wetness is the major limitation to use of this Granby soil for crops. Even where adequate drainage has been installed, this soil is poorly suited to the crops commonly grown in the survey area, but it can be used for some special crops. Most of the acreage is in pasture. A small acreage that is adequately drained and is well managed is used for truck crops and corn. (Capability unit IIIw-5; woodland group 8; wildlife group 5; recreation group 7; shrub and vine group 3)

Grays Series

The Grays series consists of well-drained, silty soils that are underlain by stratified lacustrine deposits of silt and fine sand. These soils are in old glacial lakebeds and on river benches. The native vegetation was a deciduous forest consisting mainly of oak, hickory, maple, and basswood.

In a typical profile, the surface layer is very dark grayish-brown, slightly acid silt loam about 7 inches thick. The subsoil is about 19 inches thick. The upper part of the subsoil is dark-brown, slightly acid silt loam. The middle part is dark-brown, slightly acid silty clay loam. The lower part is dark yellowish-brown, mildly alkaline to moderately alkaline and slightly calcareous silt loam. The substratum is yellowish-brown, friable, strongly calcareous, stratified silt and fine sand.

The Grays soils are moderately permeable and have high available water capacity. Natural fertility is moderate. The silt and fine sand in the substratum have low bearing capacity, and they tend to flow easily when saturated.

Typical profile of Grays silt loam, 2 to 6 percent slopes (NE1/4 SW1/4 sec. 15, T. 5 N., R. 22 E.):

Ap--0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, fine, subangular blocky structure; friable; slightly acid; abrupt, smooth boundary.
B1--7 to 9 inches, dark-brown (7.5YR 4/4) silt loam; weak, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.
B2t--9 to 18 inches, dark-brown (7.5YR 4/4) silty clay loam; moderate, medium, subangular blocky structure; thin, discontinuous clay films; firm; slightly acid; gradual, wavy boundary.
B3--18 to 26 inches, dark yellowish-brown (10YR 4/4) silt loam; weak, medium, subangular blocky structure; friable; mildly alkaline in the upper part, moderately alkaline and slightly calcareous in the lower part; clear, wavy boundary.
C1--26 to 42 inches, yellowish-brown (10YR 5/4), stratified silt and fine sand; massive; friable; strongly calcareous; gradual, wavy boundary.
C2--42 to 62 inches, yellowish-brown (10YR 5/4), weakly stratified silt and fine sand; few, fine, distinct, light brownish-gray (10YR 6/2) and yellowish-brown (10YR 5/6 and 5/8) mottles; massive; friable; strongly calcareous.

In areas that have not been cultivated, the A1 horizon is black (10YR 2/1) to very dark brown (10YR 2/2), and it ranges from 3 to 5 inches in thickness. In those areas the A2 horizon is pale brown (10YR 6/3) or brown (10YR 5/3) and is 2 to 4 inches thick. Depth to free carbonates is typically 20 to 30 inches. The C horizons generally contain more silt than fine sand, but fine sand is predominant in some places.

The Grays soils occur with somewhat poorly drained Mundelein and poorly drained Colwood soils. They have a coarser textured solum than the Saylesville soils, and unlike the Saylesville soils, they have a substratum of silt and fine sand.

Grays silt loam, 0 to 2 percent slopes (GrA).--This soil is on river benches and on the tops of rises in basins formerly occupied by glacial lakes. Runoff is slow, and erosion is not a hazard or is only a slight hazard.

Included with this soil in mapping were small areas of a Mundelein silt loam having slopes of 0 to 2 percent, and some fairly large areas in which the surface layer is fine sandy loam or loam.

Nearly all of the acreage is used for crops. A small acreage is in trees. (Capability unit I-1; woodland group 1; wildlife group 1; recreation group 1; shrub and vine group 1)

Grays silt loam, 2 to 6 percent slopes (GrB).--This soil is on river benches and on rises in basins formerly occupied by old glacial lakes. It has the profile described as representative of the Grays series. Runoff is medium. The hazard of erosion is slight.

Included with this soil in mapping were small areas of Saylesville silt loam, 2 to 6 percent slopes, and a Mundelein silt loam having slopes of 2 to 6 percent. Also included were small areas in which slopes are steeper than 6 percent; a few large moderately eroded areas; and areas in which the surface layer is fine sandy loam or loam.

Nearly all of the acreage is used for crops. A small acreage is in trees. (Capability unit IIe-1; woodland group 1; wildlife group 1; recreation group 1; shrub and vine group 1)

Griswold Series

In the Griswold series are well-drained soils on glaciated uplands in the southern part of Waukesha County. These soils consist of a thin layer of silt loam over a clay loam subsoil that is underlain by calcareous, loamy glacial till. The native vegetation was prairie grasses and a few scattered oaks.

In a typical profile, the surface layer is very dark brown, mildly alkaline gritty silt loam about 8 inches thick. The subsurface layer is dark-brown, mildly alkaline heavy loam about 3 inches thick. The subsoil is about 13 inches thick. The upper part of the subsoil is dark yellowish-brown, mildly alkaline clay loam; the middle part is dark-brown, mildly alkaline clay loam; and the lower part is brown, slightly calcareous heavy loam. The middle and lower parts of the subsoil contain a few pebbles. The substratum is pale-brown, very friable loam glacial till that is strongly calcareous.

The Griswold soils have moderate permeability and high available water capacity. Natural fertility is moderate.

Typical profile of Griswold silt loam, 2 to 6 percent slopes (SE1/4 SW1/4 sec. 27, T. 5 N., R. 19 E.):

Ap--0 to 8 inches, very dark brown (10YR 2/2) gritty silt loam; weak, medium, subangular blocky structure parting to weak, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

A3--8 to 11 inches, dark-brown (10YR 3/3) heavy loam; weak, medium, subangular blocky structure; friable; mildly alkaline; clear, wavy boundary.

B1t--11 to 15 inches, dark yellowish-brown (10YR 3/4 to 4/4) clay loam; moderate, medium, subangular blocky structure; thin, discontinuous clay films; friable; mildly alkaline; clear, wavy boundary.

B2t--15 to 20 inches, dark-brown (7.5YR 4/4) clay loam; moderate, medium, subangular blocky structure; thin, discontinuous clay films; firm; few pebbles of dolomite; mildly alkaline; clear, wavy boundary.

B3--20 to 24 inches, brown (10YR 5/3) heavy loam; weak, medium, subangular blocky structure; friable; few pebbles of dolomite; slightly calcareous; clear, wavy boundary.

C--24 to 62 inches, pale-brown (10YR 6/3) light loam; massive; very friable; many small pebbles of dolomite; strongly calcareous.

The A horizon is black (10YR 2/1) to very dark brown (10YR 2/2), and it ranges from 10 to 14 inches in thickness. In places the mantle of silt is as much as 20 inches thick and only a small part of the B horizon formed in glacial till. The B2t horizon generally has a hue of 7.5YR, but the hue is 10YR in places. The C horizon is commonly light loam, but it is light sandy loam in some areas.

Griswold silt loam, 2 to 6 percent slopes (GtB).--This soil occupies oval-shaped areas that generally extend in a northeast-southwest direction. It has the profile described as typical of the Griswold series. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping were small areas of Miami loam, sandy loam substratum, 2 to 6 percent slopes, and a few fairly large areas that are moderately eroded.

This Griswold soil is used mainly for crops. A small acreage is in pasture or trees. (Capability unit IIe-1; woodland group 12; wildlife group 4; recreation group 2; shrub and vine group 1)

Griswold silt loam, 6 to 12 percent slopes, eroded (GtC2).--This soil occupies long, narrow areas that generally extend in a northeast-southwest direction. It has lost part of its original surface layer through erosion. The present surface layer contains a moderate amount of dark yellowish-brown clay loam from the subsoil that was mixed with the remaining original surface soil during tillage. Runoff is medium, and further erosion is a moderate hazard.

Included with this soil in mapping were small areas of Miami loam, sandy loam substratum, 6 to 12 percent slopes. Also included were slightly eroded areas and areas that have a loam surface layer.

Nearly all of the acreage is used for crops. A small acreage is in pasture or trees. (Capability unit IIIe-1; woodland group 12; wildlife group 4; recreation group 2; shrub and vine group 1)

Griswold Series, Mottled Subsoil Variant

Soils of the Griswold series, mottled subsoil variant, are somewhat poorly drained. They are on the foot slopes of glaciated uplands in the southern part of Waukesha County. These soils consist of a layer of silt loam and a dominantly clay loam subsoil underlain by calcareous sandy loam glacial till. The native vegetation was water-tolerant prairie grasses and a few widely spaced oak trees.

In a typical profile, the surface layer is black silt loam that is neutral in reaction and is about 10 inches thick. The subsoil is about 19 inches thick. The upper part of the subsoil is dark grayish-brown, slightly acid, mottled silty clay loam; the middle part is dark yellowish-brown and yellowish-brown, mottled clay loam that is neutral in reaction; and the lower part is brown to pale-brown, slightly calcareous, mottled loam. The substratum is yellowish-brown, very friable, strongly calcareous, mottled sandy loam glacial till.

Soils of the Griswold series, mottled subsoil variant, have moderate permeability and high available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is high.

Typical profile of Griswold silt loam, mottled subsoil variant, 2 to 6 percent slopes (NW1/4 SE1/4 sec. 31, T. 5 N., R. 19 E.):

A1--0 to 10 inches, black (10YR 2/1) silt loam; moderate, medium, granular structure; friable; neutral; abrupt, smooth boundary.

B1--10 to 15 inches, dark grayish-brown (2.5Y 4/2) light silty clay loam; few, fine, faint, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/8) mottles; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

IIB2t--15 to 24 inches, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/4) clay loam; many, fine, distinct, grayish-brown (10YR 5/2) and light brownish-gray (10YR 6/2) mottles and prominent, yellowish-brown (10YR 5/8) mottles; moderate, medium, subangular blocky structure; thin, discontinuous clay films; firm; few pebbles of dolomite; neutral; gradual, wavy boundary.

IIB3--24 to 29 inches, brown (10YR 5/3) to pale-brown (10YR 6/3) heavy loam; many, medium, faint, grayish-brown (10YR 5/2) mottles; weak, medium, subangular blocky structure; friable; many pebbles; slightly calcareous; clear, wavy boundary.

IIC--29 to 60 inches, yellowish-brown (10YR 5/4) sandy loam; many, common, distinct, grayish-brown (10YR 5/2) mottles and prominent, yellowish-brown (10YR 5/8) mottles; massive; very friable; many pebbles and a few cobblestones; strongly calcareous.

The A1 horizon is black (10YR 2/1) to very dark brown (10YR 2/2), and it ranges from 10 to 15 inches in thickness. The part of the profile that formed in the mantle of silt is generally 15 to 25 inches thick. In places the part of the B horizon that formed in till has a hue of 7.5YR. The IIC horizon is commonly sandy loam, but the texture ranges to light loam in some places.

Soils of the Griswold series, mottled subsoil variant, occur with the well-drained typical soils of the Griswold series. They have a darker, slightly thicker surface layer and a thinner solum than the Lamartine soils.

Griswold silt loam, mottled subsoil variant, 2 to 6 percent slopes (GwB).--This soil occurs in areas that are long and narrow. Ponding is a hazard in spring and during periods of heavy rainfall. Runoff is medium, and erosion is a slight hazard, especially in the more sloping areas.

Included with this soil in mapping were small areas of Griswold silt loam, 2 to 6 percent slopes. Also included were small areas of Brookston silt loam, 0 to 3 percent slopes.

Most of the acreage is used for the crops commonly grown in the survey area, but a small acreage is in pasture. Wetness is the major limitation where crops are grown. (Capability unit IIw-2; woodland group 12; wildlife group 5; recreation group 6; shrub and vine group 3)

Hebron Series

In the Hebron series are well drained or moderately well drained soils that have formed partly in medium-textured glacial outwash and partly in loamy and clayey lacustrine material. These soils are in old glacial lake basins and on benches along streams. The native vegetation was a deciduous forest consisting mainly of oak, hickory, maple, and basswood.

In a typical profile, the surface layer is very dark grayish-brown or dark grayish-brown loam that is neutral in reaction and is about 9 inches thick. The subsoil is about 23 inches thick. The upper

part of the subsoil is dark-brown clay loam that is neutral in reaction. The middle part of the subsoil is dark-brown loam that contains many pebbles and is mildly alkaline. The lower part is dark-brown silty clay that is strongly calcareous. Just beneath the subsoil is the substratum of grayish-brown, strongly calcareous silty clay loam.

The Hebron soils are slowly permeable, have high available water capacity. Natural fertility is moderate.

Typical profile of Hebron loam, 2 to 6 percent slopes (NE1/4 SW1/4 sec. 3, T. 5 N., R. 21 E.):

Ap--0 to 9 inches, very dark grayish-brown (10YR 3/2) or dark grayish-brown (10YR 4/2) loam, light brownish gray (10YR 6/2) when dry; weak, fine, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

B1--9 to 16 inches, dark-brown (7.5YR 4/4) light clay loam; moderate, fine, subangular blocky structure; firm; neutral; clear, wavy boundary.

B21t--16 to 22 inches, dark-brown (7.5YR 4/4) clay loam; moderate, medium, subangular blocky structure; thin, continuous clay films; firm; few small pebbles; neutral; clear, wavy boundary.

B22t--22 to 27 inches, dark-brown (7.5YR 4/4) loam; weak, medium, subangular blocky structure; thin, discontinuous clay films; friable; many pebbles of dolomite; mildly alkaline; clear, wavy boundary.

IIB3t--27 to 32 inches, dark-brown (7.5YR 4/3) silty clay; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; thin, discontinuous clay films; very firm; strongly calcareous; clear, wavy boundary.

IIC--32 to 60 inches, grayish-brown (10YR 5/2) silty clay loam; weak, thick, platy structure to massive; very firm; many streaks of segregated lime; strongly calcareous.

In areas that have not been cultivated, the A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2), and it ranges from 3 to 5 inches in thickness. In those areas the A2 horizon is generally brown (10YR 5/3) and ranges from 2 to 6 inches in thickness. Texture of the upper part of the B horizon ranges from silty clay loam to loam. The B horizon has a hue of 10YR in places. In some places the IIB3 horizon is silty clay loam. The IIC horizon consists of thin layers of silty clay and silty clay loam in many places, but it contains thin layers of silt and fine sand in some areas. In some places the IIC horizon has a hue of 7.5YR.

The Hebron soils occur with poorly drained Navan soils. The upper part of their solum is coarser textured than that of the Saylesville soils.

Hebron loam, 0 to 2 percent slopes (HeA).--This soil dries slowly in spring and after heavy rains. Runoff is slow. Erosion is not a hazard or is only a slight hazard.

Included with this soil in mapping were small areas in which the surface layer is silty, and small areas of Saylesville silt loam, 0 to 2 percent slopes. Also included were small areas of Fox loam, 0 to 2 percent slopes; a few fairly large areas in which the surface layer is sandy loam; areas where the surface layer is darker colored than typical for the Hebron soils; and small areas of a Hebron loam that has a mottled subsoil and slopes of 0 to 3 percent.

Most of the acreage is in crops, but a small acreage is in trees or pasture. (Capability unit IIs-7; woodland group 1; wildlife group 1; recreation group 3; shrub and vine group 1)

Hebron loam, 2 to 6 percent slopes (HeB).--This soil is on river benches and on rises in old glacial lake basins. It is not eroded or is only slightly eroded. Runoff is medium, however, and erosion is a slight hazard. The profile is the one described as representative of the Hebron series.

Included with this soil in mapping were small areas in which the surface layer is silty. Also included were small areas of Fox loam, 2 to 6 percent slopes, and a few fairly large areas that are moderately eroded, that have a surface layer of sandy loam or that have a surface layer that is darker colored than typical for the Hebron soils. Other inclusions consist of small areas of a Hebron loam that has a mottled subsoil and slopes of 0 to 3 percent.

Most of the acreage is in crops, but a small acreage is in trees or pasture. (Capability unit IIe-6; woodland group 1; wildlife group 1; recreation group 3; shrub and vine group 1)

Hebron loam, 6 to 12 percent slopes, eroded (HeC2).--This soil is on river benches and on rises in old glacial lake basins. It is eroded to the extent that some material from the subsoil has been mixed in the plow layer during tillage. Runoff is medium, and further erosion is a moderate hazard.

Included with this soil in mapping were small areas of Fox loam, 6 to 12 percent slopes, eroded. Other inclusions consist of a few fairly large slightly eroded areas, and areas in which the surface layer is sandy loam or silt loam.

This Hebron soil is used mainly for crops. A small acreage is in trees or pasture. (Capability unit IIIe-6; woodland group 1; wildlife group 1; recreation group 3; shrub and vine group 1)

Hochheim Series

The Hochheim series consists of soils that are well drained and loamy and are underlain by highly calcareous loam glacial till (pl. V). These soils occur in long, narrow areas on the convex side slopes of drumlins and glacial ground moraines, generally east of the Kettle Moraine. The native vegetation was a deciduous forest consisting mainly of hard maple, basswood, oak, and hickory.

In a typical profile, the surface layer is very dark brown loam that is neutral in reaction and is about 3 inches thick. The subsurface layer is dark grayish-brown or grayish-brown loam that is neutral in reaction and is also about 3 inches thick. The subsoil is about 11 inches thick. The upper part of the subsoil is dark yellowish-brown and dark-brown, slightly acid clay loam. The lower part is dark yellowish-brown or yellowish-brown, slightly calcareous heavy loam. The substratum is yellowish-brown, strongly calcareous gravelly loam glacial till.

The Hochheim soils are moderately permeable and have moderate available water capacity. Natural fertility is moderate.

Typical profile of Hochheim loam, 2 to 6 percent slopes (NE1/4 NW1/4 sec. 26, T. 6 N., R. 19 E.):

O2--1/2 inch to 0, partly decomposed leaf litter and small twigs.

A1--0 to 3 inches, very dark brown (10YR 2/2) loam; weak, medium, granular structure; friable; neutral; abrupt, smooth boundary.

A2--3 to 6 inches, dark grayish-brown (10YR 4/2) or grayish-brown (10YR 5/2) loam; weak, medium, platy structure parting to moderate, medium, granular structure; friable; some material from the A1 horizon is mixed with the material in this horizon; many roots up to one-half inch in diameter; neutral; clear, wavy boundary.

B1t--6 to 9 inches, dark yellowish-brown (10YR 4/4) light clay loam; moderate, medium, subangular blocky structure; discontinuous clay films; friable; many roots up to one-half inch in diameter; few pebbles of dolomite; slightly acid; clear, wavy boundary.

B2t--9 to 15 inches, dark-brown (7.5YR 4/4) clay loam; moderate, medium, subangular blocky structure; clay films on the surfaces of most peds; few dark-brown (7.5YR 3/2) stains of organic matter; firm; many, fine, fibrous roots up to one-fourth inch in diameter; few pebbles and cobblestones of dolomite; slightly acid; clear, wavy boundary.

B3--15 to 17 inches, dark yellowish-brown (10YR 4/4) to yellowish-brown (10YR 5/4) heavy loam; friable; slightly calcareous; clear, wavy boundary.

C--17 to 60 inches, yellowish-brown (10YR 5/4) gravelly loam till; massive; friable; few, fine, fibrous roots in uppermost 5 inches; strongly calcareous.

The solum ranges from 12 to 24 inches in thickness. In some places the soil is covered by a thin layer of silt loam. The solum is generally thinnest where the surface layer is loam, and it is thickest where the mantle of silt is thickest. In cultivated areas the plow layer is dark grayish brown (10YR 3/2) to dark brown (10YR 3/3) and is 6 to 8 inches thick. In many places pebbles in the solum are larger and more numerous below the B2t horizon than in that horizon. In some areas that have not been cultivated, reaction of the solum is slightly acid, but the reaction ranges to neutral or moderately alkaline in areas that are intensively cultivated. Typically, the texture of the glacial till is loam, but it ranges to gravelly sandy loam in places. The calcium carbonate equivalent of the glacial till ranges from 40 to 60 percent.

The profile of the Hochheim soils is somewhat similar to that of the Theresa soils, except that the solum is thinner.

Hochheim loam, 2 to 6 percent slopes (HmB).--This soil has the profile described as representative of the Hochheim series. Runoff is medium, and erosion is a slight hazard.

Included with this soil in mapping were areas in which the surface layer is silt loam; some moderately eroded areas; and small areas of Theresa silt loam, 2 to 6 percent slopes.

This Hochheim soil can be cropped intensively if it is well managed. Most of the acreage is used for crops commonly grown in the survey area, but a small acreage is in pasture or trees. (Capability unit IIe-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Hochheim loam, 2 to 6 percent slopes, eroded (HmB2).--This soil has lost part of its original surface layer through erosion. In the present plow layer, some dark yellowish-brown clay loam from the subsoil is mixed with the remaining original surface soil. Runoff is medium, and further erosion is a slight hazard. The rate of infiltration is slightly lower than in uneroded or only slightly eroded areas.

Included with this soil in mapping were areas in which the surface layer is silt loam; small areas of Theresa silt loam, 2 to 6 percent slopes; and a few places where little or no erosion has taken place.

If this Hochheim soil is well managed, it can be cropped intensively. Nearly all of the acreage is used for the crops commonly grown in the survey area, but a small acreage is in pasture. (Capability unit IIe-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Hochheim loam, 6 to 12 percent slopes, eroded (HmC2).--Erosion has removed part of the original surface layer of this soil. Dark yellowish-brown clay loam from the subsoil is mixed with the remaining original surface soil in the plow layer. Runoff is medium, and further erosion is a moderate hazard. The rate of infiltration is slightly lower than in uneroded or only slightly eroded areas.

Included with this soil in mapping were areas in which the surface layer is silt loam. Also included were small areas of Theresa silt loam, 6 to 12 percent slopes, eroded, and a few fairly large areas in which little or no erosion has taken place.

Nearly all of the acreage is used for the crops commonly grown in the survey area. A small acreage is in pasture. (Capability unit IIIe-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

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Hochheim loam, 12 to 20 percent slopes, eroded (HmD2).--This soil has a profile similar to the one described as representative of the Hochheim series, except that a large part of the surface layer has been lost through erosion. As a result, in cultivated areas the plow layer now consists partly of dark yellowish-brown clay loam from the subsoil that is mixed with the remaining original surface soil. Runoff is rapid, and further erosion is a severe hazard. The rate of infiltration is slightly lower than in areas that are not eroded or that are only slightly eroded.

Included with this soil in mapping were areas in which little or no erosion has taken place and the surface layer is silt loam. Also included were areas in which the solum is thicker than 24 inches.

Most of the acreage is used for the crops commonly grown in the survey area, but a small acreage is in pasture or is used as pastured woodland. (Capability unit IVe-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Hochheim loam, 20 to 30 percent slopes, eroded (HmE2).--This soil has lost a large part of its original surface layer through erosion. Runoff is rapid, and the hazard of further erosion is very severe.

Included with this soil in mapping were small areas of Hochheim soils, 20 to 30 percent slopes, severely eroded. Also included were a few fairly large areas in which slopes are steeper than 30 percent, and areas where little or no erosion has taken place.

Most of the acreage is used for pasture, but some of it is used for crops, mainly alfalfa and bromegrass hay. A small acreage is in trees. Where forage crops are grown, the hayfields or pastures can be safely renovated occasionally. This soil is suitable only for use as pasture, woodland, or wildlife habitat. (Capability unit VIe-4; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Hochheim soils, 6 to 12 percent slopes, severely eroded (HoC3).--Erosion has removed all of the original surface layer and part of the subsoil of these soils, and the present surface layer is loam or clay loam. Runoff is medium, and the hazard of further erosion is severe. These soils are difficult to keep in good tilth if they are cultivated.

Included with these soils in mapping were small areas of Hochheim loam, 6 to 12 percent slopes, eroded.

Nearly all of the acreage is used for the crops commonly grown in the survey area. (Capability unit IVe-1; woodland group 5; wildlife group 1; recreation group 2; shrub and vine group 2)

Hochheim soils, 12 to 20 percent slopes, severely eroded (HoD3).--These soils occur in small areas on drumlins or ground moraines. They have lost all of their original surface layer and part of their subsoil through erosion, and the present surface layer is loam or clay loam. The soils are difficult to keep in good tilth. Runoff is rapid, and the hazard of further erosion is very severe.

Included with these soils in mapping were small areas of Hochheim loam, 12 to 20 percent slopes, eroded.

Nearly all of the acreage is used for the crops commonly grown in the survey area. These soils have severe limitations that affect the growth of row crops. (Capability unit VIe-4; woodland group 5; wildlife group 1; recreation group 2; shrub and vine group 2)

Hochheim soils, 20 to 30 percent slopes, severely eroded (HoE3).--These soils occur in small areas on drumlins or ground moraines. They have lost all of their original surface layer and part of their subsoil through erosion, and the present surface layer is loam or clay loam. The soils are difficult to keep in good tilth. Runoff is rapid, and the hazard of further erosion is very severe.

Included with these soils in mapping were small areas of Hochheim loam, 20 to 30 percent slopes, eroded.

These soils are suited to use for forage crops, trees, or wildlife habitat. Limitations to their use for cultivated crops are very severe. (Capability unit VIIe-4; woodland group 5; wildlife group 1; recreation group 2; shrub and vine group 2)

Houghton Series

In the Houghton series are very poorly drained organic soils that consist of thick deposits of decomposed residue from water-tolerant plants. These soils occupy areas in old glacial lakebeds. The native vegetation was mainly reeds, sedges, and forbs.

In a typical profile, the surface layer is black, slightly acid muck about 9 inches thick. Just beneath the surface layer is a second layer of black, slightly acid muck about 8 inches thick. This muck is underlain by a layer of very dark grayish-brown, moderately alkaline peaty muck about 43 inches thick, over very dark grayish-brown, slightly calcareous peat.

The Houghton soils have moderately rapid permeability and very high available water capacity. Ground water is at or near the surface throughout most of the year. Natural fertility is low.

Typical profile of Houghton muck, 0 to 2 percent slopes (SE1/4 NE1/4 sec. 7, T. 6 N., R. 17 E.):

1--0 to 9 inches, black (N 2/0) muck; weak, medium, subangular blocky structure breaking to weak, fine, granular structure; very friable; slightly acid; abrupt, wavy boundary.
2--9 to 17 inches, black (10YR 2/1) muck; weak, coarse, subangular blocky structure; friable; slightly acid; clear, wavy boundary.
3--17 to 60 inches, very dark grayish-brown (10YR 3/2) peaty muck; massive; many, fine, fibrous fragments of sedges, grasses, and forbs that break down easily when rubbed between the

fingers; moderately alkaline; gradual, wavy boundary.

4--60 to 65 inches, very dark grayish-brown (10YR 3/2) peat; matted; few small fragments of snail shells; slightly calcareous.

In places most of the solum is muck and there is little or no disintegrated peat. Snail shells are common below a depth of 40 inches in some areas.

The Houghton soils, like the Adrian, Ogden, Palms, and Rollin soils, have formed in deposits of organic material, but they have formed in a thicker deposit than have those soils.

Houghton muck, 0 to 2 percent slopes (HtA).--This soil has the profile described as representative of the Houghton series. Where drainage has been installed and cultivated crops are grown, subsidence and soil blowing are hazards.

Included with this soil in mapping were small areas of Adrian, Ogden, Palms, Rollin, and Muskego soils.

Only a small part of the acreage of this Houghton soil has been cultivated. A large and increasing acreage is now being used for crops, however, and some areas that have not been cultivated are used for pasture. The crops commonly grown where drainage is adequate are corn, potatoes, and carrots and other vegetables, and a fairly large acreage is used intensively for growing sod for lawns. This soil can be cropped intensively if it is well managed. (Capability unit IIIw-9; woodland group 10; wildlife group 6; recreation group 9; shrub and vine group 3)

Houghton muck, 2 to 6 percent slopes (HtB).--This soil occupies rather small areas at the base of steep slopes, adjacent to Houghton muck, 0 to 2 percent slopes. It is a wet soil and is difficult to drain because it receives a large amount of water from springs and seep areas. Where drainage has been installed and cultivated crops are grown, subsidence, soil blowing, and water erosion are hazards. The risk of erosion can be severe, especially in spring when thawing begins.

Included with this soil in mapping were small areas of Adrian, Ogden, and Palms soils. Also included were a few areas that are sloping or moderately steep.

Only a small acreage of this Houghton soil is cultivated, but some areas are used for pasture. Where drainage is adequate, corn, potatoes, and carrots and other vegetables can be grown. (Capability unit IIIw-9; woodland group 10; wildlife group 6; recreation group 9; shrub and vine group 3)

Juneau Series

The Juneau series consists of well drained or moderately well drained soils in long, narrow areas on foot slopes and in intermittent drainageways. These soils are made up of silty local alluvium underlain by older buried soils of uplands. The native vegetation was a forest of deciduous trees, mainly oak, hickory, maple, and basswood.

In a typical profile, the surface layer is very dark grayish-brown or dark grayish-brown silt loam that is neutral in reaction and is about 7 inches thick. The subsurface layer is dark grayish-brown and very dark grayish-brown silt loam that is neutral or slightly acid in reaction and is about 20 inches thick. The subsoil is about 23 inches thick. The upper part of the subsoil is brown silt loam that is slightly acid. The lower part is dark yellowish-brown and dark-brown silty clay loam and clay loam, and it is also slightly acid. The substratum is yellowish-brown, calcareous loam glacial till.

The Juneau soils are moderately permeable and have high available water capacity. Natural fertility is high.

Typical profile of Juneau silt loam, 1 to 3 percent slopes (NE1/4 NE1/4 sec. 21, T. 6 N., R. 19 E.):

Ap--0 to 7 inches, very dark grayish-brown (10YR 3/2) to dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, medium, subangular blocky structure parting to moderate, medium, granular structure; friable; neutral; abrupt, smooth boundary.

A1--7 to 22 inches, dark grayish-brown (10YR 4/2) silt loam; weak, thin, platy structure parting to moderate, medium, granular structure; friable; neutral; abrupt, wavy boundary.

A1b--22 to 27 inches, dark grayish-brown (10YR 4/2) to very dark grayish-brown (10YR 3/2) silt loam; weak, medium, subangular blocky structure; moderate, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B1b--27 to 33 inches, brown (10YR 5/3) silt loam; weak, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21tb--33 to 38 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; moderate, medium, subangular blocky structure; thin, discontinuous clay films; firm; slightly acid; clear, wavy boundary.

B22tb--38 to 44 inches, dark yellowish-brown (10YR 4/4) silty clay loam; moderate, medium, subangular blocky structure; thin, discontinuous clay films; firm; slightly acid; gradual, wavy boundary.

B23tb--44 to 50 inches, dark-brown (7.5YR 4/4) clay loam; moderate, medium, subangular blocky structure; thin, continuous clay films; firm; slightly acid.

C--50 to 60 inches, yellowish-brown (10YR 5/4) loam till; massive; friable.

The layer of silty alluvium ranges from 20 to 40 inches in thickness, and it contains thin layers of loamy material in places. Color of the alluvium is mainly dark grayish brown (10YR 4/2) to dark brown (10YR 4/3), but some thin layers are very dark grayish brown (10YR 3/2). The buried soil

generally contains an A1b horizon of silt loam, and it contains B2tb horizons.

The Juneau soils occur with somewhat poorly drained Pistakee soils.

Juneau silt loam, 1 to 3 percent slopes (JuA).--This is the only soil of the Juneau series mapped in the survey area. It receives runoff from the surrounding slopes and is subject to occasional overflow. Erosion is a slight hazard.

Included with this soil in mapping were small areas of Pistakee silt loam, 1 to 3 percent slopes.

If this Juneau soil is well managed, it can be cropped intensively. Nearly all of the acreage is used for the crops commonly grown in the survey area. Only a small acreage is in trees or permanent pasture. (Capability unit I-1; woodland group 1; wildlife group 7; recreation group 6; shrub and vine group 1)

Kane Series

The Kane series consists of somewhat poorly drained, nearly level or gently sloping soils on glacial outwash plains. These are silty soils that have a clay loam subsoil underlain by calcareous sand and gravel outwash. The native vegetation was prairie grasses.

In a typical profile, the surface layer is very dark brown silt loam that is neutral in reaction and is about 11 inches thick. The subsurface layer is very dark grayish-brown silt loam that is also neutral in reaction and is about 3 inches thick. The subsoil is about 22 inches thick. The upper part of the subsoil is dark-brown, medium acid, mottled gritty silty clay loam. The middle part is dark yellowish-brown, medium acid, mottled clay loam. The lower part is dark-brown, mottled clay loam that is neutral in reaction. The substratum is pale-brown, loose, stratified sand and gravel that are slightly calcareous.

The Kane soils have moderate available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility and permeability are moderate.

Typical profile of Kane silt loam, 1 to 3 percent slopes (SE1/4 NE1/4 sec. 9, T. 6 N., R. 19 E.):

Ap--0 to 8 inches, very dark brown (10YR 2/2) silt loam; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A1--8 to 11 inches, very dark brown (10YR 2/2) silt loam; moderate, medium, granular structure; friable; neutral; clear, wavy boundary.

A3--11 to 14 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, medium, subangular blocky structure parting to moderate, fine, granular structure; friable; slightly acid; clear, wavy boundary.

B1--14 to 19 inches, dark-brown (10YR 4/3) light gritty silty clay loam; few, fine, faint, grayish-brown (10YR 5/2) mottles and prominent, yellowish-brown (10YR 5/8) mottles; moderate, medium, subangular blocky structure; friable; medium acid; clear, wavy boundary.

IIB2t--19 to 32 inches, dark yellowish-brown (10YR 4/4) clay loam; common, medium, distinct, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/8) mottles; moderate, medium, subangular blocky structure; continuous clay films; firm; few pebbles of dolomite; medium acid; clear, wavy boundary.

IIB3--32 to 36 inches, dark-brown (10YR 4/3) clay loam; common, medium, faint, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/8) mottles; moderate, coarse, subangular blocky structure; firm; dark-brown (10YR 3/3) coatings of organic matter on the peds; few pebbles of dolomite; neutral; clear, wavy boundary.

IIC--36 to 60 inches, pale-brown (10YR 6/3), stratified sand and gravel; single grain; loose; slightly calcareous.

The solum ranges from 20 to 40 inches in thickness, but it is commonly 24 to 36 inches thick. The A horizon is black (10YR 2/1) to very dark brown (10YR 2/2) or very dark gray (10YR 3/1), and it ranges from 10 to 15 inches in thickness. Most of the B horizon has formed in glacial outwash, but the upper part has formed in silty deposits and it is generally silty clay loam. The lower part, formed in outwash, is commonly clay loam. In some places the IIC horizon is mostly sand, and in others it is mostly gravel.

The Kane soils occur with well-drained Warsaw and poorly drained Sebewa soils. They have a darker colored surface layer than the Matherton soils, a thicker solum than the Fabius soils, and a thinner solum than the Virgil soils that have a gravelly substratum.

Kane silt loam, 1 to 3 percent slopes (KeA).--This is the only soil of the Kane series mapped in the survey area. It is subject to ponding in spring and during periods of heavy rainfall. Runoff is slow, and little or no erosion has taken place.

Included with this soil in mapping were small areas of Warsaw silt loam, 0 to 2 percent slopes, and Sebewa silt loam.

Wetness is the major limitation to use of this Kane soil for crops. Under good management, however, cropping can be intensive. Nearly all of the acreage is now used for the crops commonly grown in the survey area. (Capability unit IIw-5; woodland group 12; wildlife group 5; recreation group 6; shrub and vine group 3)

Kendall Series

The Kendall series consists of somewhat poorly drained, silty soils underlain by calcareous loam glacial till. These soils are on the concave side slopes of ridges and drainageways, and on ground moraines and foot slopes of glaciated uplands.

Where the soils are on foot slopes and on the side slopes of small drainageways, the areas are generally long and narrow. Where the soils are at the heads of large drainageways, the areas generally have an irregular shape. The native vegetation was a deciduous forest consisting mainly of oak, hickory, maple, and basswood.

In a typical profile, the surface layer is dark grayish-brown or very dark grayish-brown, slightly acid silt loam about 8 inches thick. The subsoil is about 37 inches thick. The upper part of the subsoil is dark-brown, slightly acid, mottled silt loam. The middle part is dark-brown and dark yellowish-brown, mottled silty clay loam that is slightly acid and neutral in reaction. The lower part is grayish-brown, slightly calcareous, mottled silt loam that contains a few pebbles. A substratum of yellowish-brown, friable, strongly calcareous, mottled loam glacial till underlies the subsoil.

The Kendall soils have moderate permeability and high available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is high.

Typical profile of Kendall silt loam, 1 to 3 percent slopes (NW1/4 NW1/4 sec. 8, T. 8 N., R. 20 E.):

Ap--0 to 8 inches, dark grayish-brown (10YR 4/2) to very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, medium, subangular blocky structure parting to moderate, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.

B1--8 to 15 inches, dark-brown (10YR 4/3) heavy silt loam; few, fine, faint, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; slightly acid; gradual, wavy boundary.

B21t--15 to 27 inches, dark-brown (10YR 4/3) silty clay loam; common, medium, faint, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/6 and 5/8) mottles; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; thick, continuous clay films; firm; slightly acid; gradual, wavy boundary.

B22t--27 to 39 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; many, medium, distinct, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/6 and 5/8) mottles; moderate, medium, subangular blocky structure; thin, discontinuous clay films; firm; neutral; gradual, wavy boundary.

IIB3--39 to 45 inches, grayish-brown (10YR 5/2) heavy silt loam; many, medium, prominent, yellowish-brown (10YR 5/6 and 5/8) mottles; weak, medium, subangular blocky structure; friable; few pebbles of dolomite; slightly calcareous; gradual, wavy boundary.

IIC--45 to 62 inches, yellowish-brown (10YR 5/4) loam; many, medium, distinct, light brownish-gray (10YR 6/2) and prominent, yellowish-brown (10YR 5/8) mottles; massive; friable; many pebbles of dolomite; strongly calcareous.

In areas that have not been cultivated, the A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2), and it ranges from 3 to 5 inches in thickness. The A2 horizon in those areas is generally brown and is 3 to 6 inches thick. The B2 horizon has formed mostly in a mantle of silt that is 36 to 50 inches thick. Where the B2 horizon has formed in this mantle of silt, its texture is silty clay loam, but the texture is clay loam to loam where the B2 horizon formed in till. In many places the IIC horizon contains a number of cobblestones, mainly of dolomite. Reaction of the solum is generally strongly acid in areas that have not been cultivated, but the reaction ranges to neutral in cultivated areas.

The Kendall soils occur with well-drained St. Charles and poorly drained Pella soils. They have formed partly in a thicker mantle of silt than the Lamartine soils, and they have a thicker solum than the Lamartine soils.

Kendall silt loam, 1 to 3 percent slopes (K1A).--This is the only soil of the Kendall series mapped in the survey area. It receives runoff from the slopes above, and it is subject to ponding in spring and during periods of heavy rainfall. Runoff is slow, and little or no erosion has taken place. Erosion is a slight hazard, however, in the more sloping areas.

Included with this soil in mapping were small areas of Lamartine silt loam, Pella silt loam, and St. Charles silt loam.

This Kendall soil is used mainly for crops. It is suited to the crops commonly grown in the survey area where drainage is adequate. Practices that help to control erosion are needed in the areas that are intensively cropped. (Capability unit IIw-2; woodland group 7; wildlife group 5; recreation group 6; shrub and vine group 3)

Kewaunee Series

In the Kewaunee series are well drained or moderately well drained soils that consist of a thin layer of silt loam over a clay loam subsoil that is underlain by calcareous silty clay till. These soils are on glacial ground moraines east of the Milwaukee River in the northern part of Milwaukee County. They occupy areas of irregular shape on convex side slopes. The native vegetation was a deciduous forest consisting mainly of beech, maple, and basswood.

In a typical profile, the surface layer is dark grayish-brown silt loam that is neutral in reaction and is about 8 inches thick. The subsurface layer is brown silt loam that is also neutral in reaction and is about 2 inches thick. The subsoil is about 14 inches thick. The upper part of the subsoil is reddish-brown clay that is slightly acid. The lower part is reddish-brown silty clay that is mildly alkaline. The substratum is light reddish-brown silty clay glacial till that is strongly calcareous.

The Kewaunee soils are slowly permeable and have high available water capacity. In some places ground water is less than 5 feet below the surface in wet periods. Natural fertility is moderate.

Typical profile of Kewaunee silt loam, 2 to 6 percent slopes (SE1/4 NE1/4 sec. 1, T. 8 N., R. 21 E.):

Ap--0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, medium, granular structure; friable; neutral; abrupt, smooth boundary.
A2--8 to 10 inches, brown (10YR 5/3) silt loam; moderate, medium, subangular blocky structure; friable; neutral; abrupt, wavy boundary.
B2t--10 to 16 inches, reddish-brown (5YR 4/4) clay; strong, medium, angular blocky structure; thin, continuous clay films; firm; slightly acid; gradual, wavy boundary.
B3--16 to 24 inches, reddish-brown (5YR 5/3) silty clay; strong, medium, subangular blocky structure; firm; mildly alkaline; gradual, wavy boundary.
C--24 to 62 inches, light reddish-brown (5YR 6/3) silty clay; massive; firm; strongly calcareous.

In areas that have not been cultivated, the A horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2), and it ranges from 3 to 5 inches in thickness. The B2t horizon is silty clay in some places. Depth to free carbonates is commonly 20 to 28 inches. In places the C horizon contains pockets and lenses of silt loam or silty clay loam.

The Kewaunee soils occur with somewhat poorly drained Manawa soils. They have formed in reddish, slightly finer textured material than the Ozaukee and Morley soils. Unlike the Saylesville soils, the Kewaunee soils have formed in silt loam over silty clay glacial till.

Kewaunee silt loam, 2 to 6 percent slopes (KnB).--This soil has the profile described as representative of the Kewaunee series. It absorbs water slowly, and movement of water downward through this soil is slow. Therefore, much of the water from precipitation runs off, especially during periods of heavy rainfall. The rate of runoff is medium. Erosion is a slight hazard.

Included with this soil in mapping were small areas of Manawa silt loam, 1 to 3 percent slopes.

This Kewaunee soil was formerly used mostly for crops. Now, most of the acreage is in residential developments. A small acreage is farmed, and some small areas are still in woodlots. (Capability unit IIe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Kewaunee silt loam, 6 to 12 percent slopes, eroded (KnC2).--This soil has lost part of its original surface layer through erosion. The present surface layer contains some of the reddish-brown subsoil that is mixed with the remaining original surface soil. Because this soil absorbs water slowly, and movement of water downward through the profile is slow, much of the water from precipitation runs off, especially during periods of heavy rainfall. The rate of runoff is medium. Further erosion is a moderate hazard.

This soil is mainly in areas that have been developed for nonfarm uses, but part of the acreage is in small woodlots that are within or near the developed areas. Only a small acreage is used for crops. (Capability unit IIIe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Knowles Series

The Knowles series consists of well-drained, silty soils that have a clay loam subsoil and are underlain by dolomite bedrock (pl. V). These soils occur on ground moraines in the northeastern part of Waukesha County. The native vegetation was a deciduous forest consisting mainly of oak and maple.

In a typical profile, the surface layer is very dark grayish-brown silt loam that is mildly alkaline and is about 3 inches thick. The subsurface layer is brown silt loam that is neutral in reaction and is about 4 inches thick. The subsoil is about 20 inches thick. The upper part of the subsoil is dark-brown, slightly acid silty clay loam. The middle part is dark-brown, medium acid clay loam. The lower part is dark grayish-brown, slightly calcareous clay loam that contains many fragments of dolomite. Just beneath the subsoil is bedrock of cracked dolomite.

The Knowles soils have moderate permeability and moderate available water capacity. Natural fertility is moderate.

Typical profile of Knowles silt loam, 2 to 6 percent slopes (SE1/4 SW1/4 sec. 24, T. 6 N., R. 18 E.):

A1--0 to 3 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, medium, granular structure; friable; mildly alkaline; clear, wavy boundary.
A2--3 to 7 inches, brown (10YR 5/3) silt loam; weak, thin, platy structure; friable; many earthworm casts; neutral; clear, wavy boundary.
B1--7 to 11 inches, dark-brown (7.5YR 4/4) silty clay loam; moderate, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.
IIB21t--11 to 18 inches, dark-brown (7.5YR 4/4) clay loam; moderate, medium, subangular blocky structure; discontinuous clay films; firm; few pebbles; medium acid; gradual, wavy boundary.
IIB22t--18 to 26 inches, dark-brown (7.5YR 4/4) clay loam; strong, medium, subangular blocky structure; continuous clay films; firm; few pebbles; medium acid; gradual, wavy boundary.

IIB3--26 to 27 inches, dark grayish-brown (10YR 4/2) clay loam; massive; friable; many partly weathered fragments of dolomite; slightly calcareous; abrupt, smooth boundary.
IIIR--27 inches, hard, platy, cracked dolomitic bedrock.

The A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2), and it ranges from 3 to 5 inches in thickness. In cultivated areas the Ap horizon is commonly dark grayish-brown (10YR 4/2). The A horizon and the upper part of the B horizon have formed in silt, and the upper part of the B horizon is generally silty clay loam. The lower part of the B horizon has formed in glacial till, and it is generally clay loam. The mantle of silt is commonly 10 to 24 inches thick, and the solum is 20 to 40 inches thick. Depth to bedrock is also 20 to 40 inches. Reaction of the solum ranges from medium acid to neutral or mildly alkaline.

The Knowles soils occur with somewhat poorly drained soils of the Ritchey series, mottled subsoil variant, and with poorly drained soils of the Pella series, moderately shallow variant. They have a thicker solum than the Ritchey soils.

Knowles silt loam, 0 to 2 percent slopes (KwA).--This soil is slightly droughty. Runoff is slow, and little or no erosion has taken place. In a few places, dolomite bedrock is near enough to the surface that it hinders tillage.

Included with this soil in mapping were small areas of Ritchey silt loam, 1 to 6 percent slopes.

This Knowles soil is used mainly for the crops commonly grown in the survey area. A small acreage is in pasture or trees. (Capability unit IIs-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Knowles silt loam, 2 to 6 percent slopes (KwB).--This soil is underlain by dolomite bedrock that in places is near enough to the surface that it can interfere with tillage. The profile is the one described as representative of the Knowles series. Runoff is medium. Erosion and droughtiness are slight hazards.

Included with this soil in mapping were small areas of Ritchey silt loam, 1 to 6 percent slopes.

This Knowles soil is used mainly for the crops commonly grown in the survey area. A small acreage is in pasture or trees. (Capability unit IIe-2; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Lamartine Series

The Lamartine series consists of somewhat poorly drained soils in drainageways, on foot slopes, and in slight depressions of glaciated uplands and ground moraines. These soils are silt loam over a subsoil that is mainly silty clay loam and clay loam and is underlain by calcareous loam glacial till. The native vegetation was a deciduous forest consisting mainly of oak, hickory, maple, and basswood.

In a typical profile, the surface layer is very dark brown silt loam that is neutral in reaction and is about 4 inches thick. The subsurface layer is dark grayish-brown or grayish-brown, slightly acid silt loam, and it is also about 4 inches thick. The subsoil is about 28 inches thick. The upper part of the subsoil is dark-brown, mottled silt loam that is neutral in reaction. The middle part is dark-brown, mottled silty clay loam and clay loam that are also neutral in reaction. The lower part is dark-brown, slightly calcareous, mottled heavy loam that contains a few pebbles. A substratum of yellowish-brown, friable, strongly calcareous, mottled loam glacial till is just beneath the subsoil.

The Lamartine soils have moderate permeability and high available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is high.

Typical profile of Lamartine silt loam, 1 to 4 percent slopes (SW1/4 SE1/4 sec. 20, T. 7 N., R. 20 E.):

A1--0 to 4 inches, very dark brown (10YR 2/2) silt loam; moderate, medium, granular structure; friable; neutral; clear, wavy boundary.
A2--4 to 8 inches, dark grayish-brown (10YR 4/2) or grayish-brown (10YR 5/2) silt loam; few, fine, distinct, yellowish-brown (10YR 5/4) mottles; weak, thin, platy structure; very friable; slightly acid; clear, wavy boundary.
B11--8 to 12 inches, dark-brown (10YR 4/3) silt loam; few, medium, prominent, yellowish-brown (10YR 5/6) and faint, grayish-brown (10YR 5/2) mottles; weak, fine, subangular blocky structure; friable; neutral; clear, wavy boundary.
B12--12 to 18 inches, dark-brown (10YR 4/3) heavy silt loam; few, medium, prominent, yellowish-brown (10YR 5/6) and faint, grayish-brown (10YR 5/2) mottles; moderate, fine, subangular blocky structure; firm; neutral; gradual, wavy boundary.
B21t--18 to 25 inches, dark-brown (10YR 4/3) silty clay loam; common, medium, promient, yellowish-brown (10YR 5/6 and 5/8) and faint, grayish-brown (10YR 5/2) mottles; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; thin, discontinuous clay films; firm; neutral; gradual, wavy boundary.
IIB22t--25 to 30 inches, dark-brown (10YR 4/3) clay loam; many, coarse, prominent, yellowish-brown (10YR 5/6 and 5/8) and faint, grayish-brown (10YR 5/2) mottles; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; thick, continuous, very dark grayish-brown (10YR 3/2) clay films; firm; few pebbles of dolomite; neutral; clear, wavy boundary.
IIB3--30 to 36 inches, dark-brown (10YR 4/3) heavy loam; many, coarse, prominent, yellowish-brown (10YR 5/6 and 5/8) and faint,

grayish-brown (10YR 5/2) mottles; weak, coarse, subangular blocky structure; friable; few pebbles of dolomite; slightly calcareous; gradual, wavy boundary.

IIC--36 to 60 inches, yellowish-brown (10YR 5/4) loam; common, medium, distinct, grayish-brown (10YR 5/2) mottles; massive; friable; many pebbles of dolomite; strongly calcareous.

The A1 horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2), and it ranges from 3 to 6 inches in thickness. The A2 horizon is dark grayish brown (10YR 4/2) to brown (10YR 5/3) and ranges from 3 to 5 inches in thickness. The Ap horizon in cultivated fields is generally very dark grayish brown (10YR 3/2). The A horizon and most of the B horizon have formed in a mantle of silt 20 to 36 inches thick. The part of the B2 horizon that formed in silt is generally silty clay loam, and the part that formed in till is commonly clay loam. The IIC horizon is commonly loam, and it contains many pebbles of dolomite and a few cobblestones. Reaction of the solum ranges from slightly acid to moderately alkaline.

The Lamartine soils occur with well drained Dodge, moderately well drained Mayville, and poorly drained Pella soils. They have a thinner mantle of silt than the Kendall soils.

Lamartine silt loam, 1 to 4 percent slopes (LmB).--This is the only soil of the Lamartine series mapped in the survey area. It generally occurs in long, narrow areas that extend in a northeast-southwest direction. Because this soil receives runoff from the slopes above, ponding is a hazard in spring and during periods of heavy rainfall. Little or no erosion has taken place.

Included with some areas of this soil in mapping were small areas of Mayville silt loam; Theresa silt loam, 2 to 6 percent slopes; and Pella silt loam.

Wetness is the major limitation to use of this Lamartine soil for crops. Much of the acreage is used for the crops commonly grown in the area. Some of it is in pasture or trees. (Capability unit IIw-2; woodland group 7; wildlife group 5; recreation group 6; shrub and vine group 3)

Lawson Series

The Lawson series consists of somewhat poorly drained, silty soils that have formed in deep, silty alluvium. These soils occur along streams. The native vegetation was mainly grasses and widely spaced trees.

In a typical profile, the surface layer is very dark grayish-brown and very dark gray silt loam about 14 inches thick. Just beneath the surface layer and extending to a depth of about 34 inches is very dark gray and dark olive-gray silt loam. Underlying this silt loam is grayish-brown and very dark gray silt loam that extends to a depth of more than 60 inches. The entire profile is neutral in reaction.

The Lawson soils have moderate permeability and very high available water capacity. Ground water is less than 3 feet below the surface in wet periods. These soils are subject to flooding. Natural fertility is high.

Typical profile of Lawson silt loam (0 to 2 percent slopes) (NW1/4 SW1/4 sec. 20, T. 6 N., R. 21 E.):

A11--0 to 10 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, fine, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

A12--10 to 14 inches, very dark gray (10YR 3/1) silt loam; moderate, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

A13--14 to 21 inches, very dark gray (2.5Y 3/1) heavy silt loam; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; firm; fine, common, distinct, dark yellowish-brown (10YR 4/4) mottles; neutral; clear, smooth boundary.

A14g--21 to 26 inches, dark olive-gray (5Y 3/2) heavy silt loam; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; firm; common, coarse, distinct, dark yellowish-brown (10YR 4/4) mottles; neutral; clear, smooth boundary.

A15--26 to 34 inches, very dark gray (10YR 3/1) heavy silt loam; weak, medium, subangular blocky structure; friable; few, prominent, dark yellowish-brown (10YR 4/4) mottles; neutral; clear, smooth boundary.

A16g--34 to 42 inches, grayish-brown (2.5Y 5/2) heavy silt loam; many, coarse, prominent, yellowish-brown (10YR 5/6) mottles; massive; friable; neutral; clear, smooth boundary.

A17--42 to 60 inches, very dark gray (10YR 3/1) silt loam; massive; friable; neutral.

Color of the upper A horizons ranges from black (N 2/0) to very dark grayish brown (10YR 3/2). Texture throughout the solum is generally silt loam, but the solum contains thin layers of loam and silty clay loam in places. In some places these soils are underlain by a buried poorly drained soil at a depth of 40 to 60 inches. Reaction of the solum ranges from slightly acid to mildly alkaline.

The Lawson soils have formed in a thicker deposit of alluvial material than have the Pistakee soils, and they are darker colored than the Pistakee soils.

Lawson silt loam (0 to 2 percent slopes) (Lo).--This is the only soil of the Lawson series mapped in the survey area. It is subject to flooding and has a high water table much of the time.

Included with this soil in mapping were small areas of Alluvial land and of Pistakee silt loam, 1 to 3 percent slopes.

Where drainage and protection from flooding are adequate, this Lawson soil is suited to the crops commonly grown in the survey area. Where

protection from flooding cannot be provided, this soil is better suited to use for pasture, as woodland, or as wildlife habitat than to use for cultivated crops. Most of the acreage is in pasture, and only a small acreage is cultivated. (Capability unit IIw-13; woodland group 12; wildlife group 5; recreation group 8; shrub and vine group 3)

Loamy Land

Loamy land (Lu) is a miscellaneous land type that consists of fill areas and of cut or borrow areas. It is mainly within or near areas used for housing developments or related purposes, or it is in cities or towns.

In the cut or borrow areas, the entire solum of the soil has been removed by man, and the raw underlying material is exposed. These areas differ from gravel pits in that the side slopes of the adjacent banks have been graded and sloped so that they blend with adjacent less disturbed areas that are accessible for building sites or roads.

The fill areas consist of a layer of fill material, about 1 to 5 feet thick, that is deposited over a mineral soil that is generally somewhat poorly drained to very poorly drained. In some places the fill material covers a well-drained mineral soil, however, and in others it covers an organic soil.

The material in this land type is mainly sandy loam to silt loam. In cut areas, where the solum of the original soil has been removed, the material is generally loamy glacial till that contains pockets or lenses of sand and gravel or, in some places, clayey material. In fill areas the material is more variable, and it contains cinders, rocks, broken slabs of concrete, and other debris in some places.

The surface of this land type is generally compacted, but the soil material is somewhat more favorable for the growth of plants than that in Clayey land. Limitations and hazards that affect engineering uses are so variable that they can be determined only by onsite investigation. (Capability unit VIIIs-10; woodland group 11; wildlife group 1; recreation group 10; shrub and vine group 4)

Lorenzo Series

In the Lorenzo series are well-drained, loamy soils that have a clay loam subsoil underlain by calcareous sand and gravel glacial outwash. The native vegetation was mainly prairie grasses.

In a typical profile, the surface layer is very dark grayish-brown loam that is neutral in reaction and is about 8 inches thick. The subsoil is about 11 inches thick. It is dark-brown clay loam that is slightly acid, and it has a few pebbles in the lower part. The substratum is pale-brown, loose, stratified sand and gravel (pl. V).

The Lorenzo soils are moderately permeable and have low available water capacity. Natural fertility is moderate.

Typical profile of Lorenzo loam, 2 to 6 percent slopes, eroded (SW1/4 NE1/4 sec. 7, T. 5 N., R. 17 E.):

Ap--0 to 8 inches, very dark grayish-brown (10YR 2/2) loam; moderate, fine, granular structure; neutral; abrupt, wavy boundary.
B1--8 to 14 inches, dark-brown (10YR 4/3) light clay loam; moderate, medium, subangular blocky structure; firm; slightly acid; gradual, wavy boundary.
B2t--14 to 19 inches, dark-brown (7.5YR 4/4) clay loam; moderate, medium, subangular blocky structure; discontinuous clay films; few pebbles of dolomite; firm; slightly acid; clear, wavy boundary.
IIC--19 to 60 inches, pale-brown (10YR 6/3), stratified sand and gravel; single grain; loose, slightly calcareous.

The solum ranges from 10 to 20 inches in thickness, but it is generally 16 to 20 inches thick. The A horizon is commonly 7 to 10 inches thick. Texture of the B horizon is typically clay loam, but it ranges from silty clay loam to sandy clay loam. In some places the C horizon is mostly sand, and in others it is mostly gravel.

The Lorenzo soils occur with somewhat poorly drained Fabius and poorly drained Mussey soils. They have a darker colored surface layer than the Casco soils and a thinner solum than the Warsaw soils.

Lorenzo loam, 2 to 6 percent slopes, eroded (LyB2).--This soil has the profile described as representative of the Lorenzo series. Runoff is medium, and further erosion is a slight hazard. In addition, this soil is droughty.

Included with this soil in mapping were small areas of Warsaw loam, 2 to 6 percent slopes, and areas where little or no erosion has taken place. Also included were a few fairly large areas in which the surface layer is sandy loam.

Nearly all of the acreage is used for the crops commonly grown in the survey area. A small acreage is in pasture. (Capability unit IIIe-4; woodland group 12; wildlife group 4; recreation group 2; shrub and vine group 2)

Lorenzo loam, 6 to 12 percent slopes, eroded (LyC2).--This soil is droughty, and it is moderately susceptible to further erosion. Runoff is medium.

Included with this soil in mapping were a few small areas of Warsaw loam, 6 to 12 percent slopes, eroded, and a few fairly large areas in which little or no erosion has taken place.

Nearly all of the acreage is used for the crops commonly grown in the survey area. A small acreage is in pasture. (Capability unit IVe-4; woodland group 12; wildlife group 4; recreation group 2; shrub and vine group 2)

Lorenzo loam, 12 to 20 percent slopes, eroded (LyD2).--This soil is droughty. Because runoff is rapid, further erosion is a severe hazard.

Included with this soil in mapping were small areas of a moderately eroded Warsaw loam having slopes of 12 to 20 percent. Also included were a few fairly large areas of a Lorenzo loam in which little or no erosion has taken place.

Most of the acreage is used for crops grown for forage, but a small acreage is in pasture. This soil is better suited to use for pasture, forage crops, or trees than to use for crops that require cultivation, and it can also be used as wildlife habitat. Renovation of pastures and hayfields should be kept to a minimum. (Capability unit VIe-4; woodland group 12; wildlife group 4; recreation group 2; shrub and vine group 2)

Manawa Series

The Manawa series consists of somewhat poorly drained, silty soils that have a silty clay subsoil over calcareous silty clay glacial till. These soils occupy the concave side slopes of drainageways and slight depressions. They lie east of the Milwaukee River in the northern part of Milwaukee County. The native vegetation was a deciduous forest consisting mainly of beech, basswood, and elm.

In a typical profile, the surface layer is very dark grayish-brown, mildly alkaline silt loam about 9 inches thick. The subsurface layer is brown, mildly alkaline, mottled silty clay loam about 3 inches thick. The subsoil is about 18 inches thick. The upper part of the subsoil is reddish-brown, mildly and moderately alkaline, mottled silty clay. The lower part is reddish-brown, strongly calcareous, mottled silty clay. The substratum is reddish-brown, strongly calcareous, mottled silty clay glacial till containing a few pebbles and a few segregations of soft lime.

The Manawa soils are slowly permeable and have high available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is moderate.

Typical profile of Manawa silt loam, 1 to 3 percent slopes (SE1/4 NE1/4 sec. 1, T. 8 N., R. 21 E.):

Ap--0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, fine, subangular blocky structure parting to moderate, fine, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

A1--8 to 9 inches, very dark grayish-brown (10YR 3/2) heavy silt loam; few, fine, distinct, dark-brown (7.5YR 4/4) mottles; moderate, fine, subangular blocky structure; friable; mildly alkaline; abrupt, wavy boundary.

A2--9 to 12 inches, brown (7.5YR 5/2) silty clay loam; few, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, thin, platy structure; friable; mildly alkaline; abrupt, smooth boundary.

B21t--12 to 17 inches, reddish-brown (5YR 4/4) silty clay; many, medium, distinct, grayish-brown (10YR 5/2) mottles; strong, fine, angular blocky structure; thick, continuous clay films; firm; few small pebbles; mildly alkaline; clear, wavy boundary.

B22t--17 to 21 inches, reddish-brown (5YR 4/4) silty clay; many, medium, prominent, gray (10YR 5/1) mottles; strong, fine, angular blocky structure; thick, continuous clay films; few small pebbles; moderately alkaline; clear, wavy boundary.

B23t--21 to 30 inches, reddish-brown (5YR 4/4) silty clay; many, medium, prominent, gray (10YR 5/1) mottles; weak, medium, prismatic structure parting to moderate, medium, angular blocky structure; few, thick, patchy clay films; firm; few small pebbles; strongly calcareous; gradual, wavy boundary.

C1--30 to 53 inches, reddish-brown (5YR 5/4) silty clay; many, coarse, prominent, gray (10YR 5/1) mottles; weak, medium, prismatic structure; firm; few pebbles; few segregations of soft lime; highly calcareous; gradual, wavy boundary.

C2--53 to 73 inches, reddish-brown (5YR 5/4) silty clay; massive; firm; highly calcareous.

In areas that have not been cultivated, the A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2), and it ranges from 5 to 9 inches in thickness. The A2 horizon is 2 to 4 inches thick, and it is brown (10YR 5/3) in places. In some places the B2t horizons have a hue of 7.5YR. The C horizons are silty clay loam in some areas. Thickness of the solum ranges from 22 to 32 inches.

The Manawa soils occur with well drained or moderately well drained Kewaunee soils. They have formed in somewhat finer textured glacial material than the Mequon and Blount soils.

Manawa silt loam, 1 to 3 percent slopes (MaA).--This is the only soil of the Manawa series mapped in the survey area. Runoff is medium at times, especially during periods of heavy rainfall, and the more sloping areas are then slightly susceptible to erosion.

Included with this soil in mapping were small areas of Kewaunee silt loam, 2 to 6 percent slopes, and some areas of poorly drained soils.

Wetness is the major limitation to use of this Manawa soil for crops. Much of the acreage was formerly used for crops, but most of it is now used for housing developments. A small acreage is still farmed or is in woodlots. (Capability unit IIw-2; woodland group 7; wildlife group 5; recreation group 6; shrub and vine group 3)

Markham Series

In the Markham series are well drained or moderately well drained, silty soils that have a silty clay subsoil over calcareous silty clay loam glacial

till. These soils occur in the southern part of Milwaukee County and the southeastern part of Waukesha County. The native vegetation was mainly prairie grasses and a few scattered oaks.

In a typical profile, the surface layer is black silt loam that is neutral in reaction and is about 9 inches thick. The subsurface layer is dark grayish-brown silt loam that is slightly acid and is about 2 inches thick. The subsoil is about 20 inches thick. The upper part of the subsoil is dark-brown silty clay loam that is slightly acid in reaction. The middle part of the subsoil is dark yellowish-brown to dark-brown silty clay that is mildly alkaline. The lower part is brown, mottled silty clay loam that is slightly calcareous and contains a few pebbles. Underlying the subsoil is a substratum of brown, mottled silty clay loam glacial till that is highly calcareous and contains a few pebbles.

The Markham soils have moderately slow permeability and high available water capacity. In some places ground water is less than 5 feet below the surface during wet periods. Natural fertility is high.

Typical profile of Markham silt loam, 2 to 6 percent slopes (SW1/4 SW1/4 sec. 28, T. 5 N., R. 21 E.):

Ap--0 to 9 inches, black (10YR 2/1) silt loam; moderate, medium, granular structure; friable; neutral; abrupt, smooth boundary.

A2--9 to 11 inches, dark grayish-brown (10YR 4/2) silt loam; weak, medium, platy structure parting to moderate, medium, granular structure; friable; some mixing with material from the Ap horizon through worm action; slightly acid; clear, wavy boundary.

B1t--11 to 13 inches, dark-brown (10YR 4/3) silty clay loam; moderate, medium, subangular blocky structure; thin, discontinuous clay films; firm; some worm action; slightly acid; clear, wavy boundary.

IIB21t--13 to 20 inches, dark yellowish-brown (10YR 4/4) silty clay; weak, medium, prismatic structure parting to moderate, fine, angular blocky structure; continuous clay films; firm; few pebbles of dolomite; mildly alkaline; gradual, wavy boundary.

IIB22t--20 to 26 inches, dark-brown (10YR 4/3) silty clay; few, fine, prominent, yellowish-brown (10YR 5/8) mottles; weak, coarse, prismatic structure parting to moderate, medium, angular blocky structure; continuous clay films; firm; few pebbles of dolomite; mildly alkaline; gradual, wavy boundary.

IIB3--26 to 31 inches, brown (10YR 5/3) silty clay loam; common, fine, faint, light brownish-gray (10YR 6/2) and prominent, yellowish-brown (10YR 5/6) mottles; weak, coarse, prismatic structure breaking to weak, coarse, subangular blocky structure; firm; few pebbles of dolomite; slightly calcareous; clear, wavy boundary.

IIC--31 to 60 inches, brown (10YR 5/3) silty clay loam; common, medium, faint, dark-brown (10YR 4/3) mottles; massive; firm; few pebbles of dolomite; highly calcareous.

The solum is commonly 24 to 32 inches thick, but the thickness ranges from 20 to 40 inches. Thickness of the mantle of silt is typically 10 to 20 inches. The A2 horizon is dark grayish brown (10YR 4/2) to brown (10YR 5/3), and it ranges from 1 to 4 inches in thickness. In some places the IIB21t horizon is silty clay loam. Reaction of the solum ranges from slightly acid to mildly alkaline.

The Markham soils occur with somewhat poorly drained Elliott and poorly drained Ashkum soils. They have a darker colored surface layer and subsurface layer than the Morley and Ozaukee soils.

Markham silt loam, 2 to 6 percent slopes (MeB).--This is the only soil of the Markham series mapped in the survey area. Runoff is medium, and erosion is a slight hazard. This soil remains wet for several days after periods of heavy rain.

Included with this soil in mapping were small areas of Morley silt loam, 2 to 6 percent slopes, and of an Elliott silt loam having slopes of 0 to 3 percent. Also included were some moderately eroded areas.

Nearly all of the acreage is used for the crops commonly grown in the survey area. (Capability unit IIe-6; woodland group 1; wildlife group 4; recreation group 3; shrub and vine group 1)

Marsh

Marsh (Mf) is a miscellaneous land type that is nearly level and is very poorly drained. It is covered with water throughout most of the year, and the areas contain small bodies of water in some places. The larger areas are adjacent to lakes and streams. Small areas are scattered throughout the two counties. The native vegetation was mainly sedges, rushes, reeds, and other water-tolerant plants.

Both mineral and organic material are in this land type. The material near the surface is generally dark colored, and the material underlying the surface layer has a grayish color. The reaction is generally neutral to moderately alkaline.

This land type is not suited to any of the crops commonly grown in the area, and draining it is not economically feasible. One of the best uses is habitat for wildlife. (Capability unit VIIIw-15; woodland group 11; wildlife group 6; recreation group 10; shrub and vine group 4)

Martinton Series

The Martinton series consists of somewhat poorly drained, nearly level or gently sloping soils that have formed in lacustrine material. These soils lie on the concave side slopes of low stream benches and of basins formerly occupied by glacial lakes. The native vegetation was mainly water-tolerant grasses, but it included a few scattered oak and elm trees.

In a typical profile, the surface layer is black silt loam that is slightly acid and is about 11 inches thick. The subsurface layer is very dark grayish-brown silty clay loam that is also slightly acid and is about 5 inches thick. The subsoil is about 19 inches thick. The upper part of the subsoil is grayish-brown silty clay loam that is neutral in reaction. The middle part is brown silty clay that is also neutral in reaction. The lower part is brown clay that is slightly calcareous. Underlying the subsoil is the substratum of brown, calcareous heavy silty clay loam. Both the subsoil and the substratum contain distinct and prominent mottles.

The Martinton soils are slowly permeable and have high available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is high.

Typical profile of Martinton silt loam, 1 to 3 percent slopes (SW1/4 SE1/4 sec. 20, T. 6 N., R. 19 E.):

Ap--0 to 7 inches, black (10YR 2/1) silt loam; moderate, fine, granular structure; many, fine, fibrous roots; friable; slightly acid; abrupt, smooth boundary.

A1--7 to 11 inches, black (10YR 2/1) silt loam; weak, medium, subangular blocky structure parting to moderate, fine, granular structure; friable; slightly acid; clear, wavy boundary.

A3--11 to 16 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; moderate, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B1--16 to 23 inches, grayish-brown (10YR 5/2) silty clay loam; common, fine, prominent, yellowish-brown (10YR 5/6) mottles; moderate, fine, subangular blocky structure; firm; neutral; gradual, wavy boundary.

B21t--23 to 26 inches, brown (10YR 5/3) silty clay; common, medium, prominent, yellowish-brown (10YR 5/8) and faint, grayish-brown (10YR 5/2) mottles; moderate, medium, angular blocky structure; continuous clay films; firm; neutral; clear, wavy boundary.

B22t--26 to 35 inches, brown (7.5YR 4/4) clay; common, fine, distinct, light brownish-gray (10YR 6/2) mottles; weak, medium, prismatic structure parting to strong, medium, angular blocky structure; continuous clay films; firm; roots are common; slightly calcareous; gradual, wavy boundary.

C1--35 to 44 inches, brown (7.5YR 5/3) heavy silty clay loam; common, medium, faint, light brownish-gray (10YR 6/2) mottles; weak, medium, prismatic structure parting to moderate, medium, angular blocky structure; firm; calcareous; gradual, wavy boundary.

C2--44 to 62 inches, brown (7.5YR 5/3) heavy silty clay loam; many, medium, faint, light brownish-gray (10YR 6/2) and prominent, yellowish-brown (10YR 5/8) mottles; structureless (massive) or weak, medium, prismatic structure; firm; highly calcareous.

Thickness of the A horizon ranges from 10 to 16 inches, and thickness of the solum ranges from 24 to 36 inches. In many places the C horizons contain thin layers of coarse silt and fine sand, as well as patches where secondary lime has accumulated.

The Martinton soils occur with well drained or moderately well drained Saylesville and poorly drained Montgomery soils. They have less grit and pebbles throughout their profile than the Elliott soils. The upper part of their solum is finer textured than that of the Aztalan soils.

Martinton silt loam, 1 to 3 percent slopes (MgA).--This is the only soil of the Martinton series mapped in the survey area. In places its surface layer is lighter colored and thinner than the one in the profile described as representative of the Martinton series. Runoff is slow, and this soil is subject to ponding in spring and during periods of heavy rainfall. It is not eroded or is only slightly eroded.

Included with this soil in mapping were small areas of Saylesville silt loam, 0 to 2 percent slopes, and of Montgomery silty clay loam.

This Martinton soil is used mostly for the crops commonly grown in the survey area. A small acreage is in pasture or trees. (Capability unit IIw-2; woodland group 12; wildlife group 5; recreation group 6; shrub and vine group 3)

Matherton Series

The Matherton series consists of somewhat poorly drained soils that have formed partly in deposits of medium-textured material and partly in calcareous outwash. These soils are on glaciated outwash plains. The native vegetation was a deciduous forest consisting mainly of oak, hickory, and elm.

In a typical profile, the surface layer is very dark grayish-brown silt loam that is neutral in reaction and is about 6 inches thick. The subsurface layer, about 8 inches thick, is dark grayish-brown, slightly acid silt loam and dark grayish-brown, slightly acid, mottled loam. The subsoil is about 21 inches thick, and it is mottled throughout. The upper part of the subsoil is dark grayish-brown, slightly acid loam; the middle part is dark-brown, slightly acid clay loam; and the lower part is dark yellowish-brown, mildly alkaline sandy clay loam. The substratum is light brownish-gray, loose, stratified sand and gravel that are slightly calcareous.

The Matherton soils are moderately permeable, have moderate available water capacity, and have moderate natural fertility. Ground water is less than 3 feet below the surface in wet periods.

Typical profile of Matherton silt loam, 1 to 3 percent slopes (NE1/4 SW1/4 sec. 34, T. 7 N., R. 17 E.):

A1--0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, fine, granular structure; friable; neutral; abrupt, wavy boundary.
A2--6 to 11 inches, dark grayish-brown (10YR 4/2) silt loam; weak, medium, platy structure parting to weak, fine, granular structure; friable; slightly acid; clear, wavy boundary.
A3--11 to 14 inches, dark grayish-brown (10YR 4/2) loam; few, fine, faint, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/8) mottles; weak, fine, subangular blocky structure; slightly acid; clear, wavy boundary.
B1--14 to 17 inches, dark grayish-brown (10YR 4/2) loam; common, medium, faint, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/8) mottles; moderate, medium, subangular blocky structure; discontinuous clay films; friable; slightly acid; clear, wavy boundary.
B2t--17 to 29 inches, dark-brown (10YR 4/3) clay loam; common, medium, faint, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/8) mottles; moderate, medium, subangular blocky structure; continuous clay films; firm; few pebbles of dolomite; few iron concretions; slightly acid; gradual, wavy boundary.
B3--29 to 35 inches, dark yellowish-brown (10YR 4/4) sandy clay loam; many, medium, distinct, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; friable; many pebbles of dolomite; mildly alkaline; abrupt, wavy boundary.
IIC--35 to 62 inches, light brownish-gray (10YR 6/2), stratified sand and gravel; single grain; loose; slightly calcareous.

The solum is commonly 30 to 36 inches thick, but its thickness ranges from 20 to 40 inches. In places the mantle of silt is lacking, and in those areas the surface layer is sandy loam. In the areas where this soil formed partly in silt, the surface layer is silt loam. Color of the A1 horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2), and that horizon is commonly 4 to 6 inches thick. In some places where the surface layer is silt loam, the upper part of the B horizon is silty clay loam and the lower part of the B horizon is clay loam. Where the surface layer is sandy loam, the entire B horizon is commonly sandy clay loam. In some places the C horizon is mostly sand, and in others it is mostly gravel.

Matherton soils occur with well-drained Fox and poorly drained Sebewa soils. They have a lighter colored surface layer than the Kane soils, a thinner solum than the Virgil soils, and a thicker solum than the Fabius soils.

Matherton sandy loam, 1 to 3 percent slopes (MhA).--This soil is subject to ponding in spring and during periods of heavy rainfall. Runoff is slow, and little or no erosion has taken place.

Included with this soil in mapping were small areas of Fox sandy loam, 0 to 2 percent slopes, and small areas of a Sebewa soil that has a loam surface layer.

Wetness is the major limitation to use of this Matherton soil for crops. Most of the acreage is used for the crops commonly grown in the area, however, and only a small acreage is in pasture or trees. (Capability unit IIw-5; woodland group 7; wildlife group 5; recreation group 6; shrub and vine group 3)

Matherton silt loam, 1 to 3 percent slopes (MmA).--This soil has the profile described as representative of the Matherton series. Runoff is slow, and little or no erosion has taken place. This soil is subject to ponding in spring and during periods of heavy rainfall. Wetness is its major limitation to use for crops.

Included with this soil in mapping were small areas of Sebewa silt loam and of Fox silt loam, 0 to 2 percent slopes. Also included were areas in which the surface layer is loam.

Where this Matherton soil is adequately drained, it is suited to the crops commonly grown in the survey area. Most of the acreage is used for crops, but a small acreage is in pasture or trees. (Capability unit IIw-5; woodland group 7; wildlife group 5; recreation group 6; shrub and vine group 3)

Mayville Series

The Mayville series consists of moderately well drained, nearly level or gently sloping, silty soils that are underlain by calcareous loam glacial till. These soils occur on ridgetops and along the bases of foot slopes in glaciated uplands. The native vegetation was a deciduous forest consisting mainly of maple, basswood, oak, and hickory.

In a typical profile, the surface layer is very dark grayish-brown or dark grayish-brown silt loam that is neutral in reaction and is about 7 inches thick. The subsoil is about 25 inches thick. The upper part of the subsoil is dark-brown, slightly acid and medium acid silt loam and silty clay loam over dark-brown, slightly acid, mottled silty clay loam. The lower part is dark yellowish-brown, slightly calcareous, mottled clay loam. The substratum is brown, very friable, strongly calcareous, mottled loam glacial till.

The Mayville soils are moderately permeable and have high available water capacity. Natural fertility is high.

Typical profile of Mayville silt loam, 2 to 6 percent slopes (SE1/4 SE1/4 sec. 18, T. 7 N., R. 20 E.):

Ap--0 to 7 inches, very dark grayish-brown (10YR 3/2) or dark grayish-brown (10YR 4/2) silt

loam, light brownish gray (10YR 6/2) when dry; weak, fine, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

B1--7 to 12 inches, dark-brown (10YR 4/3) silt loam; weak, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21t--12 to 18 inches, dark-brown (10YR 4/3) light silty clay loam; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; firm; medium acid; clear, wavy boundary.

B22t--18 to 24 inches, dark-brown (10YR 4/3) silty clay loam; common, coarse, prominent, yellowish-brown (10YR 5/6 and 5/8) mottles; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; discontinuous clay films; firm; slightly acid; clear, wavy boundary.

IIB3t--24 to 32 inches, dark yellowish-brown (10YR 4/4) light clay loam; few, distinct, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/6 and 5/8) mottles; weak, coarse, prismatic structure parting to moderate, medium, blocky structure; continuous clay films; firm; dark-brown (10YR 3/3) stains of organic matter; few pebbles of dolomite; slightly calcareous; clear, wavy boundary.

IIC--32 to 60 inches, brown (10YR 5/3) loam; few, faint, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/6 and 5/8) mottles; massive; very friable; many pebbles of dolomite; strongly calcareous.

The mantle of silt is typically 20 to 30 inches thick, but the thickness ranges from 20 to 36 inches. The solum is 30 to 40 inches thick. In areas that have not been cultivated, the A1 horizon is generally very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2) and is 3 to 5 inches thick. The part of the B horizon that formed in silt is typically silt loam and silty clay loam. The part that formed in till is generally clay loam or loam. The IIC horizon commonly contains many cobblestones and pebbles of dolomite, and it is heavy sandy loam in places.

The Mayville soils occur with well-drained Dodge, somewhat poorly drained Lamartine, and poorly drained Pella soils. They have a thinner solum than the St. Charles soils.

Mayville silt loam, 0 to 2 percent slopes (MoA).--This soil sometimes remains wet for a few days after heavy rains. Runoff is slow, and little or no erosion has taken place.

Included with this soil in mapping were small areas of Theresa silt loam, 0 to 2 percent slopes; Dodge silt loam, 0 to 2 percent slopes; and a Lamartine silt loam that has slopes of 0 to 2 percent.

This Mayville soil is used mainly for the crops commonly grown in the survey area. A small acreage is in pasture or is used as woodland. (Capability unit I-1; woodland group 1; wildlife group 1; recreation group 1; shrub and vine group 1)

Mayville silt loam, 2 to 6 percent slopes (MoB).--This soil has the profile described as representative of the Mayville series. Runoff is medium, and erosion is a slight hazard.

Included with this soil in mapping were small areas of Theresa silt loam, 2 to 6 percent slopes; Dodge silt loam, 2 to 6 percent slopes; and a Lamartine silt loam that has slopes of 2 to 6 percent.

This Mayville soil is used mostly for the crops commonly grown in the survey area. A small acreage is in pasture or is used as woodland. (Capability unit IIe-1; woodland group 1; wildlife group 1; recreation group 1; shrub and vine group 1)

Mequon Series

In the Mequon series are somewhat poorly drained, silty soils that have a silty clay subsoil underlain by calcareous silty clay loam glacial till. These soils are on the concave side slopes of drainageways and in slight depressions in the northern part of Milwaukee County and the northeastern part of Waukesha County. The native vegetation was a deciduous forest consisting mainly of oak, maple, hickory, and elm.

In a typical profile, the surface layer is dark-brown to very dark grayish-brown silt loam that is neutral in reaction and is about 8 inches thick. The subsoil is about 18 inches thick. The upper part of the subsoil is dark grayish-brown, mottled silty clay loam that is neutral in reaction. The middle part of the subsoil is dark-brown, mottled silty clay that is also neutral in reaction. The lower part is brown, mottled silty clay loam that is slightly calcareous. A substratum of brown, firm, highly calcareous silty clay loam glacial till underlies the subsoil. The substratum contains mottles and coatings of light-gray lime.

The Mequon soils have moderately slow permeability and high available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is low.

Typical profile of Mequon silt loam, 1 to 3 percent slopes (SE1/4 NE1/4 sec. 5, T. 8 N., R. 21 E.):

Ap--0 to 8 inches, dark-brown (10YR 3/3) to very dark grayish-brown (10YR 3/2) silt loam; weak, medium, subangular blocky structure parting to moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

B1--8 to 12 inches, dark grayish-brown (10YR 4/3) silty clay loam; few, fine, faint, grayish-brown (10YR 5/2) mottles; moderate, medium, subangular blocky structure; friable; neutral; clear, wavy boundary.

IIB2t--12 to 19 inches, dark-brown (10YR 4/3) silty clay; many, medium, faint, grayish-brown

(2.5Y 5/2) mottles; strong, medium, angular blocky structure; thick, continuous clay films; firm; few small pebbles of dolomite; neutral; gradual, wavy boundary.

IIB3--19 to 26 inches, brown (7.5YR 5/4) heavy silty clay loam; common, fine, distinct, strong-brown (7.5YR 5/6) and dark-brown (7.5YR 4/2) mottles; moderate, coarse, prismatic structure parting to moderate, medium, angular blocky structure; firm; few pebbles of dolomite; slightly calcareous; gradual, wavy boundary.

IIC--26 to 60 inches, brown (7.5YR 5/2 to 5/4) silty clay loam; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; weak, coarse, prismatic structure to massive; firm; light-gray (10YR 7/2) coatings of segregated lime; few pebbles of dolomite; highly calcareous.

In areas that have not been cultivated, the A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and ranges from 4 to 7 inches in thickness. The A2 horizon in uncultivated areas is generally brown (10YR 5/3) and ranges from 2 to 4 inches in thickness. In many places the IIB2t horizon has a hue of 7.5YR. The solum is 24 to 30 inches thick. It is medium acid in areas that have not been cultivated, but the reaction ranges to mildly alkaline in areas that have been limed and intensively cultivated.

The Mequon soils occur with well drained or moderately well drained Ozaukee and poorly drained Ashkum soils. They have a thinner, lighter colored surface layer than the Elliott soils, and they have browner hues in their subsoil and substratum than the Manawa soils.

Mequon silt loam, 1 to 3 percent slopes (MtA).--This is the only soil of the Mequon series mapped in the survey area. It is not eroded or is only slightly eroded. Runoff is slow, but erosion is a slight hazard in the more sloping areas.

Included with this soil in mapping were small areas of Ozaukee silt loam, 2 to 6 percent slopes, and of an Ashkum silty clay loam having slopes of 0 to 2 percent. Also included were small areas of a Martinton silt loam.

Wetness is the major limitation to use of this Mequon soil for crops. This soil is suited to the crops commonly grown in the survey areas, however, if adequate drainage is established and maintained. Formerly, a large part of the acreage was farmed, but much of this acreage is now in housing developments and related uses. A small acreage is still in woodlots or is used for pasture. (Capability unit IIw-2; woodland group 7; wildlife group 5; recreation group 6; shrub and vine group 3)

Miami Series

The Miami series consists of soils that are well drained and gently sloping to steep. These soils are loamy and have a clay loam subsoil underlain by calcareous glacial till that, in this survey area, has a texture of sandy loam. They are on drumlins and ground moraines in the southwestern part of Waukesha County. Most of the less sloping areas have an irregular shape, and the steeper areas are mainly long and narrow. The native vegetation was a deciduous forest consisting mainly of oak and hickory.

In a typical profile, the survey layer is dark grayish-brown loam that is neutral in reaction and is about 7 inches thick. The subsoil is about 27 inches thick. The upper part of the subsoil is dark yellowish-brown loam that is neutral in reaction. The middle part of the subsoil is brown clay loam that is also neutral in reaction. The lower part is dark yellowish-brown sandy clay loam that is mildly alkaline. Underlying the subsoil is a substratum of yellowish-brown, friable sandy loam glacial till that is slightly calcareous.

The Miami soils are moderately permeable and have moderately high available moisture capacity. Natural fertility is moderate.

Typical profile of Miami loam, sandy loam substratum, 2 to 6 percent slopes (SE1/4 NE1/4 sec. 19, T. 6 N., R. 17 E.):

Ap--0 to 7 inches, dark grayish-brown (10YR 4/2) loam; weak, medium, subangular blocky structure breaking to moderate, medium, granular structure; friable; neutral; abrupt, smooth boundary.

B1--7 to 11 inches, dark yellowish-brown (10YR 4/4) heavy loam; weak, medium, subangular blocky structure; some material from the Ap horizon mixed with the material in this horizon by worm action; friable; neutral; clear, wavy boundary.

B21--11 to 19 inches, brown (7.5YR 4/4) clay loam; moderate, medium, subangular blocky structure; thin, discontinuous clay films; friable; neutral; gradual, wavy boundary.

B22t--19 to 27 inches, brown (7.5YR 4/4) clay loam; moderate, medium, subangular blocky structure; thin clay films on most ped faces; firm; neutral; clear, wavy boundary.

B3--27 to 34 inches, dark yellowish-brown (10YR 4/4) sandy clay loam; weak, medium, subangular blocky structure; few dark yellowish-brown (10YR 3/4) stains of organic matter; friable; mildly alkaline; abrupt, wavy boundary.

C--34 to 62 inches, yellowish-brown (10YR 5/4) sandy loam glacial till; massive; friable; slightly calcareous.

In places the A horizon is sandy loam. The color of the Ap horizon in cultivated fields ranges from very dark grayish brown (10YR 3/2) to dark grayish brown (10YR 4/2). In areas that have not been cultivated, the A1 horizon is generally very dark gray (10YR 3/1) and is 3 to 4 inches thick. In these uncultivated areas, the A1 horizon is underlain by a grayish-brown (10YR 5/2) to brown (10YR 5/3) A2 horizon that is 2 to 5 inches thick. Texture of the B2 horizons generally is clay loam, but it ranges to sandy clay loam in places. Thickness

of the solum ranges from 20 to 40 inches. The solum is medium acid in areas that have not been cultivated, but the reaction ranges to neutral in some cultivated fields. In some places cobblestones and boulders, 4 inches to 2 feet in diameter, are on the surface of these soils.

The Miami soils have a thicker solum than the Hochheim soils. Unlike the Theresa soils, they have a surface layer and upper subsoil of loam or sandy loam. The Miami soils also have less pronounced clay films in the subsoil, a thicker lower subsoil horizon, and a more sandy substratum than the Theresa soils, and their substratum is lower in content of calcium carbonate than that of the Theresa soils. The Miami soils contain a greater number of igneous pebbles and cobblestones, and fewer pebbles and cobblestones of dolomite, than either the Hochheim or Theresa soils.

Miami sandy loam, sandy loam substratum, 2 to 6 percent slopes (MvB).--This soil is droughty, and it is slightly susceptible to erosion. Runoff is medium.

Included with this soil in mapping were some moderately eroded areas, and small areas of Miami loam, sandy loam substratum, 2 to 6 percent slopes.

Most of the acreage is used for the crops commonly grown in the survey area. A small acreage is in pasture or trees. (Capability unit IIe-1; woodland group 3; wildlife group 1; recreation group 2; shrub and vine group 2)

Miami sandy loam, sandy loam substratum, 6 to 12 percent slopes, eroded (MvC2).--This soil is droughty, and it has lost part of its original surface layer through moderate erosion. The present plow layer consists partly of brown clay loam from the subsoil that is mixed with the remaining original surface soil. Runoff is medium, and further erosion is a moderate hazard.

Included with this soil in mapping were small areas of Miami loam, sandy loam substratum, 6 to 12 percent slopes, eroded. Also included were some severely eroded areas, and a few fairly large areas that are not eroded or are only slightly eroded.

Most of the acreage is used for the crops commonly grown in the survey area. A small acreage is in pasture. (Capability unit IIIe-1; woodland group 3; wildlife group 1; recreation group 2; shrub and vine group 2)

Miami loam, sandy loam substratum, 2 to 6 percent slopes (MxB).--This soil has the profile described as representative of the Miami series. Little or no erosion has taken place. Erosion is a slight hazard, however, because of the medium runoff.

Included with this soil in mapping were some moderately eroded areas and small areas of Theresa silt loam, 2 to 6 percent slopes.

This Miami soil is used mainly for the crops commonly grown in the survey area, but a small acreage is in pasture or trees. If management is good, cropping can be intensive. (Capability unit IIe-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Miami loam, sandy loam substratum, 6 to 12 percent slopes, eroded (MxC2).--This soil has lost part of its original surface layer through erosion. The present plow layer consists partly of brown clay loam from the subsoil that is mixed with the remaining original surface soil. Runoff is medium, and further erosion is a moderate hazard.

Included with this soil in mapping were small areas of Theresa silt loam, 6 to 12 percent slopes, eroded, and a few fairly large wooded areas that are not eroded or that are only slightly eroded.

This Miami soil is used mostly for the crops commonly grown in the survey area. A small acreage is in pasture. (Capability unit IIIe-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Miami loam, sandy loam substratum, 12 to 20 percent slopes, eroded (MxD2).--This soil has a plow layer in which some brownish material from the subsoil is mixed with the remaining original surface soil. Runoff is rapid, and further erosion is a severe hazard.

Included with this soil in mapping were a few fairly large, severely eroded areas. Also included were some wooded areas in which little or no erosion has taken place, and small areas in which the texture of the surface layer is sandy loam.

This Miami soil is used mainly for the forage crops commonly grown in the survey area. A small acreage is in pasture. A desirable cropping system for areas that are cultivated is one in which forage crops and other close-growing crops are grown most of the time. (Capability unit IVe-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Miami loam, sandy loam substratum, 20 to 30 percent slopes (MxE).--This soil has a solum that is generally only 20 to 24 inches thick. Runoff is rapid, and erosion is a very severe hazard. This soil is also droughty.

Included with this soil in mapping were a few fairly large areas that are moderately eroded, and small areas of Hochheim loam, 20 to 30 percent slopes, eroded. Also included were areas in which the surface layer is sandy loam.

This Miami soil is used mostly as woodland or pasture, but a small acreage is cultivated and is mainly in forage crops. This soil is better suited to forage crops or pasture and to use as woodland or wildlife habitat than to crops that require cultivation. (Capability unit VIe-1; woodland group 5; wildlife group 1; recreation group 2; shrub and vine group 2)

Montgomery Series

In the Montgomery series are poorly drained, silty clay loam soils that have a silty clay subsoil

underlain by lacustrine deposits. These soils occupy rather large areas of irregular shape in old glacial lakebeds and river basins. The native vegetation was mostly water-tolerant grasses and trees. The trees are mainly elms.

In a typical profile, the surface layer is black silty clay loam that is neutral in reaction and is about 11 inches thick. The subsoil is about 19 inches thick. The upper part of the subsoil is dark-gray or gray, mottled silty clay that is neutral in reaction. The lower part is grayish-brown, mottled silty clay that is calcareous. The substratum is grayish-brown, mottled silty clay that is strongly calcareous.

The Montgomery soils are slowly permeable and have high available water capacity. Ground water is at or near the surface during most of the year. Natural fertility is high.

Typical profile of Montgomery silty clay loam (0 to 2 percent slopes) (NE1/4 SW1/4 sec. 36, T. 5 N., R. 20 E.):

Ap--0 to 7 inches, black (10YR 2/1) silty clay loam; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A1--7 to 11 inches, black (10YR 2/1) silty clay loam; moderate, medium, subangular blocky structure parting to moderate, fine, granular structure; friable; neutral; abrupt, wavy boundary.

B1g--11 to 16 inches, dark-gray and gray (5Y 4/1 to 5/1) silty clay; few, fine, prominent, yellowish-brown (10YR 5/8) mottles; moderate, medium, prismatic structure parting to moderate, medium, angular blocky structure; very firm; neutral; clear, wavy boundary.

B2tg--16 to 20 inches, grayish-brown (2.5Y 5/2) silty clay; many, medium, distinct, light olive-brown (2.5Y 5/4 and 5/6) mottles; moderate, medium, prismatic structure parting to strong, medium, angular blocky structure; continuous clay films; very firm; slightly calcareous; clear, wavy boundary.

B3g--20 to 30 inches, grayish-brown (2.5Y 5/2) silty clay; few, fine, distinct, yellowish-brown (10YR 5/4) mottles; weak, medium, prismatic structure parting to weak, medium, subangular blocky structure; very plastic; strongly calcareous; gradual, wavy boundary.

C--30 to 60 inches, grayish-brown (2.5Y 5/2) silty clay; common, medium, distinct, light olive-brown (2.5Y 5/4) mottles; massive; very plastic; strongly calcareous.

The A horizon ranges from 10 to 15 inches in thickness. Texture of the B horizon ranges from silty clay to silty clay loam, and depth to carbonates ranges from 15 to 26 inches. In places the C horizon contains lenses of silt and very fine sand.

The Montgomery soils occur with well drained and moderately well drained Saylesville and somewhat poorly drained Martinton soils. They have a solum that is finer textured throughout than that of the Pella soils. The upper part of their solum has not been influenced by glacial outwash as has that of the Navan soils.

Montgomery silty clay loam (0 to 2 percent slopes) (Mzb).--This is the only soil of the Montgomery series mapped in the survey area. It tends to remain wet in spring and after periods of heavy rainfall, even where drainage has been installed.

Included with this soil in mapping were small areas of Pella silt loam and of Martinton silt loam, 1 to 3 percent slopes.

Wetness is the major limitation to use of this Montgomery soil for crops. Corn is grown on a large part of the acreage, and the rest is wooded or in pasture. (Capability unit IIw-1; woodland group 7; wildlife group 5; recreation group 7; shrub and vine group 3)

Morley Series

The Morley series consists of well drained and moderately well drained, silty soils over calcareous silty clay loam glacial till. These soils occupy convex side slopes of ground moraines in the southern part of Milwaukee County and the southeastern part of Waukesha County. Areas of the less sloping soils are rather large, and all of the areas have an irregular shape. The native vegetation was a deciduous forest consisting mainly of oak and hickory.

In a typical profile, the surface layer is very dark grayish-brown silt loam that is neutral in reaction and is about 4 inches thick. The subsurface layer is brown silt loam that is slightly acid and is also about 4 inches thick. The subsoil is about 20 inches thick. The upper part of the subsoil is dark-brown, medium acid silty clay loam; the middle part is dark yellowish-brown to dark-brown, medium acid and slightly acid silty clay; and the lower part is dark-brown, slightly calcareous silty clay loam. The substratum is brown, firm, highly calcareous silty clay loam glacial till.

The Morley soils have moderately slow permeability and high available water capacity. Ground water is less than 5 feet below the surface in wet periods. Natural fertility is moderate.

Typical profile of Morley silt loam, 2 to 6 percent slopes (NE1/4 NW1/4 sec. 18, T. 5 N., R. 22 E.):

A1--0 to 4 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, fine, granular structure; neutral; abrupt, wavy boundary.

A2--4 to 8 inches, brown (10YR 5/3) silt loam; moderate, medium, platy structure parting to moderate, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B1--8 to 12 inches, dark-brown (10YR 4/3) light silty clay loam; moderate, medium, subangular blocky structure; firm; medium acid; clear, wavy boundary.

IIB21t--12 to 16 inches, dark yellowish-brown (10YR 4/4) silty clay; strong, medium, subangular

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blocky structure; thick, continuous clay films; firm; dark-brown (10YR 3/3) coatings of organic matter; few pebbles of dolomite; medium acid; clear, wavy boundary.

IIB22t--16 to 23 inches, dark-brown (10YR 4/3) silty clay; moderate, medium, prismatic structure parting to strong, medium, subangular blocky structure; thick, continuous clay films; firm; few pebbles of dolomite; dark-brown (10YR 3/3) stains of organic matter; slightly acid; gradual, wavy boundary.

IIB3--23 to 28 inches, dark-brown (10YR 4/3) heavy silty clay loam; moderate, medium, prismatic structure parting to weak, medium, subangular blocky structure; firm; thin, discontinuous clay films; few pebbles of dolomite; slightly calcareous; clear, wavy boundary.

IIC--28 to 62 inches, brown (10YR 5/3) silty clay loam; massive; firm; thin, discontinuous clay films in the uppermost few inches of soil material; light brownish-gray (10YR 6/2) coatings of segregated lime on the vertical faces of peds; few pebbles of dolomite and small chips of shale; highly calcareous.

The A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2), and it ranges from 3 to 5 inches in thickness. The A2 horizon ranges from 3 to 6 inches in thickness. The solum is typically 24 to 30 inches thick. The lower subsoil in some places contains yellowish-brown mottles. In other areas there are no mottles in the solum. In some areas that have not been cultivated, the solum is strongly acid, but the reaction ranges to mildly alkaline in areas that have been limed and intensively cultivated. The IIC horizon contains pockets or lenses of heavy loam in some places.

The Morley soils occur with somewhat poorly drained Blount and poorly drained Ashkum soils. They have a thinner, lighter colored surface layer and subsurface layer than the Markham soils. The Morley soils have a browner subsoil and substratum than the Kewaunee and Ozaukee soils, and they contain more pebbles and sand than the Saylesville soils.

Morley silt loam, 2 to 6 percent slopes (MzdB).--This soil has the profile described as representative of the Morley series. Runoff is generally medium, and erosion is a slight hazard. The rate of runoff increases during periods of heavy rainfall because this soil is not permeable enough for the water to soak in and pass through it readily.

Included with this soil in mapping were small areas of a Blount silt loam that has slopes of 0 to 2 percent. Also included were small areas of Saylesvile silt loam, 0 to 2 percent slopes, and Ozaukee silt loam, 2 to 6 percent slopes.

This Morley soil was formerly used mostly for crops. Now, much of the acreage is in housing developments and related uses. A small acreage is still in trees or pasture. (Capability unit IIe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Morley silt loam, 2 to 6 percent slopes, eroded (MzdB2).--The plow layer of this soil has some dark-brown silty clay loam from the subsoil mixed with the remaining original surface soil. Good tilth is difficult to maintain, and germination of seeds is likely to be poor. Runoff is generally medium. Because this soil is not permeable enough that water can soak in and pass through it readily, the rate of runoff is rapid during periods of heavy rainfall. Further erosion is a slight hazard.

Included with this soil in mapping were small areas of a Blount silt loam that has slopes of 0 to 2 percent. Also included were small areas of Ozaukee silt loam, 2 to 6 percent slopes, eroded, and areas that are not eroded or are only slightly eroded.

Nearly all of the acreage was formerly used for crops. Now, much of the acreage is in housing developments and related uses. (Capability unit IIe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Morley silt loam, 6 to 12 percent slopes, eroded (MzdC2).--Dark-brown silty clay loam from the subsoil is mixed with the remaining original surface soil in the plow layer of this soil. Runoff is generally medium. The rate of runoff is rapid during periods of heavy rainfall, however, because this soil is not permeable enough for water to soak in and pass through it readily. Further erosion is a moderate hazard.

Included with this soil in mapping were small areas of Ozaukee silt loam, 6 to 12 percent slopes, eroded, and Morley silt loam, 2 to 6 percent slopes, eroded. Also included were small areas that are not eroded or that are only slightly eroded.

Nearly all of the acreage was formerly used for crops. Now, much of the acreage is in housing developments and related uses. A few small areas are still in trees or pasture. (Capability unit IIIe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Morley silt loam, 12 to 20 percent slopes, eroded (MzdD2).--The plow layer of this soil contains some dark-brown silty clay loam from the subsoil that is mixed with the remaining original surface soil. Runoff is rapid, and further erosion is a severe hazard.

Included with this soil in mapping were small areas of Ozaukee silt loam, 12 to 20 percent slopes, eroded, and a Morley silt loam that has slopes of 6 to 12 percent. Also included were a few steep areas, a few fairly large areas where little or no erosion has taken place, and a few areas where erosion has removed all of the surface layer and some of the subsoil.

Formerly, most of the acreage was used for crops. Housing developments now occupy part of the acreage. and a few small areas are still in trees or pasture.

Limitations are severe to use of this soil for housing developments, especially where no public sewer facilities are available. (Capability unit IVe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Mundelein Series

Somewhat poorly drained, silty soils that have a silty clay loam subsoil underlain by stratified lacustrine silt and fine sand are in the Mundelein series. These soils are on the concave side slopes of drainageways, old glacial lake basins, and river benches. The native vegetation was water-tolerant grasses and a deciduous forest consisting mainly of elm and basswood.

In a typical profile, the surface layer is very dark grayish-brown silt loam that is neutral in reaction and is about 9 inches thick. The subsoil is about 16 inches thick. The upper part of the subsoil is dark grayish-brown and dark yellowish-brown silty clay loam that is neutral in reaction. The lower part is pale-brown silt loam that is slightly calcareous. The substratum is brown, very friable silt loam that contains thin lenses of fine sand and is highly calcareous. Both the subsoil and the substratum contain mottles.

The Mundelein soils are moderately permeable and have high available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is moderate.

Typical profile of Mundelein silt loam, 1 to 3 percent slopes (NE1/4 NE1/4 sec. 34, T. 5 N., R. 22 E.):

Ap--0 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, medium, subangular blocky structure parting to weak, medium, granular structure; friable; neutral; abrupt, smooth boundary.

B21t--9 to 15 inches, dark grayish-brown (2.5Y 4/2) silty clay loam; common, fine, prominent, yellowish-brown (10YR 5/8) and faint, grayish-brown (2.5Y 5/2) mottles; moderate, medium, subangular blocky structure; thin, discontinuous clay films; firm; neutral; gradual, wavy boundary.

B22t--15 to 20 inches, dark yellowish-brown (10YR 4/4) silty clay loam; many, medium, prominent, yellowish-brown (10YR 5/8) and distinct, grayish-brown (2.5Y 5/2) mottles; moderate, medium, subangular blocky structure; firm; neutral; clear, wavy boundary.

B3--20 to 25 inches, pale-brown (10YR 6/3) silt loam; common, fine, prominent, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; friable; slightly calcareous; abrupt, wavy boundary.

C--25 to 60 inches, brown (10YR 5/3) silt loam containing thin leneses of fine sand; many, medium, distinct, yellowish-brown (10YR 5/4 and 5/6) mottles; massive; very friable; highly calcareous.

The Ap horizon ranges from 9 to 11 inches in thickness. In areas that have not been cultivated, the A1 horizon ranges from 5 to 7 inches in thickness. The solum ranges from mildly alkaline to slightly acid in reaction, and it is commonly 22 to 27 inches thick.

The Mundelein soils occur with well-drained Grays and poorly drained Colwood soils. They have formed in coarser textured lacustrine deposits than the Martinton soils.

Mundelein silt loam, 1 to 3 percent slopes (MzfA).--This is the only soil of the Mundelein series mapped in the survey area. It is not eroded or is only slightly eroded. Runoff is slow, and ponding occurs in spring and during periods of heavy rainfall. Providing drainage is difficult because the silty material and fine sand tend to flow when they are saturated, and they fill the ditches and tile lines.

Included with this soil in mapping were small areas of Grays silt loam, 0 to 2 percent slopes; Colwood silt loam; and an Aztalan soil that has a silt loam surface layer. Also included were a few small areas in which the surface layer is fine sandy loam, and other areas in which the surface layer is loam. Other inclusions consist of areas in which the solum is less than 22 inches thick.

Wetness is the major limitation to use of this Mundelein soil for crops. Most of the acreage is used for the crops commonly grown in the survey area. A small acreage is in pasture or trees. (Capability unit IIw-2; woodland group 7; wildlife group 5; recreation group 6; shrub and vine group 3)

Muskego Series

In the Muskego series are very poorly drained organic soils that consist of the moderately well decomposed residue of water-tolerant plants underlain by sedimentary peat. These soils are in old, shallow glacial lakebeds. The native vegetation was mainly reeds and sedges.

In a typical profile, the surface layer and the subsurface layer are black, slightly acid muck. The combined thickness of these two layers is about 16 inches. The muck is underlain by a layer, also about 16 inches thick, of very dark brown, slightly acid muck that breaks down readily when rubbed between the fingers. Next is a layer of dark-brown sedimentary peat, about 10 inches thick, that is neutral in reaction and that also breaks down readily when rubbed between the fingers. Underlying this sedimentary peat are layers of very dark grayish-brown, finely laminated sedimentary peat that is moderately alkaline between depths of 42 and 50 inches. The sedimentary peat is slightly calcareous and contains many snail shells below a depth of about 50 inches.

The Muskego soils have moderately slow permeability and very high available water capacity. Ground water is at or near the surface throughout most of the year. These soils are generally very difficult to drain. Natural fertility is low.

Typical profile of Muskego muck (SW1/4 NW1/4 sec. 36, T. 5 N., R. 20 E.):

1--0 to 8 inches, black (10YR 2/1) muck; moderate, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.
2--8 to 16 inches, black (10YR 2/1) muck; moderate, medium, subangular blocky structure; friable; slightly acid; abrupt, wavy boundary.
3--16 to 32 inches, very dark brown (10YR 2/2) muck; massive; firm; many dark yellowish-brown (10YR 3/4) leaves, roots, and stems of sedges, and these turn very dark brown (10YR 2/2) if they are exposed to air for a short time, and they break down easily when rubbed between the fingers; slightly acid; abrupt, smooth boundary.
4--32 to 42 inches, dark-brown (10YR 3/3) sedimentary peat; finely laminated; friable; many dark yellowish-brown (10YR 4/4) roots, leaves, and steams of sedges, and these break down easily when rubbed between the fingers; neutral; clear, wavy boundary.
5--42 to 50 inches, very dark grayish-brown (2.5Y 3/2) sedimentary peat; finely laminated; non-sticky; has greasy feel when rubbed between the fingers; contains many olive-brown (2.5Y 4/4) roots, leaves, and stems of sedges, and these break down easily when rubbed between the fingers; moderately alkaline; clear, wavy boundary.
6--50 to 55 inches, very dark grayish-brown (2.5Y 3/2) sedimentary peat; finely laminated; non-sticky; has greasy feel when rubbed between the fingers; many snail shells; slightly calcareous; clear, wavy boundary.
7--55 to 65 inches, very dark grayish-brown (2.5Y 3/2) sedimentary peat; finely laminated; has greasy feel when rubbed between the fingers; slightly calcareous.

Depth to the sedimentary peat ranges from 24 to 36 inches. In some places the profile contains no snail shells, and in others all horizons contain these shells. The sedimentary peat shrinks as it dries, and the thin layers of dried sedimentary peat then become irreversibly hard.

The Muskego soils are similar to the Houghton soils, except that they contain sedimentary peat, which is at a depth of less than 36 inches. The Muskego soils are also somewhat similar to the Adrian, Ogden, and Palms soils, except that they lack a substratum of mineral material that is typical in the profile of those soils. Muskego soils differ from the Rollin soils in that they are underlain by sedimentary peat instead of marl.

Muskego muck (Mzg).--This is the only soil of the Muskego series mapped in the survey area. It is a wet soil, and it is difficult to drain because of the moderately slow permeability of the sedimentary peat.

Included with this soil in mapping were small areas of Ogden muck, Palms muck, and Houghton muck, 0 to 2 percent slopes.

Wetness is the major limitation to use of this Muskego soil for crops. Only a small acreage has been cultivated. This acreage is used mainly to grow corn and sod, and the rest has not been farmed. Where this soil cannot be drained and used for crops, use as wildlife habitat is desirable. (Capability unit IVw-7; woodland group 10; wildlife group 6; recreation group 9; shrub and vine group 3)

Mussey Series

In the Mussey series are poorly drained, loamy soils that are underlain by calcareous sandy and gravelly outwash. These soils lie in depressions and on low, broad flats of glacial outwash plains. The native vegetation was water-tolerant grasses and a deciduous forest consisting mainly of elm.

In a typical profile, the surface layer is black, mildly alkaline loam about 10 inches thick. The subsoil is about 8 inches thick. The upper part of the subsoil is dark-gray, mildly alkaline, mottled sandy clay loam. The lower part is light brownish-gray, moderately alkaline, mottled loam. Underlying the subsoil is the substratum of light brownish-gray, loose, stratified sand and gravel that are slightly calcareous.

The Mussey soils are moderately permeable and have moderate available water capacity. Ground water is at or near the surface throughout most of the year. Natural fertility is moderate.

Typical profile of Mussey loam (0 to 2 percent slopes) (SW1/4 NW1/4 sec. 33, T. 5 N., R. 17 E.):

Ap--0 to 7 inches, black (10YR 2/1) loam; moderate, fine, granular structure; friable; mildly alkaline; abrupt, smooth boundary.
A1--7 to 10 inches, black (10YR 2/1) heavy loam; weak, thin, platy structure parting to moderate, fine, granular structure; friable; mildly alkaline; clear, wavy boundary.
B2g--10 to 15 inches, dark-gray (N 4/0) sandy clay loam; few, fine, prominent, yellowish-brown (10YR 5/8) mottles; moderate, fine, subangular blocky structure; friable; few pebbles; mildly alkaline; clear, wavy boundary.
B3--15 to 18 inches, light brownish-gray (10YR 6/2) loam; few, fine, prominent, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; very friable; few pebbles; moderately alkaline; clear, wavy boundary.
C--18 to 60 inches, light brownish-gray (10YR 6/2), stratified sand and gravel; single grain; loose; slightly calcareous.

In areas that have not been cultivated, the A1 horizon ranges from 10 to 13 inches in thickness. In places where a thin mantle of silt covers the glacial outwash, the texture of the Ap horizon is silt loam and the texture of the B2g horizon ranges to heavy loam. In areas where the mantle of silt is lacking, texture of the B2g horizon ranges to sandy clay loam and heavy sandy loam and the texture

of the Ap horizon ranges to sandy loam. Thickness of the solum is commonly 16 to 20 inches. Reaction of the solum ranges from slightly acid to moderately alkaline.

The Mussey soils occur with well-drained Casco and Lorenzo soils and somewhat poorly drained Fabius soils. They have a thinner solum than the Sebewa and Gilford soils. The Mussey soils have a finer textured subsoil than the Granby soils.

Mussey loam (0 to 2 percent slopes) (Mzk).--This is the only soil of the Mussey series mapped in the survey area. Runoff is very slow, and this soil is subject to flooding or ponding in spring and during periods of heavy rainfall.

Included with this soil in mapping were small areas of Sebewa loam and Gilford loam, and a few fairly large areas in which the surface layer is silt loam or sandy loam.

Wetness is the major limitation to use of this Mussey soil for crops. Where adequate drainage is established and maintained, however, this soil is suited to most of the crops commonly grown in the survey area. Most of the acreage is in pasture or trees, but a small acreage is farmed. (Capability unit IIw-5; woodland group 7; wildlife group 5; recreation group 7; shrub and vine group 3)

Navan Series

The Navan series consists of nearly level, poorly drained silt loam soils that have a loamy and clayey subsoil underlain by clayey lacustrine deposits. These soils are in old glacial lake basins and on river benches. The native vegetation was water-tolerant grasses and a deciduous forest consisting mainly of elm.

In a typical profile, the surface layer is black, mildly alkaline silt loam about 11 inches thick. The subsoil is about 13 inches thick. The upper part of the subsoil is dark grayish-brown, mottled sandy clay loam that is neutral in reaction. The middle part is grayish-brown, mottled sandy loam that is mildly alkaline. The lower part is light brownish-gray, mottled silty clay loam that is slightly calcareous. A substratum of light brownish-gray, firm, mottled, laminated silty clay and silty clay loam that is highly calcareous underlies the subsoil.

The Navan soils are slowly permeable and have high available water capacity. Ground water is at or near the surface throughout most of the year. Natural fertility is high.

Typical profile of Navan silt loam (0 to 2 percent slopes) (NW1/4 SE1/4 sec. 8, T. 5 N., R. 17 E.):

Ap--0 to 11 inches, black (10YR 2/1) silt loam; weak, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

B21g--11 to 17 inches, dark grayish-brown (2.5Y 4/2) sandy clay loam; few, fine, faint, light brownish-gray (10YR 6/2) and prominent, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; neutral; clear, wavy boundary.

B22tg--17 to 20 inches, grayish-brown (10YR 5/2) sandy loam; few, fine, faint, light brownish-gray (10YR 6/2) and prominent, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; discontinuous clay films; friable; few pebbles; mildly alkaline; abrupt, wavy boundary.

IIB3tg--20 to 24 inches, light brownish-gray (2.5Y 6/2) silty clay loam; common, fine, prominent, yellowish-brown (10YR 5/8) mottles; moderate, thick, platy structure parting to moderate, fine, subangular blocky structure; discontinuous clay films; firm; slightly calcareous; clear, wavy boundary.

IIC1--24 to 29 inches, light brownish-gray (2.5Y 6/2), laminated silty clay; common, fine, prominent, yellowish-brown (10YR 5/8) mottles; weak, thick, platy structure parting to medium subangular blocky structure; firm; highly calcareous; clear, wavy boundary.

IIC2--29 to 60 inches, light brownish-gray (2.5Y 6/2), laminated silty clay and silty clay loam; common, fine, faint, brown (7.5YR 5/2) and prominent, strong-brown (7.5YR 5/8) mottles; massive; firm; highly calcareous.

The A horizon is generally 10 to 15 inches thick. In places, however, a thin mantle of loamy material covers the surface, and in those places the A horizon is 10 to 18 inches thick and has a loam texture. The A horizon and the B2 horizons have formed in glaciofluvial material. Texture of the B2 horizons ranges from heavy sandy loam to the more typical sandy clay loam or clay loam. The IIB3tg horizon, which has formed in lacustrine material, has a texture of silty clay loam. In places the IIC horizons contain thin lenses of silt and very fine sand.

The Navan soils occur with well drained or moderately well drained Hebron and somewhat poorly drained Aztalan soils. All except the lowest horizon of their subsoil is coarser textured than comparable horizons in the Montgomery and Pella soils.

Navan silt loam (0 to 2 percent slopes) (Na).--This is the only soil of the Navan series mapped in the survey area. It is subject to ponding in spring and during periods of heavy rainfall. Runoff is very slow, and little or no erosion has taken place.

Included with this soil in mapping were small areas in which the surface layer is loam. Also included were small areas of Sebewa silt loam, Montgomery silty clay loam, and an Aztalan silt loam that has slopes of 0 to 3 percent.

Wetness is the major limitation to use of this Navan soil for crops. Most of the acreage is used for the commonly grown crops, mainly corn and truck crops. A small acreage is in pasture or trees. (Capability unit IIw-1; woodland group 7; wildlife group 5; recreation group 7; shrub and vine group 3)

Ogden Series

In the Ogden series are very poorly drained organic soils that consist of the decomposed residue of water-tolerant plants underlain by clay. These soils occupy areas in the basins of extinct glacial lakes. The native vegetation was mainly sedges and reeds.

In a typical profile, the surface layer is black, slightly acid muck about 7 inches thick. The next layer, about 17 inches thick, is black, slightly acid muck that contains remnants of sedges and reeds in the lower part. The substratum is dark-gray and pale-olive, very sticky clay that is slightly acid in the upper part and slightly calcareous in the lower part.

The Ogden soils are slowly permeable and have very high available water capacity. Ground water is at or near the surface throughout most of the year. Natural fertility is low.

Typical profile of Ogden muck (0 to 2 percent slopes) (SE1/4 SW1/4 sec. 28, T. 5 N., R. 20 E.):

1--0 to 7 inches, black (10YR 2/1) muck; weak, medium, granular structure; friable; slightly acid; abrupt, smooth boundary.
2--7 to 19 inches, black (10YR 2/1) muck; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.
3--19 to 24 inches, black (10YR 2/1) muck; moderate, medium, subangular blocky structure; friable; few remnants of sedges and reeds; slightly acid; clear, wavy boundary.
IIC1g--24 to 27 inches, dark-gray (5Y 4/1) clay; massive; very sticky when wet; slightly acid; abrupt, smooth boundary.
IIC2--27 to 60 inches, pale-olive (5Y 6/3) clay; massive; very sticky when wet; slightly calcareous.

The organic soil ranges from 12 to 40 inches in thickness and from slightly acid to mildly alkaline in reaction. In places the IIC horizons are clay loam. The IIC2 horizon contains small snail shells, remnants of plants, and layers of mucky peat in some places.

The Ogden soils have formed in a thinner deposit of organic material than the Houghton soils. They have a substratum that is finer textured than those of the Palms and Adrian soils. Their substratum lacks the marl that is typical in the substratum of the Rollin soils, and it lacks that sedimentary peat that is typical in the lower part of the profile of the Muskego soils.

Ogden muck (0 to 2 percent slopes) (Oc).--This is the only soil of the Ogden series mapped in the survey area. It is a wet soil. Where drainage has been established and cultivated crops are grown, soil blowing and subsidence are hazards.

Included with this soil in mapping were small areas of Houghton muck, 0 to 2 percent slopes, and Palms muck.

Wetness is the major limitation to use of this Ogden soil for crops. Cropping can be intensive, however, if this soil is properly managed, and if it is protected from soil blowing and subsidence. A considerable acreage of this soil is used to grow corn, vegetables, and sod, but much of the acreage has not been cultivated. (Capability unit IIIw-8; woodland group 10; wildlife group 6; recreation group 9; shrub and vine group 3)

Oshtemo Series

The Oshtemo series consists of well-drained soils that have a sandy loam and sandy clay loam subsoil underlain by calcareous sand. These soils are in fairly large areas on glacial outwash plains in the western part of Waukesha County. The native vegetation was a deciduous forest consisting mainly of oak.

In a typical profile, the surface layer is dark grayish-brown, mildly alkaline loamy sand about 9 inches thick. The subsurface layer is brown and dark-brown, mildly alkaline loamy sand about 11 inches thick. The subsoil is about 26 inches thick. The upper part of the subsoil is dark-brown, slightly acid sandy loam; the middle part is dark-brown, medium acid sandy clay loam; and the lower part is dark-brown, slightly acid to mildly alkaline, mottled sandy loam and loamy sand. The substratum is pale-brown, loose, strongly calcareous medium sand.

The Oshtemo soils have moderately rapid permeability and low available water capacity. Natural fertility is low.

Typical profile of Oshtemo loamy sand, 1 to 6 percent slopes (SW1/4 SE1/4 sec. 32, T. 7 N., R. 17 E.):

Ap--0 to 9 inches, dark grayish-brown (10YR 4/2) loamy sand; weak, medium and fine, subangular blocky structure; friable; mildly alkaline; abrupt, smooth boundary.
A2--9 to 14 inches, brown (10YR 5/3) loamy sand; weak, medium, platy structure; friable; mildly alkaline; clear, wavy boundary.
AB--14 to 20 inches, brown (10YR 5/3) and dark-brown (7.5YR 4/4) loamy sand; weak, medium, subangular blocky structure; friable; mildly alkaline; clear, wavy boundary.
B21t--20 to 24 inches, dark-brown (7.5YR 4/4) heavy sandy loam; weak, medium, subangular blocky structure; clay bridging of the sand grains; friable; slightly acid; clear, wavy boundary.
B22t--24 to 35 inches, dark-brown (7.5YR 4/4) sandy clay loam; moderate, medium, subangular blocky structure; thick clay bridging of the sand grains; firm; medium acid; clear, wavy boundary.
B31--35 to 42 inches, dark-brown (7.5YR 4/4) light sandy loam; common, medium, distinct, yellowish-brown (10YR 5/6) and faint, reddish-brown (5YR 4/4) mottles; weak, medium, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B32--42 to 46 inches, dark-brown (10YR 4/3) loamy sand; single grain; loose; mildly alkaline; clear, wavy boundary.
C--46 to 65 inches, pale-brown (10YR 6/3) medium sand; single grain; loose; strongly calcareous.

The A horizons range from 10 to 16 inches in combined thickness and from loamy sand to sandy loam in texture. The B22t horizon is generally no more than 11 inches thick. The solum contains a few small pebbles in places, and it is 42 to 50 inches thick. Reaction of the solum is medium acid in places, but the reaction ranges to neutral or mildly alkaline in cultivated areas.

The Oshtemo soils have a thicker solum than the Boyer soils. They have a finer textured subsoil than the Chelsea soils.

Oshtemo loamy sand, 1 to 6 percent slopes (OmB).--This soil has the profile described as representative of the Oshtemo series. Runoff is slow, and little or no erosion has taken place. This soil is droughty, and it is moderately susceptible to soil blowing.

Included with this soil in mapping were small areas of Boyer loamy sand, 1 to 6 percent slopes, and a few fairly large areas in which the surface layer is darker colored than typical for the surface layer of Oshtemo soils.

Most of the acreage is used for the crops commonly grown in the survey area. A small acreage is in pasture or trees. (Capability unit IIIs-4; woodland group 4; wildlife group 1; recreation group 4; shrub and vine group 2)

Oshtemo sandy loam, 1 to 6 percent slopes (OnB).--This soil is droughty. It is susceptible to soil blowing, but it is less susceptible than Oshtemo loamy sand, 1 to 6 percent slopes. Runoff is slow, and little or no erosion has taken place.

Included with this soil in mapping were small areas of Fox sandy loam, 0 to 2 percent slopes, and Boyer sandy loam, 1 to 6 percent slopes.

This Oshtemo soil is used mainly for the crops commonly grown in the survey area. A small acreage is in pasture or trees. (Capability unit IIIs-4; woodland group 3; wildlife group 1; recreation group 2; shrub and vine group 2)

Ozaukee Series

The Ozaukee series consists of well drained and moderately well drained, silty soils that have a silty clay loam and silty clay subsoil underlain by calcareous silty clay loam glacial till. These soils occupy the convex side slopes of glacial moraines in the northern half of Milwaukee County and the northeastern part of Waukesha County. The gently sloping and sloping areas are mostly rather large and have an irregular shape. The moderately steep areas are long and narrow. A deciduous forest consisting mainly of oak, maple, and hickory was the native vegetation.

In a typical profile (pl. V), the surface layer is very dark grayish-brown, slightly acid silt loam about 4 inches thick. The subsurface layer, also about 4 inches thick, is brown, medium acid silt loam. The subsoil is about 17 inches thick. The upper part of the subsoil is dark-brown, strongly acid silty clay loam; the middle part is dark-brown, medium acid silty clay; and the lower part is dark-brown silty clay loam that is neutral in reaction. A substratum of brown, strongly calcareous silty clay loam glacial till underlies the subsoil.

The Ozaukee soils have moderately slow permeability and high available water capacity. Ground water is less than 5 feet below the surface in some areas and more than 5 feet below in others. Natural fertility is moderate.

Typical profile of Ozaukee silt loam, 2 to 6 percent slopes (SE1/4 NW1/4 sec. 14, T. 7 N., R. 20 E.):

A1--0 to 4 inches, very dark grayish-brown (10YR 3/2) silt loam; moderate, medium, granular structure; friable; slightly acid; clear, smooth boundary.
A2--4 to 8 inches, brown (10YR 5/3) silt loam; weak, thick, platy structure parting to moderate, medium, subangular blocky structure; friable; contains some very dark grayish-brown (10YR 3/2) material from the A1 horizon that has been mixed with the material in this horizon by worm action; medium acid; clear, wavy boundary.
B1t--8 to 11 inches, dark-brown (10YR 4/3) light silty clay loam; moderate, medium, subangular blocky structure; discontinuous clay films in lower part of horizon; friable; strongly acid; clear, wavy boundary.
IIB2t--11 to 20 inches, dark-brown (7.5YR 4/4) silty clay; strong, medium, subangular blocky structure; continuous clay films; firm; few pebbles of dolomite; few very dark grayish-brown (10YR 3/2) stains of organic matter; medium acid; gradual, wavy boundary.
IIB3--20 to 25 inches, dark-brown (7.5YR 4/3) silty clay loam; strong, medium, subangular blocky structure; discontinuous clay films; firm; few very dark grayish-brown (10YR 3/2) stains of organic matter; few pebbles of dolomite; neutral; clear, wavy boundary.
IIC--25 to 60 inches, brown (7.5YR 5/4) silty clay loam; weak, coarse, prismatic structure parting to massive; few, thin, discontinuous clay films on the vertical faces of peds; firm; few very dark grayish-brown (10YR 3/2) stains of organic matter in the upper part of horizon; patches of segregated lime; few pebbles of dolomite and chips of dark shale; strongly calcareous.

The A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2), and it ranges

from 3 to 5 inches in thickness. The A2 horizon ranges from 3 to 6 inches in thickness. The B horizon has a hue of 7.5YR to 10YR. The mantle of silt is generally 8 to 14 inches thick, and the solum is commonly 22 to 28 inches thick. In cultivated areas reaction of the solum is neutral or mildly alkaline.

The Ozaukee soils occur with somewhat poorly drained Mequon and poorly drained Ashkum soils. They are somewhat coarser textured and have a browner subsoil and substratum than the Kewaunee soils. The Ozaukee soils have formed in finer textured glacial till than the Hochheim and Theresa soils.

Ozaukee silt loam, 2 to 6 percent slopes (OuB).--This soil has the profile described as representative of the Ozaukee series. Runoff is medium, and erosion is a slight hazard.

Included with this soil in mapping were small areas of Morley silt loam, 2 to 6 percent slopes; Saylesville silt loam, 2 to 6 percent slopes; and a Mequon silt loam that has slopes of 2 to 6 percent. Also included were some moderately eroded areas.

Much of the acreage of this Ozaukee soil is used for the crops commonly grown in the survey area, and a small acreage is in trees or pasture. A large acreage is used for housing developments and related uses. (Capability unit IIe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Ozaukee silt loam, 2 to 6 percent slopes, eroded (OuB2).--This soil has lost part of its original surface layer as the result of moderate erosion. The present plow layer has some dark-brown silty clay from the subsoil mixed with the remaining original surface soil. Good tilth is difficult to maintain, and germination of seeds is likely to be poor. Because runoff is medium, further erosion is a slight hazard. This soil absorbs water a little more slowly than the soil for which a profile is described as representative of the Ozaukee series.

Included with this soil in mapping were small areas of Morley silt loam, 2 to 6 percent slopes, and of a Mequon silt loam that has slopes of 2 to 6 percent. A few areas that are not eroded or that are only slightly eroded were also included.

Part of the acreage of this Ozaukee soil is used for the crops commonly grown in the survey area, and part is used as woodland or pasture. In addition, a large acreage is used for housing developments and related purposes. (Capability unit IIe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Ozaukee silt loam, 6 to 12 percent slopes, eroded (OuC2).--This soil has lost part of its original surface layer as the result of moderate erosion. The present plow layer has some dark-brown silty clay from the subsoil mixed with the remaining original surface soil. Good tilth is difficult to maintain, and germination of seeds is likely to be poor. Runoff is medium, and further erosion is a moderate hazard. This soil absorbs water a little more slowly than the soil for which a profile is described as representative of the Ozaukee series.

Included with this soil in mapping were small areas of Morley silt loam, 6 to 12 percent slopes, eroded; some severely eroded areas; and areas that are not eroded or are only slightly eroded.

Part of the acreage of this Ozaukee soil is used for the crops commonly grown in the survey area. A large acreage is used for housing developments and related purposes. (Capability unit IIIe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Ozaukee silt loam, 12 to 20 percent slopes, eroded (OuD2).--The plow layer of this soil has some dark-brown silty clay from the subsoil mixed with the remaining original surface soil. Runoff is rapid, and further erosion is a severe hazard. This soil absorbs water a little more slowly than the soil for which a profile is described as representative of the Ozaukee series.

Included with this soil in mapping were small areas that are severely eroded, and small areas that are not eroded or that are only slightly eroded.

This Ozaukee soil was formerly used for the crops commonly grown in the survey area. A large part of the acreage is now in residential developments and related uses. Where crops are still grown, tillage should be kept to a minimum. (Capability unit IVe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Palms Series

Very poorly drained organic soils that consist of the decomposed residue of water-tolerant plants underlain by loam are in the Palms series. These soils are in old, shallow glacial lakebeds. The native vegetation was mainly sedges and reeds.

In a typical profile, the surface layer is black muck that is neutral in reaction and is about 8 inches thick. The next layer is black peaty muck that is also neutral in reaction and is about 18 inches thick. The substratum is very dark grayish-brown mucky sandy loam that is neutral in reaction, over dark-gray loam that is slightly calcareous.

The Palms soils have moderately rapid permeability and very high available water capacity. Ground water is at or near the surface during most of the year. Natural fertility is low.

Typical profile of Palms muck (0 to 2 percent slopes) (SW1/4 NE1/4 sec. 14, T. 5 N., R. 18 E.):

1--0 to 8 inches, black (10YR 2/1) muck; moderate, medium, granular structure; friable; neutral; clear, wavy boundary.
2--8 to 12 inches, black (10YR 2/1) peaty muck; moderate, medium, subangular blocky structure breaking to moderate, medium, granular structure; friable; neutral; clear, wavy boundary.
3--12 to 26 inches, black (10YR 2/1) peaty muck; massive; friable; many, fine, fibrous roots,

stems, and leaves that break down easily when rubbed between the fingers; neutral; clear, wavy boundary.

IIC1--26 to 30 inches, very dark grayish-brown (2.5Y 3/2) mucky sandy loam; massive; friable; many remnants of disintegrated roots; neutral; clear, wavy boundary.

IIC2g--30 to 60 inches, dark-gray (5Y 4/1) loam; massive; friable; slightly calcareous; clear, wavy boundary.

The organic soil ranges from 12 to 50 inches in thickness and from slightly acid to mildly alkaline in reaction. All the organic material is muck in some areas. In places all the organic horizons contain small snail shells and remnants of plants.

The Palms soils have formed in shallower deposits of organic material than the Houghton soils. Unlike the Adrian, Ogden, and Rollin soils, which also consist of organic material, the Palms soils are underlain by loam.

Palms muck (0 to 2 percent slopes) (Pa).--This is the only soil of the Palms series mapped in the survey area. It is suited to many of the crops commonly grown in the survey area if adequate drainage is established and maintained. In areas that are drained and used for cultivated crops, soil blowing and subsidence are hazards.

Included with this soil in mapping were small areas where slopes are steeper than 2 percent. Also included were small areas of Ogden muck, Adrian muck, and Houghton muck, 0 to 2 percent slopes.

Wetness is the major limitation to use of this Palms soil for crops. Cropping can be intensive, however, if drainage is provided, if management is good, and if practices are used that will protect this soil from subsidence and soil blowing. Only part of the acreage has been cultivated, but a considerable acreage is used for crops, mainly corn vegetables, and sod. (Capability unit IIw-8; woodland group 10; wildlife group 6; recreation group 9; shrub and vine group 3)

Pella Series

In the Pella series are poorly drained, silty soils that have a silty clay loam subsoil underlain by loam. These soils occupy low drainageways, and they are also on broad, depressed flats. The areas in which they occur are generally irregular in shape and range from less than 20 to more than several hundred acres in size. The native vegetation was water-tolerant grasses and a deciduous forest consisting mainly of elm.

In a typical profile the surface layer is black silt loam that is neutral in reaction and is about 11 inches thick. The subsoil is about 27 inches thick. The upper part of the subsoil is gray, mottled silty clay loam that is neutral in reaction. The middle part is olive-gray and yellowish-brown, mottled silty clay loam that is mildly alkaline and slightly calcareous. The lower part is olive-gray, mottled heavy silt loam that is slightly calcareous. A substratum of olive-gray, mottled gritty silt loam over light-gray loam underlies the subsoil. The substratum is strongly calcareous.

The Pella soils have moderately slow permeability and high available water capacity. Ground water is at or near the surface throughout most of the year. These soils are generally difficult to drain. Natural fertility is high.

Typical profile of Pella silt loam (0 to 2 percent slopes) (NE1/4 SE1/4 sec. 27, T. 7 N., R. 19 E.):

Ap--0 to 8 inches, black (N 2/0) silt loam; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A1--8 to 11 inches, black (10YR 2/1) heavy silt loam; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

B1g--11 to 17 inches, gray (5Y 5/1) silty clay loam; few, fine, distinct, olive (5Y 5/4) mottles; moderate, fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

B21g--17 to 22 inches, olive-gray (5Y 4/2) silty clay loam; common, medium, prominent, yellowish-brown (10YR 5/8) mottles; moderate, medium, subangular blocky structure; mildly alkaline; clear, wavy boundary.

B22g--22 to 30 inches, olive-gray (5Y 5/2) silty clay loam; many, medium, prominent, yellowish-brown (10YR 5/8) mottles; moderate, medium, subangular blocky structure; friable; slightly calcareous; gradual, wavy boundary.

B3g--30 to 38 inches, olive-gray (5Y 5/2) heavy silt loam; many, medium, prominent, yellowish-brown (10YR 5/8) mottles; weak, coarse, subangular blocky structure; friable; slightly calcareous; gradual, wavy boundary.

C1g--38 to 54 inches, olive-gray (5Y 5/2) gritty silt loam; many, medium, prominent, yellowish-brown (10YR 5/8) mottles; weak, coarse, subangular blocky structure to structureless (massive); friable; strongly calcareous; gradual, wavy boundary.

IIC2g--54 to 62 inches, light-gray (5Y 6/1) loam; massive; friable; few pebbles of dolomite; strongly calcareous.

The A horizon is black (N 2/0) to very dark brown (10YR 2/2), and it ranges from 10 to 15 inches in thickness. The mantle of silt ranges from 40 to 60 inches in thickness. Tne entire solum has formed in this mantle of silt. It is therefore silty throughout, and the B2g horizon is generally silty clay loam. The IIC2g horizon is calcareous loam till or lacustrine deposits. The reaction of the solum ranges from neutral to moderately alkaline.

The Pella soils occur with well drained Dodge, moderately well drained Mayville, and somewhat poorly drained Kendall and Lamartine soils. They have formed in a thicker mantle of silt and have a thicker solum than the Brookston soils. Their solum is

coarser textured than that of the Montgomery soils, and they lack the substratum of lacustrine silt and fine sand that is typical of the Colwood soils.

Pella silt loam (0 to 2 percent slopes) (Ph).--This soil is subject to flooding or ponding in spring and during periods of heavy rainfall. Runoff is very slow.

Included with this soil in mapping were small areas of Montgomery silty clay loam, Colwood silt loam, and Brookston silt loam.

Wetness is the major limitation of this Pella soil for crops. This soil is suited to the crops commonly grown in the area, however, if adequate drainage is established. Drainage is difficult, for this soil does not drain well, even after tile drains or open ditches are installed. Part of the acreage is used for crops, but most of it is in pasture or trees. (Capability unit IIw-1; woodland group 7; wildlife group 5; recreation group 7; shrub and vine group 3)

Pella Series, Moderately Shallow Variant

Soils of the Pella series, moderately shallow variant, are poorly drained, silty soils that have a silty clay loam subsoil underlain by dolomite bedrock. These soils lie in low, broad depressions. They occur in areas where the bedrock is generally within 40 inches of the surface. The native vegetation was water-tolerant grasses and a deciduous forest consisting mainly of elm.

In a typical profile, the surface layer is very dark gray, mildly alkaline silt loam about 7 inches thick. The subsurface layer is very dark gray silty clay loam that is neutral in reaction and is about 4 inches thick. The subsoil is about 19 inches thick. The upper part of the subsoil is gray to olive-gray, mottled silty clay loam that is neutral or mildly alkaline in reaction. The lower part is light olive-gray, mottled silty clay loam that is slightly calcareous. Bedrock of cracked dolomite is at a depth of about 30 inches.

Soils of the Pella series, moderately shallow variant, have moderately slow permeability and moderate available water capacity. Ground water is at or near the surface throughout most of the year. Draining these soils is generally difficult. Natural fertility is high.

Typical profile of Pella silt loam, moderately shallow variant (0 to 2 percent slopes) (NW1/4 SE1/4 sec. 18, T. 8 N., R. 20 E.):

Ap--0 to 7 inches, very dark gray (10YR 3/1) silt loam; weak, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

A3--7 to 11 inches, very dark gray (10YR 3/1) silty clay loam; few, fine, prominent, yellowish-brown (10YR 5/6) mottles; moderate, medium, granular structure; neutral; clear, wavy boundary.

B21g--11 to 17 inches, gray (5Y 5/1) to olive-gray (5Y 5/2) silty clay loam; few, fine, prominent, yellowish-brown (10YR 5/4 and 5/6) mottles; moderate, medium, subangular blocky structure; thin, discontinuous clay films; slightly plastic; neutral; gradual, wavy boundary.

B22g--17 to 28 inches, gray (5Y 5/1) silty clay loam; few, fine, prominent, yellowish-brown (10YR 5/6 and 5/8) mottles; moderate, medium, angular blocky structure; slightly plastic; mildly alkaline; gradual, wavy boundary.

B3g--28 to 30 inches, light olive-gray (5Y 6/2) heavy silt loam; common, medium, prominent, yellowish-brown (10YR 5/6) and distinct, dark yellowish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure; slightly sticky; few fragments of dolomite; slightly calcareous; abrupt, smooth boundary.

IIR--30 inches, hard, thinly bedded, cracked dolomitic bedrock that is many feet thick.

The A horizon is black (N 2/0) to very dark gray (10YR 3/1), and it ranges from 10 to 15 inches in thickness. Thickness of the mantle of silt and depth to bedrock are both commonly 24 to 40 inches, but bedrock crops out at the surface in some places. Texture of the B3g horizon ranges from loam to clay loam, and thickness of that horizon ranges from 2 to 4 inches. Reaction of the solum ranges from slightly acid to moderately alkaline.

Soils of the Pella series, moderately shallow variant, occur with well-drained Knowles soils and with somewhat poorly drained soils of the Ritchey series, mottled subsoil variant.

Pella silt loam, moderately shallow variant (Pm).--This soil is subject to flooding or ponding in spring and during periods of heavy rainfall. Runoff is very slow.

Included with this soil in mapping were small areas of Pella silt loam and Ritchey silt loam, mottled subsoil variant.

Wetness and bedrock at a depth of less than 40 inches are the major limitations to use of this soil for crops. Establishing drainage is difficult because the bedrock hinders installation of tile drains and open ditches. Wetness and bedrock near the surface are also severe limitations to use of this soil for residential developments and related purposes. Most of the acreage is in pasture or trees. (Capability unit IIIw-3; woodland group 7; wildlife group 5; recreation group 7; shrub and vine group 3)

Pistakee Series

In the Pistakee series are somewhat poorly drained, silty soils that occupy narrow areas in drainageways and at the bases of slopes. These soils consist of moderately light colored, silty alluvium that was deposited over an older buried

soil. The native vegetation was a deciduous forest consisting mainly of oak, elm, and hickory.

In a typical profile, the surface layer is dark grayish-brown silt loam that is neutral in reaction and is about 7 inches thick. The surface layer is underlain at depths between 7 and 30 inches by dark grayish-brown silt loam that also is neutral in reaction and has mottles in the lower part. A layer of grayish-brown, mottled silt loam is between depths of 30 and 36 inches. A buried soil consisting of very dark gray, mildly alkaline silty clay loam underlies the layers of silt loam.

The Pistakee soils are moderately permeable and have high available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is high.

Typical profile of Pistakee silt loam, 1 to 3 percent slopes (NW1/4 NE1/4 sec. 1, T. 6 N., R. 18 E.):

A11--0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, medium, granular structure; friable; neutral; abrupt, wavy boundary.

A12--7 to 24 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, medium, platy structure; friable; very dark brown (10YR 2/2) stains of organic matter; neutral; gradual, wavy boundary.

A13--24 to 30 inches, dark grayish-brown (10YR 4/2) silt loam; common, fine, distinct, dark-brown (7.5YR 4/4) and light brownish-gray (2.5Y 6/2) mottles; moderate, thin, platy structure; friable; neutral; gradual, wavy boundary.

A14--30 to 36 inches, grayish-brown (10YR 5/2) silt loam; common, fine, prominent, brownish-yellow (10YR 6/6) mottles; weak, thin, platy structure; neutral; abrupt, smooth boundary.

A1b--36 to 48 inches, very dark gray (10YR 3/1) silty clay loam; massive; slightly sticky; mildly alkaline.

IIB2--48 to 60 inches, dark-brown (10YR 4/3) heavy loam; massive; friable; moderately alkaline.

The silty alluvium ranges from 20 to 40 inches in thickness, and it contains thin layers of loamy material in places. The alluvium is commonly dark grayish brown (10YR 4/2), but in places it contains thin layers that are very dark grayish brown (10YR 3/2). The low chroma colors in the upper part of the profile are the result of the kind of material in which these soils formed; they are not the result of poor drainage. The A1b horizon ranges from light silt loam to heavy silty clay loam.

The Pistakee soils occur with well drained or moderately well drained Juneau soils. They have formed in a lighter colored, thinner deposit of silty alluvium than the Lawson soils.

Pistakee silt loam, 1 to 3 percent slopes (PrA).--This is the only soil of the Pistakee series mapped in the survey area. It receives runoff from the surrounding slopes, and it is subject to occasional flooding. Ponding generally occurs in spring and during periods of heavy rainfall.

Included with this soil in mapping were small areas of a Juneau silt loam having slopes of 0 to 2 percent, and small areas of Wet alluvial land.

Wetness is the major limitation to use of this Pistakee soil for crops, but erosion is also a slight hazard in the more sloping areas. Most of the acreage is used for the crops commonly grown in the survey area. A small acreage is in trees or pasture. (Capability unit IIw-2; woodland group 7; wildlife group 5; recreation group 8; shrub and vine group 3)

Ritchey Series

In the Ritchey series are well-drained soils that occupy ground moraines, mainly in the northeastern part of Waukesha County. These are silty soils that have a subsoil of silty clay loam over clay loam, underlain by dolomite bedrock that generally is within 20 inches of the surface. The native vegetation was a deciduous forest consisting mainly of oak and hickory.

In a typical profile, the surface layer is dark grayish-brown, slightly acid silt loam about 6 inches thick. The subsoil is about 12 inches thick. The upper part of the subsoil is dark yellowish-brown, slightly acid silt loam; the middle part is dark-brown, medium acid silty clay loam; and the lower part is dark-brown clay loam that is neutral in reaction or is slightly calcareous and contains fragments of rock. Bedrock is at a depth of about 18 inches.

The Ritchey soils are moderately permeable and have low available water capacity. Natural fertility is low.

Typical profile of Ritchey silt loam, 1 to 6 percent slopes (NE1/4 SE1/4 sec. 23, T. 7 N., R. 18 E.):

Ap--0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

B1--6 to 9 inches, dark yellowish-brown (10YR 4/4) heavy silt loam; moderate, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21t--9 to 13 inches, dark-brown (7.5YR 4/4) silty clay loam; moderate, medium, subangular blocky structure; thin, continuous clay films; firm; medium acid; clear, wavy boundary.

IIB22t--13 to 17 inches, dark-brown (7.5YR 4/4) clay loam; strong, medium, subangular blocky structure; thick, continuous clay films; very firm; few pebbles of dolomite; neutral; clear, wavy boundary.

IIB3--17 to 18 inches, dark-brown (7.5YR 4/4) clay loam; weak, medium, subangular blocky structure; firm; few fragments of dolomite; slightly calcareous; abrupt, wavy boundary.

IIIR--18 to 60 inches, bedrock of hard, thinly bedded, cracked dolomite.

In areas that have not been cultivated, the A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and ranges from 2 to 4 inches in thickness. The A2 horizon in uncultivated areas is generally brown (10YR 5/3) and is 2 to 5 inches thick. The IIB3 horizon is 1 to 3 inches thick, and it ranges from heavy loam to clay in texture. Depth to bedrock ranges from 8 to 20 inches, but the depth is typically between 14 and 20 inches. In places bedrock crops out at the surface.

The Ritchey soils have a thinner solum than the Knowles soils, and they are underlain by dolomite bedrock that is nearer the surface than that underlying the Knowles soils.

Ritchey silt loam, 1 to 6 percent slopes (RkB).--This soil has the profile described as representative of the Ritchey series. Runoff is slow to medium, and erosion is a slight hazard. This soil is also droughty.

Included with this soil in mapping were small areas of Knowles silt loam, 2 to 6 percent slopes, and a few fairly large areas that are moderately eroded. Also included were some areas where dolomite crops out at the surface or is within a few inches of the surface.

This Ritchey soil is mainly in pasture or trees, but a small areage is used for crops. (Capability unit IIIe-3; woodland group 5; wildlife group 3; recreation group 2; shrub and vine group 2)

Ritchey silt loam, 6 to 12 percent slopes, eroded (RkC2).--This soil has lost part of its original surface layer through erosion. The present plow layer consists partly of dark yellowish-brown material from the subsoil and partly of the remaining original surface soil. Runoff is medium, and further erosion is a moderate hazard. Droughtiness is also a hazard to crops.

Included with this soil in mapping were small areas of Knowles silt loam, 2 to 6 percent slopes, and fairly large areas that are not eroded or are only slightly eroded. Also included were areas where bedrock crops out at the surface or is within a few inches of the surface.

Most of the acreage is in pasture. A small acreage is wooded or is used for crops. (Capability unit IVe-3; woodland group 5; wildlife group 3; recreation group 2; shrub and vine group 2)

Ritchey silt loam, 12 to 30 percent slopes (RkE).--This is a droughty soil that occurs in rather small areas. Runoff is rapid, and erosion is a severe hazard.

Included with this soil in mapping were some moderately eroded areas and some areas where bedrock crops out or is within a few inches of the surface.

Limitations are severe to use of this soil for crops. Most of the acreage is in pasture or trees. (Capability unit VIe-3; woodland group 5; wildlife group 3; recreation group 2; shrub and vine group 2)

Ritchey Series, Mottled Subsoil Variant

Soils of the Ritchey series, mottled subsoil variant, are somewhat poorly drained. They are silty soils that have a subsoil of silty clay loam over clay loam that is underlain by dolomite bedrock. These soils are in depressions and drainageways. They are on ground moraines, mainly in the northeastern part of Waukesha County, where bedrock typically is within 29 inches of the surface. The native vegetation was a deciduous forest consisting mostly of oak, hickory, and elm.

In a typical profile, the surface layer is dark grayish-brown, slightly acid silt loam about 8 inches thick. The subsoil is about 21 inches thick. It is dark-brown, slightly acid silt loam in the upper part; dark-brown, mottled, slightly acid silty clay loam in the middle part; and dark-brown and yellowish-brown, mottled clay loam in the lower part. The lower part contains fragments of rock and is neutral in reaction or slightly calcareous. Dolomite bedrock is at a depth of about 29 inches.

Soils of the Ritchey series, mottled subsoil variant, are moderately permeable and have moderate available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is moderate.

Typical profile of Ritchey silt loam, mottled subsoil variant, 1 to 3 percent slopes (NE1/4 NE1/4 sec. 25, T. 8 N., R. 19 E.):

Ap--0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; weak, coarse, subangular blocky structure parting to moderate, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

B1--8 to 12 inches, dark-brown (10YR 4/3) heavy silt loam; moderate, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21t--12 to 17 inches, dark-brown (10YR 4/3) silty clay loam; few, fine, faint, grayish-brown (10YR 5/2) and distinct, yellowish-brown (10YR 5/6) mottles; moderate, fine, subangular blocky structure; thin, continuous clay films; firm; few very dark grayish-brown (10YR 3/2) stains of organic matter; slightly acid; clear, wavy boundary.

IIB22t--17 to 26 inches, dark-brown (10YR 4/3) heavy clay loam; many, fine, faint, grayish-brown (10YR 5/2) and prominent, yellowish-brown (10YR 5/6 and 5/8) mottles; strong, moderate, subangular blocky structure; thick, continuous clay films; very firm; few very dark grayish-brown (10YR 3/2) stains of organic matter; few small pebbles of dolomite; neutral; gradual, wavy boundary.

IIB3--26 to 29 inches, yellowish-brown (10YR 5/4) clay loam; many, fine, distinct, grayish-brown (10YR 5/2) and yellowish-brown

(10YR 5/6 and 6/6) mottles; moderate, medium, subangular blocky structure; firm; few fragments of dolomite; slightly calcareous; abrupt, wavy boundary.

IIIR--29 inches, bedrock of hard, platy, cracked dolomite.

In areas that have not been cultivated, the A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and ranges from 3 to 5 inches in thickness. The A2 horizon in uncultivated areas is generally brown (10YR 5/3) and is 2 to 6 inches thick. The part of the B2 horizon that formed in a mantle of silt is generally silty clay loam, and the part that formed in glacial till is clay loam. Texture of the IIB3 horizon ranges from heavy loam to clay.

Soils of the Ritchey series, mottled subsoil variant, occur with normal well-drained Ritchey soils. They also occur with Pella silt loam, moderately shallow variant.

Ritchey silt loam, mottled subsoil variant, 1 to 3 percent slopes (R1A).--This soil is rather wet, and establishing drainage is difficult. Because of the bedrock near the surface, installing tile drains and open ditch drains is generally too costly to be worth while.

Included with this soil in mapping were small areas of Knowles silt loam, 0 to 2 percent slopes, and Pella silt loam, moderately shallow variant.

Most of the acreage is wooded or in pasture. A small acreage is used for crops. (Capability unit IIIw-3; woodland group 7; wildlife group 5; recreation group 6; shrub and vine group 3)

Rodman Series

In the Rodman series are excessively drained, gravelly loam soils underlain by calcareous, stratified sand and gravel. These soils are on terrace escarpments of pitted outwash plains and on the kames, eskers, and steep convex side slopes associated with the Kettle Moraine in Waukesha County. The native vegetation was a sparse stand of hardwoods, mainly bur oak and hickory, and prairie grasses in the openings between the trees.

In a typical profile, the surface layer is black, mildly alkaline gravelly loam about 4 inches thick. The subsoil is dark-brown, mildly alkaline gravelly sandy loam, also about 4 inches thick. The substratum is pale-brown, loose, strongly calcareous gravel.

The Rodman soils have very rapid permeability and very low available water capacity. Natural fertility is very low.

Typical profile of a moderately steep Rodman gravelly loam (SW1/4 NW1/4 sec. 33, T. 5 N., R. 17 E.):

A--0 to 4 inches, black (10YR 2/1) gravelly loam; weak, fine, granular structure; friable; mildly alkaline; clear, smooth boundary.

B--4 to 8 inches, dark-brown (10YR 3/4) gravelly sandy loam; weak, medium, subangular blocky structure; friable; mildly alkaline; clear, smooth boundary.

C--8 to 72 inches, pale-brown (10YR 6/3) gravel and thin layers of coarse sand; single grain; loose; strongly calcareous.

The A horizon is black (10YR 2/1) to very dark brown (10YR 2/2) and ranges from 3 to 5 inches in thickness. In some places the B horizon is less than 2 inches thick, and in others it is absent. The C horizon ranges from gravelly sand to gravel that contains many cobblestones and stones.

The Rodman soils occur in small, intricate patterns with the Casco soils. They are mapped only in complexes with the Casco soils, and these complexes are described under the Casco series.

Rollin Series

In the Rollin series are very poorly drained organic soils that consist of the well-decomposed residue of water-tolerant plants underlain by marl. These soils occupy old, shallow glacial lakebeds and bays. The native vegetation was mainly reeds and sedges.

In a typical profile, the surface layer is black, mildly alkaline muck about 11 inches thick. Just beneath the surface layer is a layer of very dark grayish-brown to very dark brown, mildly alkaline muck about 19 inches thick. The substratum is white and light-gray, friable, highly calcareous marl that contains many small snail shells and fragments of shells.

The Rollin soils have moderately slow permeability and very high available water capacity. Ground water is at or near the surface throughout most of the year. Natural fertility is low.

Typical profile of Rollin muck, deep (SE1/4 NE1/4 sec. 20, T. 6 N., R. 19 E.):

1--0 to 11 inches, black (10YR 2/1) muck; weak, medium, subangular blocky structure breaking to weak, medium, granular structure; friable; contains a few remains of sedges, grasses, and forbs; mildly alkaline; gradual, wavy boundary.

2--11 to 30 inches, very dark grayish-brown (10YR 3/2) to very dark brown (10YR 2/2) muck; weak, coarse, subangular blocky structure; friable; contains many remains of sedges and grasses that break down easily when rubbed between the fingers; mildly alkaline; abrupt, smooth boundary.

IIC1--30 to 42 inches, white (2.5Y 8/2) marl; massive; very friable; highly calcareous; gradual, wavy boundary.

IIC2--42 to 60 inches, light-gray (2.5Y 7/1) marl; massive; very friable; many small snail shells and fragments of shells; highly calcareous.

In some places the layers of organic material contain small snail shells like those in the substratum. Depth to marl ranges from 12 to 40 inches.

The Rollin soils, like the Houghton, have formed in organic deposits, but the deposit of organic material in which they formed is thinner than that in which the Houghton soils formed. Unlike the Ogden, Palms, and Adrian soils, which have a substratum of clayey, loamy, or sandy material, the Rollin soils have a substratum of marl.

Rollin muck, deep (0 to 2 percent slopes) (Ru).--This soil has the profile described as representative of the Rollin series. Marl is at a depth of 24 to 40 inches. Where artificial drainage has been installed, this soil is susceptible to soil blowing and subsidence.

Included with this soil in mapping were small areas of Houghton muck, 0 to 2 percent slopes; Adrian muck; and Rollin muck, shallow.

Wetness is the major limitation to use of this deep Rollin soil for crops. Only a small part of the acreage has been cultivated and is used for crops. The rest is mainly used as habitat for wildlife. (Capability unit IVw-7; woodland group 10; wildlife group 6; recreation group 9; shrub and vine group 3)

Rollin muck, shallow (0 to 2 percent slopes) (Rv).--This soil has a profile similar to the one described as representative of the Rollin series, except that marl is at a depth of only 12 to 24 inches. The marl is so near the surface that some of it is likely to be mixed with the surface soil during tillage. Then, the plow layer becomes extremely calcareous. Where drainage has been established and this soil is cultivated, soil blowing and subsidence are hazards.

Included with this soil in mapping were small areas of Rollin muck, deep; Houghton muck, 0 to 2 percent slopes; and Adrian muck.

Wetness is the major limitation to use of this shallow Rollin soil for crops. Only a small acreage has been cultivated. The rest is used as wildlife habitat. (Capability unit Vw-7; woodland group 10; wildlife group 6; recreation group 9; shrub and vine group 3)

Rough Broken Land

Rough broken land (Ry) is a steep miscellaneous land type that is mainly in the northern part of Milwaukee County. It occupies the banks adjacent to Lake Michigan, and it also occurs on the side slopes of deep ravines that are adjacent to these banks. Soil material occasionally breaks off and slumps down the sides of the banks, leaving raw soil exposed. Trees that help to keep this land type fairly stable grow in places, but the surface is bare in most places.

This land type is entirely within areas used for housing developments and related purposes. Mainly, it is used as a sanctuary for songbirds and small fur-bearing animals. The areas also have value because they are at an elevation where a panoramic view of Lake Michigan and its shoreline can be obtained. The present uses are probably the best ways of utilizing this land type. (Capability unit VIIIs-10; woodland group 11; wildlife group 8; recreation group 10; shrub and vine group 4)

St. Charles Series

The St. Charles series consists of soils that, in general, are well drained. These are silty soils that have a silty clay loam subsoil underlain by calcareous, stratified sand and gravel or sandy loam glacial till. Most of the St. Charles soils in the survey area are underlain by calcareous, stratified sand and gravel. Some of these soils have mottling in the subsoil, indicating that they are moderately well drained. The St. Charles soils that have a gravelly substratum generally occur on broad glacial outwash plains. Those that have mottling in the subsoil are in small depressions, on nearly level ridgetops and till plains, and on the foot slopes of uplands. Most of the areas have an irregular shape. The native vegetation was a deciduous forest consisting mainly of oak, hickory, maple, and basswood.

In a typical profile of a St. Charles soil that has a gravelly substratum, the surface layer is dark grayish-brown or very dark grayish-brown, slightly acid silt loam about 8 inches thick. The subsurface layer is brown, slightly acid silt loam about 4 inches thick. The subsoil is about 46 inches thick. The upper part of the subsoil is dark yellowish-brown, medium acid to strongly acid silt loam that grades to silty clay loam with increasing depth. The middle part of the subsoil is dark yellowish-brown, strongly acid silty clay loam. The lower part is dark-brown, mildly alkaline gravelly clay loam. A substratum of pale-brown, loose, slightly calcareous, stratified sand and gravel underlies the subsoil.

The St. Charles soils are moderately permeable and have high available water capacity. Natural fertility is high.

Typical profile of St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes (SE1/4 SE1/4 sec. 9, T. 7 N., R. 18 E.):

Ap--0 to 8 inches, dark grayish-brown (10YR 4/2) to very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2--8 to 12 inches, brown (10YR 5/3) silt loam; weak, thin, platy structure parting to weak, very fine, granular structure; friable; slightly acid; clear, wavy boundary.

B1--12 to 15 inches, dark yellowish-brown (10YR 4/4) silt loam; moderate, fine, subangular blocky structure; friable; medium acid; clear, wavy boundary.

B21t--15 to 26 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; moderate, fine,

subangular blocky structure; thin, discontinuous clay films; friable; strongly acid; gradual, wavy boundary.

B22t--26 to 36 inches, dark yellowish-brown (10YR 4/4) silty clay loam; weak, medium, prismatic structure parting to moderate, fine, subangular blocky structure; thick, continuous clay films; firm; strongly acid; gradual, wavy boundary.

B23t--36 to 45 inches, dark yellowish-brown (10YR 4/4) silty clay loam; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; thick, continuous clay films; firm; few dark-brown (10YR 3/3) stains of organic matter; strongly acid; gradual, wavy boundary.

B31--45 to 49 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; weak, medium, prismatic structure; thin, discontinuous clay films; firm; strongly acid; clear, wavy boundary.

IIB32--49 to 58 inches, dark-brown (10YR 3/3) gravelly clay loam; massive; firm; mildly alkaline; clear, wavy boundary.

IIC--58 to 68 inches, pale-brown (10YR 6/3), stratified sand and gravel; single grain; loose; slightly calcareous.

In areas that have not been cultivated, the A1 horizon is very dark brown (10YR 2/2) to dark grayish brown (10YR 4/2), and it ranges from 3 to 5 inches in thickness. The A2 horizon is generally brown (10YR 5/3) and ranges from 4 to 8 inches in thickness. The A horizon and most of the B horizon formed in the mantle of silt, which is 36 to 50 inches thick. In places a thin layer of windblown sand overlies the mantle of silt, and the surface layer in those areas is sandy loam. The solum is commonly 45 to 60 inches thick. Reaction of the solum ranges from strongly acid to mildly alkaline.

Soils of the St. Charles series that have a gravelly substratum occur with somewhat poorly drained Virgil and poorly drained Drummer soils that have a gravelly substratum. They have a thicker solum than the Fox soils.

St. Charles sandy loam, gravelly substratum, 1 to 3 percent slopes (SaA).--This soil lies east of the Kettle Moraine in the southwestern part of Waukesha County. Its profile is similar to the one described as representative of the St. Charles series, except that the two uppermost layers are sandy loam. Runoff is slow, and erosion is not a hazard or is only a slight hazard.

Included with this soil in mapping were small areas of St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes, and Fox sandy loam, 0 to 2 percent slopes.

If management is good, cropping can be intensive. Nearly all of the acreage is used for crops, and only a small acreage is in pasture or trees. (Capability unit I-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

St. Charles silt loam, 0 to 2 percent slopes (ScA).--This soil has a profile that is similar to the one described as representative of the St. Charles series, but the lower part of the subsoil contains yellowish-brown and grayish-brown mottles and the substratum is loam glacial till. Runoff is slow. This soil is not eroded or is only slightly eroded.

Included with this soil in mapping were small areas of a Mayville silt loam, a Kendall silt loam, and St. Charles silt loam, 2 to 6 percent slopes.

If management is good, row crops can be grown intensively. Nearly all of the acreage is used for crops. (Capability unit I-1; woodland group 1; wildlife group 1; recreation group 1; shrub and vine group 1)

St. Charles silt loam, 2 to 6 percent slopes (ScB).--This soil is on the foot slopes of uplands and on the higher concave side slopes of rises on the till plain. The areas on the foot slopes are long and narrow, and those on the till plain are fan shaped or have an irregular shape. Runoff is medium, and erosion is a slight hazard. The profile is similar to the one described as representative of the St. Charles series, except that yellowish-brown and grayish-brown mottles are in the lower part of the subsoil and the substratum is sandy loam glacial till.

Included with this soil in mapping were small areas of a Mayville silt loam, a Kendall silt loam, and St. Charles silt loam, 0 to 2 percent slopes.

Nearly all of the acreage is used for crops. (Capability unit IIe-1; woodland group 1; wildlife group 1; recreation group 1; shrub and vine group 1)

St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes (SeA).--This soil is in the northwestern part of Waukesha County. Its profile is the one described as representative of the St. Charles series. Runoff is slow, and little or no erosion has taken place.

Included with this soil in mapping were small areas of Fox silt loam, 0 to 2 percent slopes, and a few fairly large areas in which the surface layer is darker colored than normal for the St. Charles soils. Also included were areas in which the lower part of the subsoil is mottled.

If this St. Charles soil is well managed, it can be cropped intensively. Nearly all of the acreage is used for crops, but a small acreage is in pasture or trees. (Capability unit I-1; woodland group 1; wildlife group 1; recreation group 1; shrub and vine group 1)

St. Charles silt loam, gravelly substratum, 2 to 6 percent slopes (SeB).--This soil is not eroded or is only slightly eroded. Runoff is medium, however, and erosion is a slight hazard.

Included with this soil in mapping were small areas of Fox silt loam, 2 to 6 percent slopes, and St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes.

Nearly all of the acreage is used for crops. Only a small acreage is wooded or in pasture. (Capability unit IIe-1; woodland group 1; wildlife group 1; recreation group 1; shrub and vine group 1)

Sandy and Gravelly Land

Sandy and gravelly land (Sf) is a miscellaneous land type that consists of fill areas and of cut or borrow areas. It is mainly within or near areas used for housing developments or related purposes.

In the cut or borrow areas, the entire solum of the soil has been removed by man, and the raw underlying material is exposed. These areas differ from gravel pits in that the side slopes of the adjacent banks have been graded and sloped so that they blend with adjacent less disturbed areas that are accessible for building sites or roads.

The fill areas consist of a layer of fill material, about 1 to 5 feet thick, that is deposited over a mineral soil that is generally somewhat poorly drained to very poorly drained. In some places the fill material covers a well-drained mineral soil, however, and in others it covers an organic soil.

The material in this land type is mainly a mixture of sand and gravel, and it contains only a small amount of fine-textured material. In cut areas the material is generally stratified sand and gravel. In fill areas the material includes some cinders, boulders, and rubble or other inorganic trash.

The soil material in this land type has lower available water capacity and greater bearing strength than that in Clayey land and Loamy land. Limitations and hazards that affect engineering uses are so variable that they can be determined only by onsite investigation. (Capability unit VIIIs-10; woodland group 11; wildlife group 8; recreation group 10; shrub and vine group 4)

Sandy Lake Beaches

Sandy lake beaches (Sfb) is a nearly level miscellaneous land type that extends from the waterline along the shores of Lake Michigan to the foot of the steep banks that border the lake. Where this land type occurs, the sand has been reworked too frequently by wind and wavy action for plants to become established.

This land type consists mostly of light-colored coarse sand, but it contains some gravel in places. The sand is soft and loose, and it is not suited to crops.

Sandy lake beaches is used mainly for swimming beaches and other recreational purposes. It appears to be better suited to these uses than to utilization for other purposes. (Capability unit VIIIs-10; woodland group 11; wildlife group 8; recreation group 10; shrub and vine group 4)

Sawmill Series, Calcareous Variant

Soils of the Sawmill series, calcareous variant, are similar to the typical Sawmill soils, except that free carbonates occur higher in their profile. They consist of dark-colored, silty alluvium, are poorly drained, and are subject to flooding. These soils occur in areas adjacent to the major streams. The native vegetation was water-tolerant grasses and sedges.

In a typical profile, the surface layer is black, mildly alkaline silt loam about 9 inches thick. The subsurface layer is black, moderately alkaline silty clay loam, also about 9 inches thick. The subsurface layer is underlain by several layers of silty clay loam that differ slightly in color or in other ways. The uppermost layer of the soil beneath the subsurface layer is black, moderately alkaline and slightly calcareous silty clay loam. The middle layers are black to very dark gray, moderately alkaline and slightly calcareous silty clay loam. The lowest layer is dark-gray, moderately alkaline and highly calcareous silty clay loam that extends to a depth of about 60 inches.

Soils of the Sawmill series, calcareous variant, have moderately slow permeability and very high available water capacity. Ground water is at or near the surface throughout most of the year. Natural fertility is high.

Typical profile of Sawmill silt loam, calcareous variant (0 to 2 percent slopes) (SE1/4 SW1/4 sec. 20, T. 6 N., R. 19 E.):

Ap--0 to 9 inches, black (N 2/0) heavy silt loam; weak, medium, subangular blocky structure parting to moderate, medium, granular structure; friable; mildly alkaline; abrupt, smooth boundary.

A11--9 to 18 inches, black (N 2/0) silty clay loam; weak, medium, subangular blocky structure parting to moderate, medium, granular structure; friable; moderately alkaline; gradual, wavy boundary.

A12--18 to 24 inches, black (N 2/0) heavy silty clay loam; weak, coarse, prismatic structure parting to moderate, fine, subangular blocky structure; slightly plastic; few, thin, discontinuous clay films; moderately alkaline and slightly calcareous; gradual, wavy boundary.

A13g--24 to 32 inches, black (2.5Y 2/1) to very dark gray (2.5Y 3/1) silty clay loam; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; few, thin, discontinuous clay films; slightly plastic; moderately alkaline and slightly calcareous; gradual, wavy boundary.

A14g--32 to 45 inches, very dark gray (5Y 3/1) gritty silty clay loam; many, fine, distinct, dark-brown (7.5YR 4/4) and prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; slightly plastic; moderately alkaline and slightly calcareous; clear, wavy boundary.

A15g--45 to 60 inches, dark-gray (5Y 4/1) silty clay loam; few, fine, distinct, dark-brown (7.5YR 4/4) mottles; massive; slightly plastic; moderately alkaline and highly calcareous.

Thickness of the individual horizons in the profile ranges from only a few inches to 18 inches. In general, the texture ranges from heavy silt loam to heavy silty clay loam, but the profiles contains thin lenses of loam and sandy loam in places. In some areas a buried soil is at a depth of 40 to 60 inches. Reaction throughout the profile ranges from neutral to moderately alkaline.

Soils of the Sawmill series, calcareous variant, commonly occur with areas of Alluvial land. They are finer textured throughout than is Alluvial land.

Sawmill silt loam, calcareous variant (0 to 2 percent slopes) (Sg).--This soil is frequently flooded in spring and during periods of heavy rainfall. Providing adequate drainage and protection from flooding is generally difficult.

Included with this soil in mapping were small areas of Montgomery silty clay loam and Wet alluvial land.

Wetness and the hazard of flooding are the major limitations to use of this Sawmill soil for crops. Even though corn is grown on a small acreage in some years, this soil is often too wet for the crop to be harvested in fall. Most of the acreage is used for pasture or for wildlife habitat. (Capability unit Vw-14; woodland group 9; wildlife group 5; recreation group 7; shrub and vine group 3)

Saylesville Series

The Saylesville series consists of well drained or moderately well drained, silty soils that have a clay subsoil underlain by stratified, silty and clayey lacustrine deposits. These soils are on river benches and in old glacial lake basins. The native vegetation was a deciduous forest consisting mainly of oak and maple.

In a typical profile, the surface layer is dark grayish-brown silt loam that is neutral in reaction and is about 8 inches thick. The subsoil is about 23 inches thick. It is dark yellowish-brown, slightly acid silty clay loam in the upper part; dark yellowish-brown, slightly acid clay to silty clay in the middle part; and dark yellowish-brown, slightly calcareous silty clay in the lower part. The substratum is brown, firm, strongly calcareous, laminated silty clay and silty clay loam that contain streaks of soft lime.

The Saylesville soils are slowly permeable and have high available water capacity. In some places ground water is less than 5 feet below the surface during wet periods. In other places ground water is seldom less than 5 feet below the surface. Natural fertility is high.

Typical profile of Saylesville silt loam, 2 to 6 percent slopes (NE1/4 SW1/4 sec. 34, T. 5 N., R. 20 E.):

Ap--0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; weak, medium, granular structure; friable; neutral; abrupt, smooth boundary.

B1--8 to 14 inches, dark yellowish-brown (10YR 4/4) silty clay loam; moderate, medium, subangular blocky structure; firm; slightly acid; clear, wavy boundary.

B2t--14 to 26 inches, dark yellowish-brown (10YR 4/4) clay; strong, medium, angular blocky structure; continuous clay films; firm; slightly acid; clear, wavy boundary.

B3--26 to 31 inches, dark yellowish-brown (10YR 4/4) silty clay; weak, medium, prismatic structure parting to moderate, medium, angular blocky structure; discontinuous clay films; firm; slightly calcareous; clear, wavy boundary.

C--31 to 60 inches, brown (10YR 5/3), laminated silty clay and silty clay loam; massive; firm; fine streaks of soft, segregated lime; strongly calcareous.

In areas that have not been cultivated, the A1 horizon is generally very dark grayish brown (10YR 3/2) to very dark brown (10YR 2/2) and ranges from 3 to 4 inches in thickness. The A2 horizon in uncultivated areas is commonly 3 to 6 inches thick and is brown (10YR 5/3). Texture of the B2t horizon is silty clay to clay, and the hue is 7.5YR in some places. In places the C horizon contains lenses of silt and very fine sand. The C horizon has a hue of 7.5YR in some areas.

The Saylesville soils occur with somewhat poorly drained Martinton and poorly drained Montgomery soils. They have slightly finer textured upper horizons than the Hebron soils, and they are finer textured throughout than the Grays soils.

Saylesville silt loam, 0 to 2 percent slopes (ShA).--This soil dries out slowly in spring and after periods of heavy rainfall. Runoff is slow, and little or no erosion has taken place.

Included with this soil in mapping were small areas of a Martinton silt loam that has slopes of 0 to 2 percent, and a Hebron silt loam that has slopes of 0 to 2 percent.

This Saylesville soil is used mostly for the crops commonly grown in the survey area. A small acreage is used as woodland. (Capability unit IIs-7; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Saylesville silt loam, 2 to 6 percent slopes (ShB).--This soil generally remains wet for several days longer in spring and after periods of heavy rainfall than do some well-drained soils. Runoff is medium, and erosion is a slight hazard. The profile is the one described as representative of the Saylesville series.

Included with this soil in mapping were small areas of a Martinton silt loam that has slopes of 2 to 6 percent, and a Hebron silt loam that has slopes of 2 to 6 percent. Also included were a few moderately eroded areas.

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Most of the acreage is used for the crops commonly grown in the survey area. The rest is in trees or pasture. (Capability unit IIe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Saylesville silt loam, 2 to 6 percent slopes, eroded (ShB2).--This soil generally remains wet for several days longer in spring and after periods of heavy rainfall than do some well-drained soils. It has lost part of its original surface layer through moderate erosion. The present surface layer consists partly of dark yellowish-brown material from the subsoil that was mixed with the remaining original surface soil during tillage. The rate of infiltration is slightly lower than that of the soil for which a profile is described as representative of the Saylesville series. Good tilth is difficult to maintain, and germination of seeds is likely to be poor. Runoff is medium. Further erosion is a slight hazard.

Included with this soil in mapping were small areas of a Martinton silt loam that has slopes of 2 to 6 percent, and a few areas that are not eroded or are only slightly eroded.

This Saylesville soil is used mainly for the crops commonly grown in the survey area. (Capability unit IIe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Saylesville silt loam, 6 to 12 percent slopes, eroded (ShC2).--This soil has lost part of its original surface layer through moderate erosion. The present plow layer consists partly of dark yellowish-brown material from the subsoil that was mixed with the remaining original surface soil during tillage. Runoff is medium, and further erosion is a moderate hazard. The rate of infiltration is slightly lower than that of the soil for which a profile is described as representative of the Saylesville series. Good tilth is difficult to maintain, and germination of seeds is likely to be poor.

Included with this soil in mapping were some small severely eroded areas. Also included were fairly large areas that have not been cultivated and that are not eroded or are only slightly eroded.

This Saylesville soil is used mainly for the crops commonly grown in the survey area. (Capability unit IIIe-6; woodland group 2; wildlife group 2; recreation group 3; shrub and vine group 1)

Sebewa Series

In the Sebewa series are poorly drained silt loam soils that have a loamy subsoil underlain by calcareous sand and gravel outwash. These soils occupy areas in low depressions and river basins, and on flats of glacial outwash plains. The native vegetation was mainly elm, oak, soft maple, and water-tolerant grasses.

In a typical profile, the surface layer is very dark brown to very dark grayish-brown, mildly alkaline silt loam about 12 inches thick. The subsurface layer is very dark gray or dark gray, mildly alkaline, mottled silt loam about 2 inches thick. The subsoil is about 18 inches thick. The upper part of the subsoil is dark grayish-brown, mildly alkaline, mottled silt loam. The middle part is gray, mildly alkaline, mottled clay loam. The lower part is yellowish-brown, slightly calcareous gravelly loam. A substratum of grayish-brown, loose, stratified, strongly calcareous sand and gravel underlies the subsoil.

The Sebewa soils are moderately permeable and have moderate available water capacity. Ground water is at or near the surface throughout most of the year. Natural fertility is moderate.

Typical profile of Sebewa silt loam (0 to 2 percent slopes) (SW1/4 NW1/4 sec. 20, T. 6 N., R. 21 E.):

Ap--0 to 7 inches, very dark brown (10YR 2/2) silt loam; weak, fine, subangular blocky structure; friable; mildly alkaline; abrupt, smooth boundary.

A1--7 to 12 inches, very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) silt loam; weak, medium, subangular blocky structure; friable; mildly alkaline; clear, wavy boundary.

A3g--12 to 14 inches, very dark gray (2.5Y 3/1) to dark gray (2.5Y 4/1) silt loam; common, medium, distinct, brown (10YR 4/3) mottles; weak, medium, subangular blocky structure; friable; mildly alkaline; clear, wavy boundary.

B1g--14 to 18 inches, dark grayish-brown (2.5Y 4/2) heavy silt loam; many, medium, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; firm; mildly alkaline; clear, wavy boundary.

IIB2g--18 to 26 inches, gray (5Y 5/1) clay loam; many, medium, prominent, dark-brown (7.5YR 4/4) mottles; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; thin, discontinuous clay films; firm; few pebbles and lime nodules; mildly alkaline; clear, wavy boundary.

IIB3--26 to 32 inches, yellowish-brown (10YR 5/4) gravelly loam; weak, medium, subangular blocky structure; friable; many pebbles and lime nodules; slightly calcareous; clear, wavy boundary.

IIC--32 to 60 inches, grayish-brown (10YR 5/2), stratified sand and gravel; single grain; loose; strongly calcareous.

In areas that have not been cultivated, the color of the A1 horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2), and the thickness of that horizon ranges from 10 to 15 inches. Texture of the IIB2g horizon ranges from gritty silty clay loam to sandy clay loam. In some places the IIC horizon is mostly gravel, and in others it is mostly sand. In some areas that have not been cultivated, the solum is medium acid, but the reaction ranges

to mildly alkaline in areas that have been intensively cultivated. Thickness of the solum ranges from 20 to 40 inches.

The Sebewa soils occur with well-drained Fox and Warsaw soils and with somewhat poorly drained Matherton and Kane soils. They have a thicker solum than the Mussey soils, and they have a finer textured solum than the Gilford soils.

Sebewa silt loam (0 to 2 percent slopes) (Sm).--This is the only soil of the Sebewa series mapped in the survey area. It is subject to flooding or ponding in spring and during periods of heavy rainfall. Runoff is very slow, and erosion is not a hazard or is only a slight hazard.

Included with this soil in mapping were small areas where the surface layer is loam. Also included were small areas of a Mussey soil having a silt loam surface layer; Drummer silt loam, gravelly substratum; and a Matherton silt loam having slopes of 0 to 2 percent.

Wetness is the major limitation to use of this Sebewa soil for crops. Much of the acreage is used for pasture, as woodland, or as habitat for wildlife. An acreage of considerable size is used to grow corn, however, and part of the acreage is used to grow other crops. (Capability unit IIw-5; woodland group 7; wildlife group 5; recreation group 7; shrub and vine group 3)

Theresa Series

The Theresa series consists of well-drained silt loam soils that have a subsoil of silty clay loam over clay loam and are underlain by calcareous loam glacial till. These soils occur in Waukesha County on the convex side slopes of uplands underlain by glacial till. The areas are long and narrow, and they generally extend in a northeast-southwest direction. The native vegetation was a deciduous forest consisting mainly of maple and basswood.

In a typical profile, the surface layer is dark grayish-brown silt loam that is neutral in reaction and is about 8 inches thick. The subsurface layer is brown silt loam that is also neutral in reaction and is about 2 inches thick. The subsoil is about 18 inches thick. The upper part of the subsoil is dark-brown silt loam that is neutral in reaction. The middle part is dark yellowish-brown silty clay loam that is slightly acid. The lower part is dark-brown clay loam that contains pebbles and is neutral and moderately alkaline and is slightly calcareous at a depth of about 24 inches. A substratum of yellowish-brown, friable loam glacial till that is highly calcareous underlies the subsoil.

The Theresa soils are moderately permeable and have high available water capacity. Natural fertility is moderate.

Typical profile of Theresa silt loam, 2 to 6 percent slopes (SW1/4 NW1/4 sec. 34, T. 8 N., R. 19 E.):

Ap--0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2--8 to 10 inches, brown (10YR 5/3) silt loam; moderate, medium, platy structure; friable; neutral; clear, wavy boundary.

B1--10 to 14 inches, dark-brown (10YR 4/3) heavy silt loam; moderate, medium and fine, subangular blocky structure; friable; light-gray (10YR 7/2), bleached silt coatings on the surfaces of some peds; neutral; clear, wavy boundary.

B21t--14 to 17 inches, dark yellowish-brown (10YR 4/4) silty clay loam; moderate, fine, subangular blocky structure; discontinuous clay films; firm; slightly acid; clear, wavy boundary.

IIB22t--17 to 24 inches, dark-brown (7.5YR 4/4) heavy clay loam; strong, fine, angular blocky structure; thick, continuous clay films; very firm; few dark-brown (7.5YR 3/2) stains of organic matter; few small pebbles; neutral; gradual, wavy boundary.

IIB3--24 to 28 inches, dark-brown (7.5YR 4/4) heavy clay loam; moderate, fine, subangular blocky structure; firm; many pebbles of dolomite; moderately alkaline and slightly calcareous; clear, wavy boundary.

IIC--28 to 60 inches, yellowish-brown (10YR 5/4) loam; massive; friable; many pebbles and cobblestones of dolomite; highly calcareous.

In areas that have not been cultivated, the A1 horizon is generally 3 to 6 inches thick and the A2 horizon is 3 to 5 inches thick. Texture of the IIC horizon is typically loam, but it ranges to gravelly sandy loam in places. Thickness of the mantle of silt ranges from 12 to 20 inches, and thickness of the solum ranges from 24 to 32 inches.

The Theresa, Hochheim, and Dodge soils have all formed in similar material, but the mantle of silt in which the upper part of the Theresa solum formed is thicker than that in which the upper part of the Hochheim solum formed and thinner than that in which the upper part of the Dodge solum formed.

Theresa silt loam, 0 to 2 percent slopes (ThA).--This soil is not eroded or is only slightly eroded. Runoff is slow.

Included with this soil during mapping were small areas of Dodge silt loam, 0 to 2 percent slopes; Mayville silt loam, 0 to 2 percent slopes; and Theresa silt loam, 2 to 6 percent slopes. Also included were small areas of a Hochheim soil that has a silt loam surface layer and slopes of 2 to 6 percent.

If management is good, cropping can be intensive. Nearly all of the acreage is used for crops. Only a small acreage remains in trees or is used for pasture. (Capability unit I-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Theresa silt loam, 2 to 6 percent slopes (ThB).--This soil has the profile described as representative of the Theresa series. In most places its slopes are nearer to 2 percent than to 6 percent, and they are generally concave. Little or no erosion has taken place. Runoff is medium, however, and there is a slight risk of erosion.

Included with this soil in mapping were small areas of Theresa silt loam, 0 to 2 percent slopes; Dodge silt loam, 2 to 6 percent slopes; and Mayville silt loam, 2 to 6 percent slopes. Also included were a few small areas in which slopes are steeper than 6 percent, and some moderately eroded areas.

Most of the acreage is used for the crops commonly grown in the survey area. A small acreage is in trees or pasture. (Capability unit IIe-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Theresa silt loam, 2 to 6 percent slopes, eroded (ThB2).--This soil has lost part of the original surface layer through moderate erosion, and the present surface layer consists partly of dark-brown material from the subsoil that is mixed with the remaining original surface soil. Runoff is medium, and further erosion is a slight hazard. This soil absorbs water at a slightly slower rate than a similar soil that is not eroded or is only slightly eroded. The slopes are generally nearer to 6 percent than to 2 percent, and most of them are convex.

Included with this soil in mapping were small areas of a moderately eroded Hochheim soil that has a surface layer of silt loam and slopes of 2 to 6 percent. Also included were small areas of Mayville silt loam, 2 to 6 percent slopes; areas that are not eroded or are only slightly eroded; and a few small areas in which slopes are steeper than 6 percent.

Nearly all of the acreage is used for the crops commonly grown in the survey area. Only a small acreage is in pasture or in pastured woodlots. (Capability unit IIe-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Theresa silt loam, 6 to 12 percent slopes, eroded (ThC2).--The present surface layer of this soil has some dark-brown material from the subsoil mixed with the remaining original surface soil. Runoff is medium, and further erosion is a moderate hazard. This soil absorbs water at a slightly slower rate than a similar soil that is not eroded or is only slightly eroded.

Included with this soil in mapping were small areas of a moderately eroded Hochheim soil that has a surface layer of silt loam and slopes of 6 to 12 percent, and a few fairly large areas that are not eroded or are only slightly eroded.

This Theresa soil is used mostly for the crops commonly grown in the survey area. A small acreage is in pasture or is used as woodland. (Capability unit IIIe-1; woodland group 1; wildlife group 1; recreation group 2; shrub and vine group 1)

Virgil Series

The Virgil series consists of somewhat poorly drained soils that occupy long, narrow areas in drainageways, in slight depressions, and near the bases of slopes on outwash plains. These are silt loam soils that have a silty clay loam subsoil underlain by calcareous sandy loam glacial till. In this survey area, the material underlying these soils is generally stratified, calcareous sand and gravel. The native vegetation was a deciduous forest consisting mainly of oak, maple, hickory, and elm.

In a typical profile, the surface layer is dark grayish-brown or dark grayish-brown silt loam that is neutral in reaction and is about 9 inches thick. The subsurface layer is grayish-brown silt loam that is also neutral in reaction and is about 4 inches thick. The subsoil is about 36 inches thick. The upper part of the subsoil is dark-brown, mottled silty clay loam that is neutral or slightly acid in reaction. The middle part is grayish-brown, mottled silty clay loam that is neutral in reaction. The lower part is dark-brown, mottled sandy loam that is moderately alkaline and slightly calcareous. Brown, loose, mottled, stratified sand and gravel make up the substratum.

The Virgil soils are moderately permeable and have moderately high available water capacity. Natural fertility is high.

Typical profile of Virgil silt loam, gravelly substratum, 0 to 3 percent slopes (NW1/4 NE1/4 sec. 10, T. 8 N., R. 17 E.):

Ap--0 to 7 inches, very dark grayish-brown (10YR 3/2) to dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A1--7 to 9 inches, dark grayish-brown (10YR 4/2) silt loam; weak, thick, platy structure parting to moderate, fine, granular structure; friable; neutral; clear, wavy boundary.

A2--9 to 13 inches, grayish-brown (10YR 5/2) silt loam; weak, thick, platy structure parting to moderate, fine, granular structure; friable; neutral; clear, wavy boundary.

B1--13 to 21 inches, dark-brown (10YR 4/3) silty clay loam; few, fine, distinct, yellowish-brown (10YR 5/4 and 5/6) and light brownish-gray (10YR 6/2) mottles; moderate, fine, subangular blocky structure; friable; neutral; gradual, wavy boundary.

B21t--21 to 29 inches, dark-brown (10YR 4/3) heavy silty clay loam; common, fine, prominent, yellowish-brown (10YR 5/8) and faint, light brownish-gray (10YR 6/2) mottles; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; thick, continuous clay films; firm; slightly acid; gradual, wavy boundary.

B22t--29 to 44 inches, grayish-brown (10YR 5/2) silty clay loam; many, medium, prominent, yellowish-brown (10YR 5/6 and 5/8) mottles; weak, medium, prismatic structure parting to moderate, medium, subangular blocky structure; thick; continuous clay films; firm; neutral; gradual, wavy boundary

IIB3--44 to 49 inches, dark-brown (10YR 3/3) sandy loam; many, coarse, prominent, yellowish-brown (10YR 5/6 and 5/8) mottles; weak, coarse, subangular blocky structure; friable; moderately alkaline and slightly calcareous; clear, wavy boundary.

IIC--49 to 72 inches, brown (10YR 5/3), stratified sand and gravel; common, medium, distinct, yellowish-brown (10YR 5/6 and 5/8) mottles; single grain; loose; strongly calcareous.

In areas that have not been cultivated, the A1 horizon is very dark brown (10YR 2/2) to dark grayish brown (10YR 4/2) and ranges from 4 to 9 inches in thickness. The A2 horizon is grayish brown (10YR 5/2) to brown (10YR 5/3) and ranges from 3 to 6 inches in thickness. The A horizon and most of the B horizon has formed in the mantle of silt that is 36 to 50 inches thick. Thickness of the solum ranges from 45 to 60 inches. In some areas that have not been cultivated, reaction throughout the solum is strongly acid, but the reaction ranges to moderately alkaline in areas that have been intensively limed and cultivated.

The Virgil soils occur with well-drained St. Charles and poorly drained Drummer soils. They have a thicker solum than the Matherton soils.

Virgil silt loam, gravelly substratum, 0 to 3 percent slopes (VsA).--This is the only soil of the Virgil series mapped in the survey area. It is subject to ponding in spring and during periods of heavy rainfall. Runoff is slow, and little or no erosion has taken place.

Included with this soil in mapping were small areas of St. Charles silt loam, 0 to 2 percent slopes; Drummer silt loam; and a Matherton silt loam having slopes of 0 to 2 percent.

Wetness is the major limitation to use of this Virgil soil for crops. If adequate drainage is established and maintained, however, this soil is suited to the crops commonly grown in the survey area. Most of the acreage is used for crops, but a small acreage is in trees or pasture. (Capability unit IIw-2; woodland group 7; wildlife group 5; recreation group 6; shrub and vine group 3)

Wallkill Series

In the Wallkill series are poorly drained silt loam soils that have formed in silty alluvium that was deposited over an organic soil. These soils generally occupy long, narrow areas along the edges of old, shallow glacial lakebeds.

In a typical profile, the surface layer is dark yellowish-brown silt loam about 2 inches thick. The subsurface layer is brown silt loam about 5 inches thick. Next is a layer of very dark grayish-brown, mottled silt loam that is about 8 inches thick. This is underlain by a layer of very dark gray to very dark brown, mottled silt loam that is about 20 inches thick. The bottom layer is black muck, which extends to a depth of about 50 inches and is a buried organic soil. The entire profile is neutral in reaction.

The Wallkill soils are moderately permeable and have very high available water capacity. Ground water is at or near the surface throughout most of the year. Natural fertility is high.

Typical profile of Wallkill silt loam (0 to 3 percent slopes) (SE1/4 SW1/4 sec. 20, T. 7 N., R. 20 E.):

A11--0 to 2 inches, dark yellowish-brown (10YR 3/4) silt loam; weak, medium, granular structure; friable; neutral; abrupt, wavy boundary.

A12--2 to 7 inches, brown (10YR 5/3) silt loam; weakly stratified; friable; neutral; abrupt, smooth boundary.

A13--7 to 15 inches, very dark grayish-brown (10YR 3/2) silt loam; few, fine, distinct, dark yellowish-brown (10YR 4/4) and prominent, yellowish-brown (10YR 5/6) mottles; weakly stratified; friable; neutral; gradual, wavy boundary.

A14--15 to 35 inches, very dark gray (10YR 3/1) to very dark brown (10YR 2/2) silt loam; common, medium, distinct, dark reddish-brown (5YR 3/4) mottles; weakly stratified; friable; neutral; abrupt, wavy boundary.

IIIb--35 to 60 inches, black (N 2/0) muck; weak, subangular blocky structure; friable; neutral; abrupt, wavy boundary.

Thickness of the silty alluvium ranges from 20 to 40 inches. The color of each A horizon ranges from dark yellowish brown (10YR 4/4) or brown (10YR 5/3) to very dark gray (10YR 3/1). Thickness of the buried organic soil ranges from 15 inches to several feet. The organic soil is underlain by sandy, loamy or clayey soil.

Wallkill silt loam (0 to 3 percent slopes) (Wa).--This is the only soil of the Wallkill series mapped in the survey area. It is a wet soil and is subject to overflow.

Included with this soil in mapping were small areas of Houghton muck, 0 to 2 percent slopes, and a Pistakee silt loam that has slopes of 0 to 3 percent.

Wetness is the major limitation to use of this Wallkill soil for crops. Corn is grown on most of the acreage, but a small acreage is wooded or is used as wildlife habitat. This soil can be cropped intensively if it is well managed and is protected from overflow. Good management should include maintenance of an adequate supply of plant nutrients,

providing regular additions of organic matter, and keeping this soil in good tilth. (Capability unit IIw-13; woodland group 9; wildlife group 5; recreation group 8; shrub and vine group 3)

Warsaw Series

The Warsaw series consists of well-drained, loamy soils that are underlain by calcareous sand and gravel outwash. These soils lie on glacial outwash plains. The native vegetation was mainly prairie grasses and a few scattered oaks.

In a typical profile the upper part of the surface layer is black, slightly acid loam about 8 inches thick. The lower part of the surface layer is very dark brown, slightly acid loam about 4 inches thick. The subsoil is about 20 inches thick. It is dark-brown, medium acid loam in the upper part, and dark-brown, medium acid gritty silty clay loam in the middle part. The lower part is dark yellowish-brown, slightly acid sandy clay loam and dark yellowish-brown, mildly alkaline sandy loam. The substratum is pale-brown, slightly calcareous, stratified sand and gravel.

The Warsaw soils are moderately permeable, have moderate available water capacity, and have moderate natural fertility.

Typical profile of Warsaw loam, 0 to 2 percent slopes (NW1/4 SW1/4 sec. 10, T. 6 N., R. 19 E.):

Ap--0 to 8 inches, black (10YR 2/1) loam; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A1--8 to 12 inches, very dark brown (10YR 2/2) loam; weak, medium, granular structure; friable; slightly acid; clear, wavy boundary.

B1--12 to 17 inches, dark-brown (10YR 4/3) heavy loam; moderate, medium, subangular blocky structure; friable; medium acid; clear, wavy boundary.

B21t--17 to 23 inches, dark-brown (10YR 4/3) gritty silty clay loam; moderate, medium, subangular blocky structure; continuous clay films; firm; medium acid; gradual, wavy boundary.

B22t--23 to 29 inches, dark yellowish-brown (10YR 3/4) sandy clay loam; moderate, medium, subangular blocky structure; discontinuous clay films; friable; few pebbles of dolomite; slightly acid; gradual, wavy boundary.

B3--29 to 32 inches, dark yellowish-brown (10YR 3/4 to 4/4) sandy loam; weak, medium, subangular blocky structure; very friable; few pebbles of dolomite; mildly alkaline; clear, wavy boundary.

IIC--32 to 96 inches, pale-brown (10YR 6/3), stratified sand and gravel; single grain; loose; slightly calcareous.

Thickness of the solum ranges from 20 to 40 inches. Where the surface layer is loam, these soils generally have a B21t horizon of silty clay loam or clay loam. Where the surface layer is sandy loam, the B21t horizon commonly is sandy clay loam. The IIC horizon is generally stratified sand and gravel, but it is mostly sand in some places and mostly gravel in others.

The Warsaw soils occur with somewhat poorly drained Kane and poorly drained Sebewa soils. They have a darker, thicker A horizon than the Fox soils, and a thicker solum than the Lorenzo soils.

Warsaw sandy loam, 2 to 6 percent slopes (WdB).--This soil is more droughty than the one for which a profile is described as representative of the Warsaw series, and it is susceptible to soil blowing. Runoff is medium, and erosion is a slight hazard.

Included with this soil in mapping were small areas of Fox sandy loam, 0 to 2 percent slopes.

Nearly all of the acreage is used for the crops commonly grown in the survey area. A small acreage is in pasture. (Capability unit IIIs-4; woodland group 12; wildlife group 4; recreation group 2; shrub and vine group 2)

Warsaw loam, 0 to 2 percent slopes (WeA).--This soil occurs in large areas. It is not eroded or is only slightly eroded, but it is slightly droughty for the commonly grown crops. The profile is the one described as representative of the Warsaw series.

Included with this soil in mapping were small areas of a Kane silt loam and of Fox loam, 0 to 2 percent slopes. Also included were small areas in which the surface layer is sandy loam, and fairly large areas in which the surface layer is silt loam.

This Warsaw soil can be cropped intensively if it is well managed, and if practices are used that conserve moisture. Proper management should include practices that will keep this soil in good tilth, maintain a good supply of plant nutrients, and provide for regular additions of organic matter. Nearly all of the acreage is used for the crops commonly grown in the survey area. (Capability unit IIs-1; woodland group 12; wildlife group 4; recreation group 2; shrub and vine group 1)

Warsaw loam, 2 to 6 percent slopes (WeB).--This soil is slightly susceptible to erosion, and it is also slightly droughty. Runoff is medium.

Included with this soil in mapping were small areas in which the surface layer is silt loam; small areas of Fox loam, 2 to 6 percent slopes; and a few moderately eroded areas.

This Warsaw soil can be cropped intensively if practices are used that keep it in good tilth, conserve moisture, maintain a good supply of plant nutrients, and provide for regular additions of organic matter. Nearly all of the acreage is used for the commonly grown crops. (Capability unit IIe-2; woodland group 12; wildlife group 4; recreation group 2; shrub and vine group 1)

Warsaw loam, 6 to 12 percent slopes, eroded (WeC2).--Erosion has removed part of the original surface layer of this soil, and the present plow

layer contains some of the brownish subsoil. Runoff is medium, and further erosion is a moderate hazard. This soil is slightly droughty.

Included with this soil in mapping were small areas of Fox sandy loam, 6 to 12 percent slopes, eroded, and a few areas where little or no erosion has taken place.

Nearly all of the acreage of this Warsaw soil is used for the crops commonly grown in the survey area. (Capability unit IIIe-2; woodland group 12; wildlife group 4; recreation group 2; shrub and vine group 1)

Warsaw silt loam, 0 to 2 percent slopes (WhA).--This soil is slightly droughty. Included with it in mapping were small areas of a soil that has mottling below a depth of 30 inches in the subsoil. Also included were small areas of a Fox silt loam and of a Kane silt loam.

Except for the slight droughtiness, this Warsaw soil is suited to all the crops commonly grown in the survey area. Nearly all of the acreage is used for crops. (Capability unit IIs-1; woodland group 12; wildlife group 4; recreation group 2; shrub and vine group 1)

Wasepi Series

In the Wasepi series are somewhat poorly drained sandy loam soils that have sandy clay loam in the subsoil and are underlain by sandy glacial outwash. These soils are in the western part of Waukesha County. The native vegetation was water-tolerant grasses and a few scattered elms and oak trees.

In a typical profile, the surface layer is black, mildly alkaline mucky sandy loam about 6 inches thick. The subsurface layer is very dark grayish-brown, slightly acid sandy loam about 3 inches thick. The subsoil is about 20 inches thick. The upper part of the subsoil is brown, medium acid loamy sand; the middle part is brown, medium acid sandy clay loam; and the lower part is brown, slightly acid loamy fine sand. The substratum is pale-brown, loose, slightly calcareous fine sand. Both the subsoil and the substratum contain mottles.

The Wasepi soils have moderately rapid permeability and low available water capacity. Ground water is less than 3 feet below the surface in wet periods. Natural fertility is low.

Typical profile of Wasepi sandy loam, 1 to 3 percent slopes (SE1/4 SE1/4 sec. 20, T. 6 N., R. 17 E.):

A1--0 to 6 inches, black (10YR 2/1) mucky sandy loam; weak, medium, subangular blocky structure parting to moderate, medium, granular structure; friable; mildly alkaline; clear, wavy boundary.

A3--6 to 9 inches, very dark grayish-brown (10YR 3/2) sandy loam; weak, medium, prismatic structure parting to weak, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B1--9 to 18 inches, brown (10YR 5/3) loamy sand; many, medium, faint mottles of grayish brown (10YR 5/2) and prominent mottles of yellowish red (5YR 5/6 and 5/8); weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; friable; medium acid; gradual, wavy boundary.

B2t--18 to 26 inches, brown (10YR 5/3) light sandy clay loam; many, medium, faint mottles of light brownish gray (10YR 6/2) and prominent mottles of yellowish red (5YR 5/6 and 5/8); weak, coarse, prismatic structure parting to moderate, medium, subangular blocky structure; thin, patchy clay films; firm; medium acid; gradual, wavy boundary.

B3--26 to 29 inches, brown (10YR 5/3) loamy fine sand; many, medium, faint mottles of light brownish gray (10YR 6/2) and prominent mottles of yellowish brown (10YR 5/6 and 5/8); weak, coarse, prismatic structure parting to weak, medium, subangular blocky structure; friable; slightly acid; abrupt, wavy boundary.

C--29 to 62 inches, pale-brown (10YR 6/3) fine sand; many, medium, faint mottles of light brownish gray (10YR 6/2) and prominent mottles of yellowish brown (10YR 5/6 and 5/8); single grain; loose; slightly calcareous.

Color of the A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2), and the A horizon is sandy loam in places. The A horizon has a variable content of organic matter. In places the texture of the B2t horizon is sandy loam. Where the texture of the B2t horizon is sandy clay loam, thickness of that horizon is less than 10 inches. Reaction of the solum ranges from medium acid to mildly alkaline.

The Wasepi soils occur with well-drained Boyer and poorly drained Gilford soils. They have a thicker solum than the Fabius soils and a thinner, coarser textured solum than the Matherton soils.

Wasepi sandy loam, 1 to 3 percent slopes (WmA).--This is the only soil of the Wasepi series mapped in the survey area. It is slightly susceptible to soil blowing. Runoff is slow, and little or no erosion has taken place.

Wetness is the major limitation to use of this soil for crops. Where drainage is established, preferably by open ditches, care should be taken not to overdrain or this soil will become droughty. Most of the acreage is in pasture or trees, and only a small acreage is used for crops. (Capability unit IVw-5; woodland group 8; wildlife group 5; recreation group 6; shrub and vine group 3)

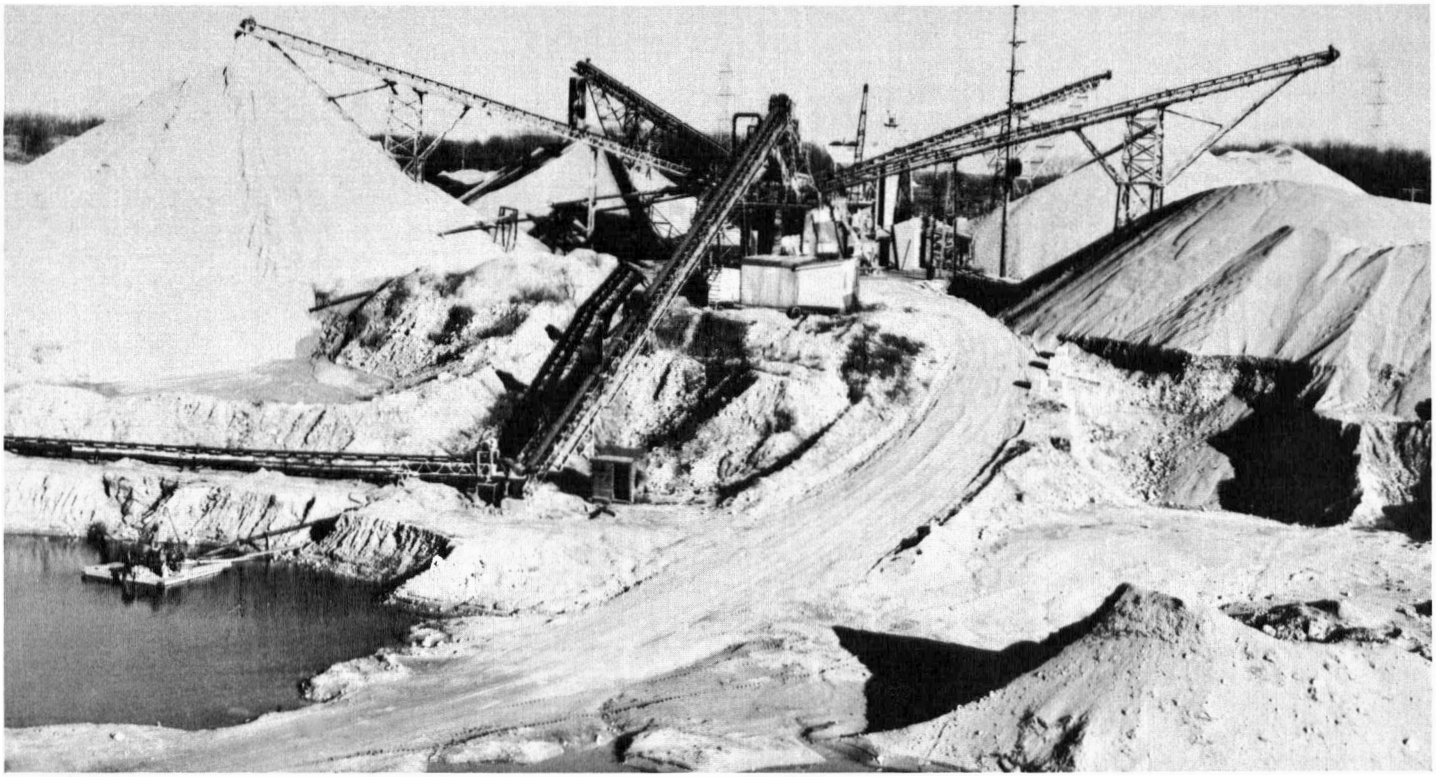
Wet Alluvial Land

Wet alluvial land (Ww) is a miscellaneous land type on the flood plains of streams. It is flooded frequently, and the water table is near the surface throughout most of the year. Most of the areas are

nearly level, but they are pitted and marked in places by old drainage channels. Permeability and the available water capacity are generally moderate.

Wet alluvial land occurs with Adrian, Palms, Ogden, and Sawmill soils. It has a greater range in texture than those soils.

This land type is generally not suited to crops. Most of the areas can be used for pasture, or they are suited to use as woodland or wildlife habitat. (Capability unit Vw-14; woodland group 9; wildlife group 5; recreation group 8; shrub and vine group 3)



Gravel pit in Casco and Fox soils east of Big Bend.

A Warsaw loam on an outwash plain in the foreground, and Miami soils on a glacial moraine in the background.

PLATE II

Complex topography typical of the Rodman-Casco association.

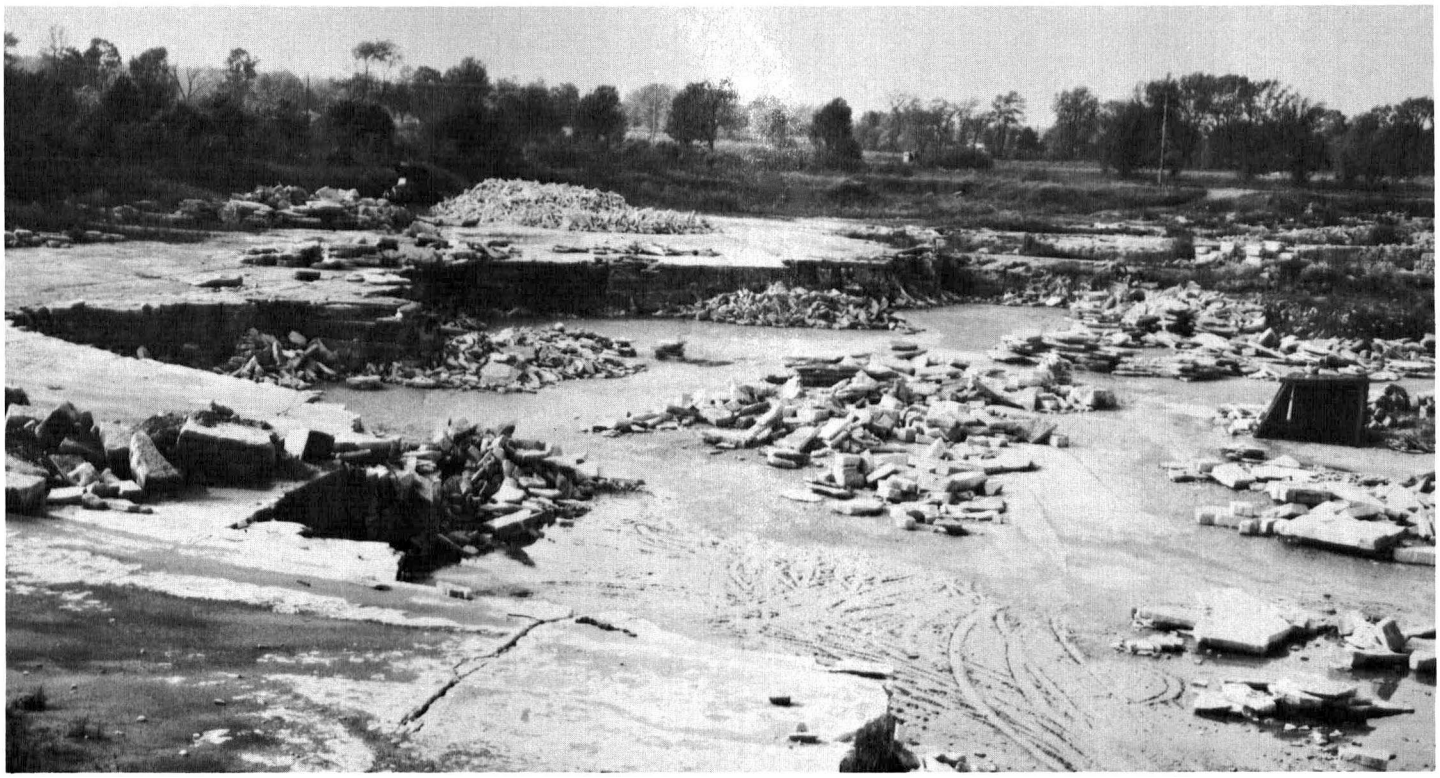
Plantation of young pines on a kettle moraine occupied by Casco soils.

Encroachment of residential developments on farmland consisting of gently sloping Ozaukee soils.

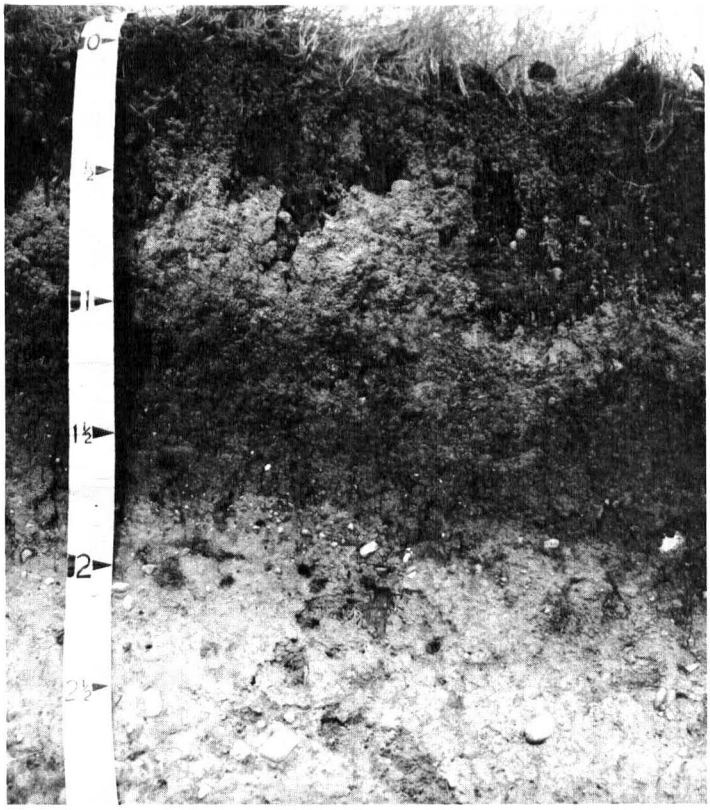
Top of a drumlin in the Hochheim-Theresa association in the southwestern part of Waukesha County.

PLATE IV

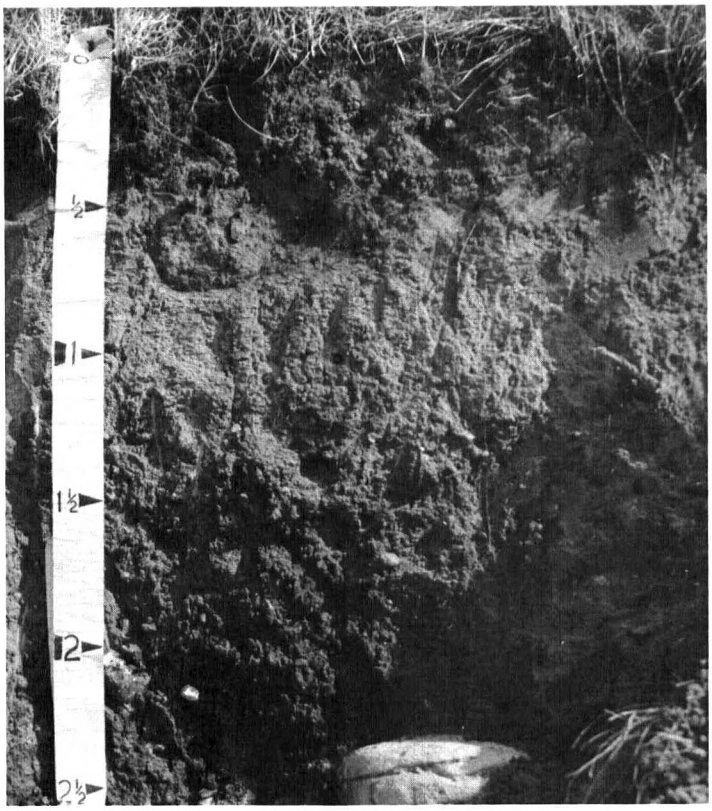
Excavation for a basement in a somewhat poorly drained soil of the Hochheim-Theresa association.



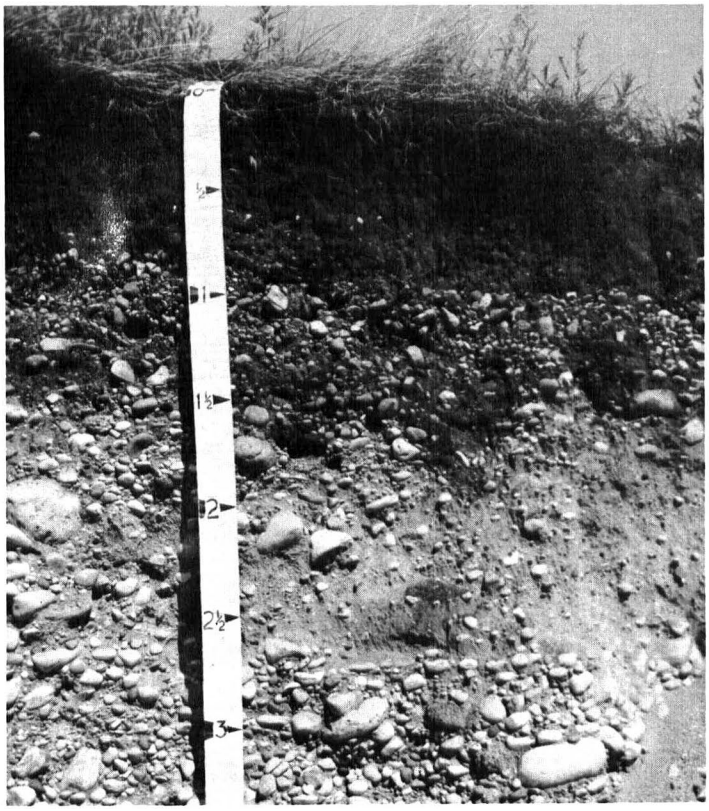
Quarry for buildingstone in the Pella, moderately shallow variant-Knowles soil association near Lannon.



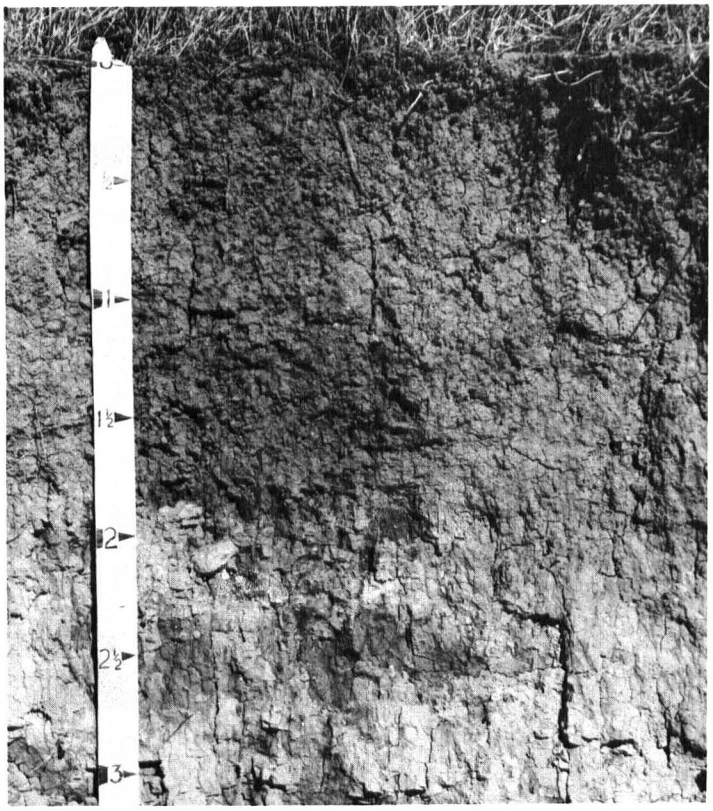
Typical profile of a Hochheim loam.



Typical profile of a Knowles silt loam.



Typical profile of a Lorenzo loam.



Typical profile of an Ozaukee silt loam.

PLATE VI

Harvesting bluegrass sod in a field of Houghton muck.

Cattails, rushes, and other water-tolerant plants in an area of Marsh in capability unit VIII w-15.

Wall of a gravel pit showing a layer of loamy glacial till, 6 to 15 feet thick, over stratified sand and gravel that were deposited during an earlier glacial period.

The first part of this section describes use and management of the soils of Milwaukee and Waukesha Counties for crops and pasture. It also discusses woodland uses of the soils, gives the names of trees suitable for ornamental planting, and provides a guide for the planting of shrubs and vines. The last part discusses wildlife, describes uses of the soils for recreation, and explains engineering uses of the soils.

Management for Crops and Pasture

Crops commonly grown in the survey area are corn, oats, hay, soybeans, forage crops, and canning peas and other special crops. In addition, a large acreage is used for pasture. In the following pages, basic practices for managing the soils for these commonly grown crops and pasture are discussed, the system of capability classification is explained, and the capability units are described. Finally, predicted average acre yields of some of the principal crops are given under two levels of management.

Basic Practices of Management

The soils of Milwaukee and Waukesha Counties vary in their suitability for specific crops, and they require widely different management. Some basic management practices are needed, however, for practically all of the soils. The following paragraphs discuss basic practices needed for maintaining fertility, providing drainage, and controlling erosion, and they also discuss renovation of pastures. In considering these suggestions for basic practices to be used in managing the soils, consideration should be given to the practices suggested in discussions of the capability units. Technical assistance in planning and applying practices suitable for the soils on a particular farm can be obtained from a local representative of the Soil Conservation Service or the Extension Service.

Maintaining fertility.--Fertility can be increased by use of a cropping system that provides for regular additions of organic matter to the soils. It can also be increased by applying barnyard manure, plowing under a green-manure crop, or adding commercial fertilizer. Dairy farmers in the area commonly use a diversified cropping system, and they add organic matter and plant nutrients through regular applications of barnyard manure. Where truck farming is practiced, or where other special crops are grown intensively, fertility is maintained by plowing under a green-manure crop and returning all crop residue to the soils.

Generally, all crops grown on these soils respond well to applications of commercial fertilizer. The Hochheim, Kewaunee, Ozaukee, and most other mineral soils of the survey area have a medium to low content of phosphorus and a medium to high content of potassium. Organic soils, such as the Palms and Houghton, have a low content of both phosphorus and potassium. Regular applications of these elements are needed for good growth of crops. On all the soils, soil tests should be made to determine the kinds and amounts of fertilizer to apply. All of the soils contain an adequate amount of lime, and some contain a large amount. The pH of the surface layer is generally between 6.5 and 7.5. Many of the soils have an alkaline subsoil.

Providing drainage.--Many of the soils of the survey area are wet because they receive runoff from adjacent areas, have a slowly permeable subsoil, or have a fluctuating high water table. Some have a combination of these factors. In some places diversions can be used to protect the soils from runoff from adjacent areas. In others shallow parallel or random field ditches are needed to convey water to a natural waterway or to a deep, open ditch. Where shallow field ditches are used for supplying drainage, tillage generally is planned so that furrows or rows cross the ditches. Shallow ditches can be used where the subsoil is unstable, and where deep ditches and tile drains are difficult to maintain. The Colwood and Mussey are examples of soils that have an unstable subsoil or substratum consisting of silty material, very fine sand, or sand and gravel.

In loamy or clayey soils where subsurface water or a combination of excess surface water and subsurface water cause wetness, tile drains and deep, open ditches are needed to provide drainage. Examples of wet loamy or clayey soils are the Manawa and Pella, which are in depressions and in drainageways. In draining these soils, the tile lines are placed at a depth of 3 to 3 1/2 feet. They are run parallel to a natural drainageway or through the outlet of a depressional area to a deep, open ditch.

Where no outlets are available, nearly level, low, flat, wet areas of mineral soils and organic soils can be drained by using tile drains and deep ditches. In organic soils tile drains are placed at a depth of 4 feet. They are laid about 2 years after the open ditches have been installed so that enough time is allowed for subsidence of the organic material. If the organic soils are properly drained, they can be farmed intensively.

In the Brookston and similar soils, a perched water table and hillside seepage are common. Tile drains can be used to provide drainage for these soils.

Controlling erosion.--Large areas of Hochheim, Kewaunee, Ozaukee, and other soils in Milwaukee and Waukesha Counties are moderately or severely eroded. Except where some gullying and cutting of ravines has taken place, losses caused by water erosion are the result of sheet and rill erosion. The Boyer soils and some of the other sandy soils are also susceptible to blowing. Wind stripcropping and shelterbelts can be used to help protect those soils.

Using a cropping system that consists largely of close-growing crops is the most common means of controlling erosion on the steeper soils that have irregular slopes. Practicing contour stripcropping and terracing allows cropping to be more intensive and helps to more effectively control erosion on nearly level and gently sloping soils. Where the cropping system consists mostly of close-growing crops, use of contour stripcropping and establishing grassed waterways and tile drains, where feasible, are desirable practices. In addition, diversions and terraces help to protect the soils.

Grassed waterways are not only commonly used where the cropping system consists largely of close-growing crops, and they are also used in areas that receive excess water as the result of hillside seepage. Tile drains are needed to help stabilize the soil material on the sides and bottom of the waterway and to help in obtaining a dense stand of sod.

Contour stripcropping is suitable for all well-drained and excessively drained soils. If the contour strips are laid out on a grade of 0.5 to 1 percent, they can be used on moderately well drained and somewhat poorly drained soils that have slopes as steep as 16 percent, and they help to direct runoff to a nearby grassed waterway. The strips can range from 60 to as much as 100 feet in width, depending on the degree of slope.

Diversions can be used to direct water away from critical areas and to reduce the length of the slope. Installing a diversion at the base of a steep slope protects soils on the slopes below, and it also protects low-lying, wet soils from runoff from higher areas. The channel of the diversion must be protected from siltation. Protection is provided by controlling erosion in areas above the diversion or by placing filter strips of sod above the diversion channel.

Terraces are the most effective means of controlling erosion on sloping soils, but they are suitable only for soils that have uniform slopes. Terraces are generally established on uniform slopes that do not exceed 8 percent, but they can be used on slopes as steep as 12 percent. The loam and silt loam soils of the Hochheim, Kewaunee, and Ozaukee series are examples of soils suitable for terracing. In the Casco and some other soils in the survey area, the soil layers are too thin for the construction of terraces. Terraces not only effectively protect the soils from erosion, but they also provide for uniform disposal of water on poorly drained and very poorly drained, sloping soils. In general, soils can be cropped more intensively after terraces are installed than before.

Renovating pastures.--Most supplies of forage in the survey area are obtained from hay grown in strips that are alternated with strips of other crops. The hay and the other crop are rotated, and the field is grazed during the last year of the rotation. On some farms the hay is cut green and is fed to livestock. On others it is allowed to dry.

Fertility can be maintained in most upland pastures on well-drained soils of capability classes II, III, IV, and VI by periodic renovation. A good stand of pasture grasses can be obtained where good seedbed preparation accompanies renovation. It is best to begin preparation of the seedbed in fall and finish preparation by May of the next year. A suitable mixture of grasses and legumes is birdsfoot trefoil and bromegrass or alfalfa and bromegrass or timothy. A companion crop of oats will provide a protective cover the first year and thereby will help in controlling erosion.

A large amount of a fertilizer that is high in content of phosphorus and potassium applied at seeding time will help insure a good stand and rapid growth. Nitrogen can also be applied as a topdressing, especially where the pasture consists mostly of grasses. Where the soils are steep or sandy, controlled grazing to maintain a good cover of plants will help to control erosion.

Pastures on soils of capability class V are subject to flooding, and the soils have a high water table. Tillage therefore is not practical, and renovation is not feasible. Soils in capability class V generally are used for meadows of reed canarygrass or bromegrass. Grazing the areas only in dry seasons is a way of keeping hummocks from developing. Where hummocks are allowed to develop, they interfere with surface drainage.

Pasture on steep soils of capability class VI are difficult to renovate, and soils of capability class VII are not suitable for renovation. On soils of these two capability classes, tillage is not feasible, and the pastures generally are kept in native grasses. Controlling grazing and applying a commercial fertilizer are ways of maintaining a satisfactory supply of plant nutrients in areas used for native pasture.

Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The classification does not apply to most horticultural crops, or to rice and other crops having special requirements. The soils are classified according to degree and kinds of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible major reclamation.

In the capability system all soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest grouping, are designated by Roman numerals, I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that restrict the choice of plants, require very careful management, or both.

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial production of plants and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

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 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 some parts of the United States but not in Milwaukee and Waukesha Counties, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by w, s, and c, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-2 or IIIe-4. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph. The Arabic numeral specifically identifies the capability unit within each subclass.

Management by Capability Units

In the following pages, the capability units in Milwaukee and Waukesha Counties are described and suggestions for use and management of the soils of each unit are given. The capability units are not numbered consecutively, because not all of the units used in Wisconsin are in these two counties. The names of soil series represented are mentioned in the description of each capability unit, but this does not mean that all soils of a given series are in the unit. To find the names of all the soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

Capability Unit I-1

This capability unit consists of deep, moderately well drained and well drained, nearly level soils of the Dodge, Grays, Juneau, Mayville, St. Charles, and Theresa series. These soils have moderate permeability, high available water capacity, and high natural fertility. They are easily managed, conserved, and kept in good tilth.

Soils of this unit are well suited to the crops commonly grown in the survey area, and they can also be used for pasture, trees, or wildlife habitat. The main crops are field corn, oats, and alfalfa grown for hay, but some soybeans, canning corn, and peas are grown. An example of a cropping system that can be used is a row crop, a small grain, and 1 year of meadow. Row crops can be grown year after year if all crop residue is returned to the soils, if high fertility is maintained, and if tillage is kept to a minimum. Where less than 2 tons per acre of crop residue is available, a cover crop should be grown to supply a large amount of organic matter.

Capability Unit IIe-1

Deep, moderately well drained and well drained, gently sloping soils of the Dodge, Grays, Griswold, Hochheim, Mayville, Miami, St. Charles, and Theresa series are in this capability unit. These soils have a surface layer of sandy loam to silt loam. They have moderate permeability, medium or high available water capacity, and moderate to high natural fertility. Moderate erosion is a hazard, but these soils are fairly easy to keep in good tilth. The main concerns of management are providing regular additions of organic matter, maintaining fertility and good soil structure, and controlling runoff.

Soils of this unit are well suited to corn, small grains, soybeans, and forage crops, and to canning

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peas and other special crops. They are also suitable for pasture, trees, and wildlife habitat. An example of a cropping system that can be used is a row crop, a small grain, and 3 years of hay.

Capability Unit IIe-2

This capability unit consists of well drained and moderately well drained, gently sloping soils of the Fox, Knowles, and Warsaw series. These soils have a surface layer of loam or silt loam, and they are underlain by bedrock or by sandy and gravelly outwash at some depth between 20 and 40 inches. Permeability is moderate, and the soils have medium available water capacity and moderate natural fertility. They are easy to cultivate but are slightly droughty and are subject to moderate erosion. Controlling erosion, providing regular additions of organic matter, and maintaining satisfactory available water capacity, fertility, and good tilth are the main concerns of management.

Soils of this unit are well suited to corn, small grains, soybeans, and forage crops. They are also well suited to canning peas and other special crops, and they can be used for pasture, trees, or wildlife habitat.

Capability Unit IIe-6

In this capability unit are deep, gently sloping soils of the Hebron, Kewaunee, Markham, Morley, Ozaukee, and Saylesville series. Most of these soils have a surface layer of silt loam. They have a moderately slow to slowly permeable subsoil, are well drained or moderately well drained, and have high available water capacity. Some of the soils are eroded, and further erosion is a moderate hazard if cultivated crops are grown. Where erosion has removed part of the original surface layer and tillage extends into the clayey subsoil, these soils are difficult to work. Because water infiltrates slowly, much of the water from precipitation runs off, especially during periods of heavy rainfall. The main concerns of management are providing regular additions of organic matter, keeping the soils in good tilth, increasing the percolation rate, and controlling erosion.

Soils of this unit are well suited to corn, small grains, and forage crops. They are especially well suited to legumes. These soils can also be used for pasture, trees, and wildlife habitat.

Growing deep-rooted legumes increases the pore space in these soils. Channels formed when the legumes die and the roots decay increase the rate of water movement through the clayey subsoil.

Capability Unit IIw-1

This capability unit consists of deep, poorly drained, nearly level or gently sloping soils of the Askum, Brookston, Colwood, Drummer, Montgomery, Navan, and Pella series. These soils have a surface layer of silt loam or silty clay loam. They have a high water table and have moderate to slow permeability, high available water capacity, and moderate to high natural fertility. Erosion is a hazard in the gently sloping areas. Lowering the level of the water table, protecting these soils from overwash, and maintaining good tilth and adequate fertility are the major concerns of management.

If these soils are adequately drained, they are suited to the crops commonly grown in the survey area. Truck crops, corn, small grains, and bromegrass and alfalfa for hay are the crops generally grown. Alfalfa is subject to frost heave, however, and small grains tend to lodge. In areas that do not have adequate drainage, alsike clover or Ladino clover can be substituted for alfalfa. Because of the excess moisture, trees generally do not grow well, but these soils can be used for pasture or wildlife habitat.

In most places outlets are available so that tile drains can be installed. Where tile drains are used, good soil structure must be maintained so that excess moisture can move downward through the soil to the tile. If an outlet is not available, surface drains can be used.

Capability Unit IIw-2

This capability unit consists of deep, somewhat poorly drained, nearly level or gently sloping soils of the Aztalan, Blount, Elliott, Griswold, Kendall, Lamartine, Manawa, Martinton, Mequon, Mundelein, Pistakee, and Virgil series. These soils have a surface layer of loam or silt loam. They have moderate to slow permeability, high available water capacity, and moderate to high natural fertility. Erosion is a slight hazard in the gently sloping areas. These soils dry out slowly in spring and after long rainy spells, and they warm up slowly in spring. Disposing of excess water, providing regular additions of organic matter, and maintaining fertility and good tilth are the major concerns of management.

If these soils are properly drained, they are suited to the crops commonly grown in the survey area. Corn, small grains, and bromegrass and alfalfa for hay are the crops commonly grown, and soybeans, truck crops, and canning crops are grown to a lesser extent. In areas not adequately drained, alfalfa is subject to winterkill and to damage from frost heaving. In those areas red clover, alsike clover, or Ladino clover can be substituted for alfalfa. Permanent pasture, woodland, and wildlife habitat are other suitable uses for these soils.

Surface drains can be used to remove the excess water, but outlets are generally available so that tile drains can also be used. Diversions can be used to reduce the length of the slopes and to protect these soils from overwash.

Capability Unit IIw-5

This capability unit consists of somewhat poorly drained, nearly level or gently sloping soils of the Fabius, Kane, Matherton, Mussey, and Sebewa series. Most of these soils have a surface layer of silt loam or loam, but one of the Matherton soils has a surface layer of sandy loam. All of the soils have a substratum of loose sand and gravel at a depth of 24 to 40 inches. Natural fertility and the available water capacity are medium, and permeability is moderate. These soils have a high or fluctuating water table. Providing regular additions of organic matter, maintaining good soil tilth and fertility, controlling erosion in the gently sloping areas, and draining the soils so that the water table will be lowered are the major concerns of management. Drainage is needed before cultivated crops can be successfully grown, and it can be provided by installing open ditches.

Where soils of this unit are properly drained, they are suited to most crops commonly grown in the survey area. These soils are also suitable for permanent pasture, trees, or use as wildlife habitat. Corn, small grains, and Ladino clover or red clover and bromegrass are the crops commonly grown. The high water table makes these soils poorly suited to alfalfa. A cropping system consisting mostly of crops that do not require much cultivation will help to control erosion in the gently sloping areas.

Capability Unit IIw-8

This capability unit consists of poorly drained, nearly level, organic soils of the Palms series. These soils consist of decomposed residue of water-tolerant plants underlain by mineral soil material of loam texture at a depth of 12 to 50 inches. The soils have moderately rapid permeability and very high available water capacity. Groundwater is at or near the surface most of the year.

Where drained by open ditches or tile drains, these soils are suitable for corn, soybeans, bluegrass for sod, and truck crops, such as cabbage, onions, and carrots. After drainage is improved, the soils are subject to subsidence, blowing, and damage from fire. Controlled drainage will help to prevent subsidence and will lessen the danger of fire. Undrained areas are in native pasture and woodlots or are used as wildlife habitat.

Capability Unit IIw-13

In this capability unit are nearly level, somewhat poorly drained, deep soils of the Lawson and Wallkill series. The Lawson soil is typically silt loam throughout, but it overlies a poorly drained soil in places. The Wallkill soil consists of silty material over a buried organic soil. Both of these soils have a high water table, are subject to overflow from adjacent streams, and receive extra water that runs off higher slopes. Permeability is moderate, and natural fertility and the available water capacity are high.

Excess water is the main limitation to use of these soils for crops. Drainage must be provided before cultivated crops can be successfully grown. Where outlets are available, tile drains can be used for draining the Wallkill soil. Tile drains are not suitable for removing excess water from the Lawson soil, but open ditches and surface drains can be used. The soils also need protection from flooding and overwash. Areas not protected from flooding can be used for pasture, as woodland, or as wildlife habitat.

Capability Unit IIs-1

This capability unit consists of well drained or moderately well drained, nearly level soils of the Fox, Knowles, and Warsaw series. These soils have a surface layer of loam or silt loam, and they are underlain by bedrock or by sandy and gravelly outwash at some depth between 20 and 40 inches. They are easy to cultivate but are slightly droughty during extended periods of dry weather. Permeability is moderate, and the available water capacity and natural fertility are medium.

Soils of this unit are suited to the crops commonly grown in the survey area, and they can also be used for pasture, as woodland, or for development of wildlife habitat. Corn, small grains, and alfalfa and bromegrass for hay are the principal crops, but truck crops, canning peas, and soybeans are also grown.

Capability Unit IIs-7

This capability unit consists of moderately deep or deep, moderately well drained or well drained, nearly level soils of the Hebron and Saylesville series. These soils are on low stream benches or on flats covered by lacustrine material. They have a surface layer of loam or silt loam and a clayey subsoil or substratum. Permeability is slow, natural fertility is moderate or high, and the available water capacity is high. These soils dry out slowly in spring and after heavy rains. Their content of organic matter is rather low. Supplying regular additions of organic matter and maintaining good soil tilth are the major concerns of management.

Soils of this unit are suited to all the crops commonly grown in the survey area, but they are especially well suited to legumes. Pasture, woodland, and development for wildlife habitat are also suitable uses. Where these soils are cultivated, the principal crops are corn, small grains, and forage crops. The risk of puddling is reduced if tillage is delayed until the soil is dry enough that it is firm. Deep-rooted legumes help to make the subsoil more permeable.

Capability Unit IIIe-1

In this capability unit are deep, well-drained, sloping, eroded Griswold, Hochheim, Miami, and Theresa soils that have a surface layer of sandy loam to silt loam. These soils are moderately fertile and are easy to cultivate. They are moderately permeable and have medium or high available water capacity. The content of organic matter is generally low. Further erosion is a hazard unless these soils are properly managed.

Cultivated areas of these soils are used mostly for corn, small grains, and legume hay, and the areas not cultivated are in pasture or woodlots. These soils can also be used as wildlife habitat.

Capability Unit IIIe-2

This capability unit consists of sloping, moderately eroded Fox and Warsaw soils on outwash plains and river terraces. The surface layer of these soils is silt loam to sandy loam, and their substratum is loose sand and gravel at some depth between 20 and 40 inches. These soils are moderately permeable, have medium available water capacity, and have moderate natural fertility. They are easy to cultivate but are slightly droughty. Providing regular additions of organic matter, maintaining good tilth and fertility, conserving moisture, and controlling erosion are the major concerns of management.

These soils are suited to corn, small grains, legume hay, and other crops commonly grown in the survey area. Small areas not cultivated can also be used for pasture, as woodland, or as wildlife habitat.

Capability Unit IIIe-3

Only one soil, Ritchey silt loam, 1 to 6 percent slopes, is in this capability unit. It is a well-drained soil of the uplands. Dolomite bedrock is at a depth of less than 20 inches. This soil has moderate permeability and rather low natural fertility. It is somewhat droughty because the available water capacity is low. The major concerns of management are controlling runoff and erosion.

The crops generally grown are corn, small grains, and forage crops. Areas in which bedrock crops out at the surface or is so close to the surface that it could interfere with tillage are generally in permanent pasture or woodlots, or they are used as wildlife habitat.

Capability Unit IIIe-4

In this capability unit are well-drained, gently sloping, droughty soils of the Casco and Lorenzo series. These soils are on outwash plains and stream terraces. They have a surface layer of sandy loam or loam, and they are moderately deep over loose, rapidly permeable sand or gravel. The subsoil is moderately permeable. Natural fertility is generally low, and the available water capacity is low. These soils are slightly susceptible to erosion. Providing regular additions of organic matter, maintaining fertility, conserving moisture, and controlling erosion are the main concerns of management.

Soils of this unit are used mostly for growing corn, small grains, and forage crops. They are not well suited to these crops, however, unless precipitation is adequate and is evenly distributed throughout the growing season. Areas not cultivated are used for pasture or trees. They can also be used for the development of wildlife habitat.

Capability Unit IIIe-6

This capability unit consists of deep, well drained or moderately well drained, moderately eroded Hebron, Kewaunee, Morley, Ozaukee, and Saylesville soils on glaciated uplands and in the basins of former glacial lakes. These soils have a surface layer of silt loam or loam, and a clayey subsoil or substratum. Natural fertility is generally moderate, and the available water capacity is high. The soils have a low content of organic matter and a slowly permeable subsoil. They are difficult to manage and to keep in good tilth, and they are susceptible to further erosion unless good management is used. Providing regular additions of organic matter, improving tilth, increasing permeability, and controlling erosion are all major concerns of management.

Cultivated crops are grown on most areas of these soils. Corn, small grains, and grasses and legumes grown for hay are the main crops, but shallow-rooted truck crops and soybeans are also grown. These soils are especially well suited to alfalfa. Alfalfa improves the permeability of the subsoil because its roots penetrate deeply and form channels through which water can flow. Small areas of these soils are in permanent pasture or woodlots, and these areas can be developed as habitat for wildlife.

Capability Unit IIIe-7

This capability unit consists of well-drained, sloping soils of the Boyer series. These soils have a loamy sand surface layer and a sandy loam subsoil over sandy underlying material. Natural fertility, organic-matter content, and available water capacity are low. The soils have moderately rapid permeability and are subject to blowing where the surface is bare and exposed to the wind. Water erosion also is a hazard because of slope and the erodible soils.

These soils are poorly suited to crops because of droughtiness. Corn, small grains, forage crops, and other crops can be grown but do not grow well in dry periods.

Some areas are in pasture or woodlots or can be developed as habitat for wildlife.

Capability Unit IIIw-3

In this capability unit are somewhat poorly drained and poorly drained, nearly level and gently sloping soils in depressions and drainageways. These are soils of the Pella series, moderately shallow variant, and of the Ritchey series, mottled subsoil variant. They have a surface layer of silt loam. The Pella soil is underlain by bedrock at some depth between 24 and 40 inches, and the Ritchey soil is underlain by bedrock at a depth of about 29 inches.

Soils of this unit have moderate or moderately slow permeability, moderate to high natural fertility, and medium available water capacity. They are susceptible to overwash, overflow, and ponding, and the gently sloping areas are slightly susceptible to erosion. Preventing overwash and lowering the water table are the main concerns of management.

Surface drainage is needed before row crops can be satisfactorily grown. Because bedrock is so near the surface, however, establishing drainage by installing open ditches is difficult and installing tile drains is not feasible. Where drainage is adequate, the soils are suited to most crops commonly grown in the survey area. Small grains tend to lodge, and the soils are better suited to red clover, Ladino clover, and alsike clover than to alfalfa. Shallow-rooted truck crops and soybeans are grown in some places. Undrained areas are used as pasture, woodland, or wildlife habitat.

Capability Unit IIIw-5

Deep, somewhat poorly drained or poorly drained, nearly level soils of the Gilford and Granby series are in this capability unit. These soils are in drainageways, on low stream terraces, and on flats of outwash plains. They have a loamy surface layer and have moderately low natural fertility, moderately rapid permeability, and medium available water capacity. The water table is high, and flooding or ponding is a hazard. Lowering the water table, providing protection from flooding, maintaining fertility, and protecting these soils from blowing are the major concerns of management.

Most areas of these soils are undrained and are used as pasture, woodland, and wildlife habitat. Where the soils are drained, they are suited to corn, small grains, and forage crops, and they are also used for shallow-rooted truck crops to some extent. Open ditches are suitable for lowering the water table.

Capability Unit IIIw-8

Ogden muck, which is very poorly drained and is nearly level or gently sloping, is the only soil in this capability unit. This soil is in areas adjacent to lake basins, in potholes, on bottoms along streams, and in seep areas adjacent to outwash plains. It is underlain by clayey material at some depth within 42 inches of the surface. Natural fertility is low, the available water capacity is very high, and permeability is slow. This soil is deficient in phosphorus and potash. The gently sloping areas are slightly susceptible to erosion.

If this soil is to be used for cultivated crops, it must be drained by installing open ditches, tile drains, or a combination of open ditches and tile drains. Where the tile is well blinded, it can be laid in the clayey substratum. Subsidence, blowing, and damage from fire are hazards after this soil is drained. Controlling drainage is desirable to prevent excessive subsidence of the organic material and to lessen the risk of damage from fire. The crops most commonly grown are corn, soybeans, bluegrass for sod, and onions, potatoes, carrots, and other truck crops. The undrained areas are used as native pasture, for woodlots, or as habitat for wildlife.

Capability Unit IIIw-9

This capability unit consists of very poorly drained, deep, nearly level or gently sloping Houghton soils, on bottoms along streams, in potholes and basins of old glacial lakes, and in seep areas adjacent to uplands. These soils are made up of muck and peaty muck. They have low natural fertility and very high available water capacity. Permeability is moderate, but internal drainage is slow. These soils are deficient in phosphorus and potash. Erosion is a slight hazard in the gently sloping areas.

These soils must be drained by means of open ditches, tile drains, or both if they are to be used for cultivated crops. After the soils are drained, they are subject to subsidence, blowing, and damage from fire. Controlling drainage is desirable to prevent excessive subsidence and to lessen the risk of damage from fire. The crops most commonly grown are corn, soybeans, bluegrass for sod (pl. VI), and mint, cabbage, potatoes, onions, carrots, and other truck crops. Undrained areas are in native pasture and woodlots, or they are used as wildlife habitat.

Capability Unit IIIw-12

Only Alluvial land, a deep, moderately well drained, loamy, nearly level land type on the flood plains of streams, is in this capability unit. This land type has moderate natural fertility and medium available water capacity. It is easy to cultivate but is subject to periodic flooding. Protection from streambank cutting is needed, and surface drainage is needed in places to remove the excess water from depressions.

Where the hazard of flooding is not severe during the growing season, row crops can be grown year after year. Where flooding is frequent, this land type is better suited to use as pasture, as woodland, or for development of habitat for wildlife than to field crops.

Capability Unit IIIs-4

In this capability unit are well-drained, nearly level and gently sloping, droughty soils of the Boyer, Fox, Oshtemo, and Warsaw series. These soils are on outwash plains and stream terraces. They have a surface layer of sandy loam or loamy sand and a substratum of sand or of stratified sand and gravel. Permeability is moderate to moderately rapid, and the available water capacity and natural fertility are medium to low. The content of organic matter is low, and soil blowing is a hazard unless these soils are protected. Water erosion is a hazard in the gently sloping areas. Providing regular additions of organic matter and plant nutrients, conserving moisture, and controlling erosion are the main concerns of management.

Droughtiness makes these soils poorly suited to crops. Corn, small grains, forage crops, and other common crops can be grown, but they do not grow well in dry seasons. Small areas that are not used for cultivated crops are in pasture or woodlots, and these can be developed for wildlife habitat.

Capability Unit IVe-1

This capability unit consists of well-drained, deep or moderately deep, sloping to moderately steep, loamy soils of the Hochheim and Miami series. These soils are on glaciated uplands and outwash plains in the west-central part of Waukesha County. They are moderately permeable, have medium available water capacity, and have moderate natural fertility. The soils that have slopes of 6 to 12 percent are severely eroded, and those that have slopes of 12 to 20 percent are slightly eroded or moderately eroded. The soils are difficult to keep in good tilth and are susceptible to further severe erosion if they are cultivated.

Some areas of these soils are used for crops and pasture. Others are used as woodlots, and they produce food and cover for wildlife. The soils are too steep and too eroded to be cropped intensively. Row crops can be grown, however, if practices are used that help to control runoff and erosion, and if other good management is used. Growing small grains and hay crops in rotation, and renovating the pastures, are good practices.

Capability Unit IVe-3

This capability unit consists of sloping Casco soils that are shallow over sand and gravel and of sloping Ritchey soils that are shallow over dolomite bedrock. These soils have a sandy loam or silt loam surface layer. They are moderately permeable and have low available water capacity. In many areas as much as half of the original surface layer has been removed by erosion. Runoff is medium, and the erosion hazard is moderate.

The soils in this unit are used for crops, but because of the low available water capacity, they are very droughty unless their organic-matter content is kept high. The addition of large amounts of plant residue, as well as infrequent cropping, will help to maintain the organic matter and thus compensate for the limited available water capacity.

Where these soils are used for permanent pasture, a good cover can be maintained and erosion can be checked by controlling grazing and by periodic renovation of pastures.

Capability Unit IVe-4

This capability unit consists of well-drained or excessively drained, sloping, eroded, droughty soils of the Casco, Lorenzo, and Rodman series. These soils are on outwash plains and glaciated uplands. They have a loam surface layer. All of the soils have a substratum of loose, sandy glacial drift, and some of them have a gravelly substratum. Most of these soils have a moderately permeable subsoil and a rapidly permeable substratum, but the Rodman soil has a subsoil and a substratum that are very rapidly permeable. Natural fertility is low or very low, and the available water capacity is low. Further erosion is a moderate hazard. Controlling erosion, conserving moisture, providing regular additions of organic matter, and maintaining fertility are the main concerns of management.

These soils are used mostly for crops. The areas not cultivated are used as permanent pasture or woodlots, and they can be developed as habitat for wildlife. Where these soils are used for permanent pasture, controlling grazing and renovating the pastures when the stand becomes thin will help to maintain a desirable cover of plants and will help to check erosion. Topdressing the pastures each year helps to maintain a good stand of long-lived plants.

Capability Unit IVe-6

In this capability unit are deep, well drained and moderately well drained, sloping to moderately steep, eroded Morley and Ozaukee soils on glaciated uplands. These soils have a slowly permeable, clayey subsoil and substratum. They are susceptible to further severe erosion, and they are difficult to cultivate and to keep in good tilth.

Soils of this unit are generally not suited to row crops, but they can be used for other crops, meadow, pasture, trees, or wildlife habitat. The meadows or pastures should be renovated once every 5 years or when the stand becomes thin. Topdressing the pastures each year helps to maintain a vigorous stand of long-lived forage plants.

Capability Unit IVw-5

Wasepi sandy loam, 1 to 3 percent slopes, is the only soil in this capability unit. This soil has a loamy to sandy subsoil and is somewhat poorly drained. It is underlain by fine sand. Runoff is slow, and there has been little or no erosion. Permeability is moderately rapid, and the available water capacity is low.

Wetness is the main limitation to use of this soil as cropland, but the low available water capacity is also an important limitation.

Where drained, this soil is suited to most crops grown in the county. Most of the acreage is used for pasture or woodlots.

Capability Unit IVw-7

This capability unit consists of very poorly drained, nearly level organic soils of the Adrian, Muskego, and Rollin series. The Adrian and Rollin soils are underlain by marl or loose sand at some depth between 24 and 40 inches. The Muskego soil has a substratum of sedimentary peat at a depth of less than 40 inches. All the soils are on bottoms along streams, in old, shallow glacial lakebeds, or around the edges of broad depressions of outwash plains, where the water table is high. The available water capacity is high or very high, and natural fertility is low. Permeability ranges from moderately rapid to moderately slow, and internal drainage is slow. These soils are deficient in phosphorus and potash.

These soils must be drained, generally by means of open ditches, before they can be successfully used for crops. After the soils are drained, they are susceptible to subsidence and blowing. Control of drainage is desirable so that excessive oxidation and subsidence of the organic material will be prevented. Where the soils are drained, corn, truck crops, and bluegrass for sod are the most commonly grown crops. The undrained areas are generally used for pasture and trees or as wildlife habitat. In areas that are cropped, overhead irrigation can be used for controlling soil blowing and for protecting seedlings from damage during that part of the growing season when the risk of damage is greatest.

Capability Unit Vw-7

Only Rollin muck, shallow, a nearly level organic soil, is in this capability unit. This soil has a substratum of marl at a depth of less than 24 inches. It is in old glacial lake basins and on bottoms along streams. Natural fertility is low, the water table is high, and periodic flooding is a hazard to crops. This soil is extremely difficult to drain sufficiently for cultivated crops to be grown. It is especially deficient in phosphorus and potash.

In some places pastures on this soil can be improved by installing surface drains and seeding the areas to improved varieties of grasses. Other areas can be improved for wildlife by planting shrubs and other plants that provide food and cover. Level ditches can be used in some places to improve the areas for mink, muskrat, and waterfowl.

Capability Unit Vw-14

This capability unit consists of Wet alluvial land and of a deep, nearly level soil of the Sawmill series. These soils are on low bottoms adjacent to the major streams. They have a high water table and are susceptible to severe damage from flooding. Providing protection from flooding, and improving drainage adequately so that tilled crops can be grown, generally are not feasible. Among the suitable uses of these soils are permanent pasture, woodland, and wildlife habitat.

In some places pastures on these soils can be improved by installing surface drains, applying fertilizer, and seeding to improved varieties of grasses. Some areas can be made more suitable for wildlife by planting shrubs and other plants that provide food and cover. Level ditches can be used in places to improve the habitat for waterfowl and for mink, muskrat, and other small fur-bearing animals.

Capability Unit VIe-1

Only Miami loam, sandy loam substratum, 20 to 30 percent slopes, is in this capability unit. This soil has a clay loam subsoil and is underlain by sandy loam glacial till. It is moderately permeable; its available moisture capacity is high. Runoff is rapid, and the hazard of erosion is very severe.

Because of the erosion hazard, this soil has very severe limitations that affect its use for crops. It is suitable for use as woodland or wildlife habitat.

Capability Unit VIe-3

Ritchey silt loam, 12 to 30 percent slopes, which is well drained, is the only soil in this capability unit. This soil is droughty. It is underlain by dolomite bedrock at a depth of less than 20 inches. In places bedrock crops out at the surface or is so near the surface that it interferes with tillage. Depth of the root zone is limited. Permeability is moderate, and the available water capacity and natural fertility are low. Further erosion is a severe hazard. Controlling erosion, conserving moisture, and maintaining fertility are the major concerns of management.

This soil is not suited to row crops. It can be used for permanent pasture, kept in woodlots, or developed for wildlife habitat.

Capability Unit VIe-4

This capability unit consists of well-drained and excessively drained, mostly moderately steep, droughty soils of the Casco, Hochheim, Lorenzo, and Rodman series. These soils are loamy and are shallow to moderately deep over sandy glacial drift. They are on pitted outwash plains, terrace escarpments, and glaciated uplands. Most of the soils are already eroded, and further severe erosion is a hazare if cultivated crops are grown.

Soils of this unit are not suited to row crops, and for the most part, they have remained in woodlots. The areas are generally suitable for wildlife, and many of them are used as permanent pasture. In places small severely eroded areas of these soils are within fields made up mostly of soils better suited to tillage, and they are farmed with these other soils. In such severely eroded spots, large applications of organic matter, including barnyard manure, are needed if a satisfactory stand of forage plants is to be obtained.

Capability Unit VIIe-4

This capability unit consists of moderately steep to very steep Casco, Rodman, and Hochheim soils that are shallow to deep over sandy glacial drift. The Hochheim soils are already severely eroded, and the other soils are susceptible to severe erosion if they are not protected by a cover of grass or trees. The severely eroded areas are low in content of organic matter and in natural fertility.

Soils of this unit can be used for permanent pasture, as woodland, or as wildlife habitat. Controlled grazing is necessary in the pastures if a good sod is to be maintained. The areas of permanent pasture that are not too steep for use of tillage equipment can be renovated about once every 5 years. Harvesting of mature trees is difficult in some of the wooded areas because of the steepness and complexity of the slopes.

Capability Unit VIIs-9

Nearly level to moderately steep, excessively drained Chelsea soils are in this capability unit. These soils have low available water capacity and low natural fertility. They are subject to severe damage from blowing if the protective cover of plants is removed as the result of cultivation or grazing. Establishing a cover of plants is difficult in bare areas. Sloping areas are also susceptible to water erosion.

Soils of this unit are not suited to crops. They can be used as woodland or as wildlife habitat.

Capability Unit VIIIw-15

Only the land type Marsh is in this capability unit. This land type is generally adjacent to streams and inland lakes. It is flooded throughout most of the year and is very poorly drained. The vegetation consists mainly of cattails, bulrushes, and other water-tolerant plants (pl. VI).

This land type is not suitable for pasture or trees, but it can be used as wildlife habitat or for recreation. In most places ditches will improve the areas for waterfowl, muskrat, and other kinds of wildlife. Because the vegetation burns readily when dry, protection from fire is needed in winter and during extremely dry periods.

Capability Unit VIIIs-10

This capability unit consists of five miscellaneous land types--Clayey land, Loamy land, Rough broken land, Sandy and gravelly land, and Sandy lake beaches. These land types are mostly bare or nearly bare. They are generally lacking in fertility and are either very droughty or are subject to flooding. They consist of beach sand that lies in narrow strips along the shores of Lake Michigan; of steep, clayey banks just above the beach sand; and of manmade cuts and fills in areas of clayey, loamy, or sandy and gravelly material.

These land types are generally not suitable for the commercial production of plants. All plants now growing on them should be protected, for establishing a cover of plants is difficult. A more favorable type of soil material must be added to the areas of manmade cuts and fills if grass is to be established. Where trees or shrubs are to be planted, holes are needed to accommodate the root system, and these holes must be filled with soil material more favorable for the growth of plants.

These land types can be used as wildlife habitat. The ones adjacent to Lake Michigan also have value as scenic areas.

Yield Predictions

Table 2 shows predicted average yields per acre of the crops commonly grown in Milwaukee and Waukesha Counties for most soils in the county. The yields are averages of those expected over a period of several years under two levels of management. Casco-Rodman complex, 30 to 45 percent slopes; Clayey land; Loamy land; Marsh; Muskego muck; Rollin muck, shallow; Rough broken land; Sandy and gravelly land; Sandy lake beaches; and Wet alluvial land are not shown in table 2, because they generally are not suited to crops. Predictions shown in table 2 are based on interviews with farmers, on results obtained by the agricultural experiment station from experimental test plots, and on observations by soil scientists and other agricultural workers who are familiar with the soils and crops in these two counties. Future improvements in technology are expected to make these predictions obsolete.

In table 2 yields in columns A are those obtained under average management practiced by most farmers at the time the soil survey was made. Those in

TABLE 2.--PREDICTED AVERAGE ACRE YIELDS OF PRINCIPAL CROPS UNDER TWO LEVELS OF MANAGEMENT

[Predicted yields in columns A are those obtained under average management; predicted yields in columns B are those obtained under improved, or a high level of, management. Absence of a yield figure indicates that the soil is not suited to the crop, or that the crop is not ordinarily grown on the soil]

Soil	Corn				Oats		Alfalfa-brome hay 1/ (dry weight)	
	Grain		Silage					
	A	B	A	B	A	B 2/	A	B
	Bu.	Bu.	Tons	Tons	Bu.	Bu.	Tons	Tons
Adrian muck	--	---	12.0	17.0	--	--	---	----
Alluvial land 3/	70	100	11.0	16.0	50	65	3.0	4.0
Ashkum silty clay loam, 0 to 3 percent slopes	70	100	12.0	17.0	50	65	---	4.0
Aztalan loam, 0 to 2 percent slopes	65	100	11.0	17.0	50	60	2.5	4.5
Aztalan loam, 2 to 6 percent slopes	65	100	11.0	17.0	50	60	2.5	4.5
Blount silt loam, 1 to 3 percent slopes	65	100	12.0	17.0	50	65	2.5	4.0
Boyer loamy sand, 1 to 6 percent slopes	45	65	8.0	11.0	35	50	1.5	2.5
Boyer loamy sand, 6 to 12 percent slopes, eroded	40	60	7.5	10.0	30	45	1.25	2.25
Boyer sandy loam, 1 to 6 percent slopes	55	70	9.0	12.0	40	55	1.5	2.5
Brookston silt loam, 0 to 3 percent slopes	75	115	13.0	18.0	50	65	----	4.0
Casco sandy loam, 2 to 6 percent slopes	50	65	8.0	11.0	30	45	1.5	2.5
Casco sandy loam, 6 to 12 percent slopes, eroded	45	60	7.0	10.0	30	40	1.25	2.25
Casco sandy loam, 12 to 20 percent slopes, eroded	--	---	----	----	25	35	1.0	2.0
Casco loam, 2 to 6 percent slopes	50	70	8.0	12.0	40	55	1.75	2.75
Casco loam, 6 to 12 percent slopes, eroded	45	65	7.0	11.0	35	50	1.5	2.5
Casco loam, 12 to 20 percent slopes, eroded	--	---	----	----	30	45	1.25	2.25
Casco soils, 6 to 12 percent slopes, severely eroded	--	---	----	----	30	45	1.25	2.25
Casco-Rodman complex, 6 to 12 percent slopes, eroded	35	50	6.0	10.0	35	50	1.5	2.5
Casco-Rodman complex, 12 to 20 percent slopes	--	---	----	----	30	45	1.25	2.25
Casco-Rodman complex, 20 to 30 percent slopes	--	---	----	----	--	--	1.0	2.0
Chelsea fine sand, 1 to 6 percent slopes	30	40	4.5	6.5	25	35	1.0	2.0
Chelsea fine sand, 6 to 20 percent slopes	15	25	4.0	5.0	20	30	1.0	2.0
Colwood silt loam	65	95	12.0	16.0	45	60	----	4.0
Dodge silt loam, 0 to 2 percent slopes	80	110	13.0	17.0	60	75	3.0	4.5
Dodge silt loam, 2 to 6 percent slopes	80	110	13.0	17.0	60	75	3.0	4.5
Drummer silt loam, gravelly substratum	70	110	12.0	18.0	45	65	----	4.0
Elliott silt loam, 1 to 3 percent slopes	65	100	12.0	17.0	50	65	2.5	4.0
Fabius loam, 1 to 3 percent slopes	55	80	9.0	14.0	40	55	2.0	3.0
Fox sandy loam, 0 to 2 percent slopes	50	70	8.0	12.0	40	55	1.75	2.5
Fox sandy loam, 2 to 6 percent slopes	48	68	7.5	11.0	35	50	1.75	2.25
Fox sandy loam, 6 to 12 percent slopes, eroded	40	60	7.0	9.5	30	40	1.25	1.75
Fox sandy loam, loamy substratum, 2 to 6 percent slopes	50	70	8.0	12.0	40	55	2.0	2.5
Fox loam, 0 to 2 percent slopes	50	80	9.0	13.0	45	60	2.5	3.25
Fox loam, 2 to 6 percent slopes	50	80	9.0	13.0	45	60	2.5	3.25
Fox loam, 6 to 12 percent slopes, eroded	45	70	8.0	11.0	35	50	2.0	2.75
Fox silt loam, 0 to 2 percent slopes	60	85	10.0	14.0	50	65	2.5	3.5

See footnotes at end of table.

TABLE 2.--PREDICTED AVERAGE ACRE YIELDS OF PRINCIPAL CROPS UNDER TWO LEVELS OF MANAGEMENT--Continued

Soil	Corn				Oats		Alfalfa-brome hay 1/ (dry weight)	
	Grain		Silage					
	A	B	A	B	A	B 2/	A	B
	Bu.	Bu.	Tons	Tons	Bu.	Bu.	Tons	Tons
Fox silt loam, 2 to 6 percent slopes	58	83	9.5	13.0	48	63	2.25	3.25
Fox silt loam, 6 to 12 percent slopes, eroded	45	75	8.0	11.0	40	55	2.0	2.75
Fox silt loam, loamy substratum, 2 to 6 percent slopes	55	80	9.0	12.0	45	60	2.25	3.0
Gilford loam	65	90	11.0	15.0	40	65	----	3.0
Granby fine sandy loam	80	60	11.0	13.0	45	60	----	3.0
Grays silt loam, 0 to 2 percent slopes	70	95	12.0	16.0	50	70	3.0	4.5
Grays silt loam, 2 to 6 percent slopes	70	95	12.0	16.0	50	70	3.0	4.5
Griswold silt loam, 2 to 6 percent slopes	70	90	12.0	15.0	50	60	2.5	3.5
Griswold silt loam, 6 to 12 percent slopes, eroded	60	80	11.0	14.0	43	53	2.0	3.0
Griswold silt loam, mottled subsoil variant, 2 to 6 percent slopes	75	110	12.0	17.0	55	65	2.5	4.0
Hebron loam, 0 to 2 percent slopes	80	110	12.0	17.0	55	70	3.0	4.5
Hebron loam, 2 to 6 percent slopes	75	105	11.0	16.5	50	65	2.75	4.25
Hebron loam, 6 to 12 percent slopes, eroded	65	95	10.0	15.5	45	60	2.5	3.75
Hochheim loam, 2 to 6 percent slopes	75	100	12.5	17.0	55	70	3.0	4.5
Hochheim loam, 2 to 6 percent slopes, eroded	70	95	12.0	16.0	55	70	2.75	4.25
Hochheim loam, 6 to 12 percent slopes, eroded	65	90	11.0	15.0	50	65	2.5	4.0
Hochheim loam, 12 to 20 percent slopes, eroded	50	80	10.0	13.5	40	55	2.25	3.5
Hochheim loam, 20 to 30 percent slopes, eroded	--	---	----	----	--	--	1.75	2.75
Hochheim soils, 6 to 12 percent slopes, severely eroded	50	70	8.0	11.0	35	50	2.0	3.0
Hochheim soils, 12 to 20 percent slopes, severely eroded	--	---	----	----	30	45	2.0	3.0
Hochheim soils, 20 to 30 percent slopes, severely eroded	--	---	----	----	--	--	2.0	3.0
Houghton muck, 0 to 2 percent slopes	--	---	15.0	19.0	--	--	---	---
Houghton muck, 2 to 6 percent slopes	--	---	15.0	19.0	--	--	---	---
Juneau silt loam, 1 to 3 percent slopes	75	105	12.0	17.0	55	70	3.5	4.5
Kane silt loam	80	100	13.0	17.0	45	65	2.5	3.5
Kendall silt loam, 1 to 3 percent slopes	80	115	13.0	18.0	55	65	2.5	4.5
Kewaunee silt loam, 2 to 6 percent slopes	60	100	10.0	16.0	55	85	2.5	4.0
Kewaunee silt loam, 6 to 12 percent slopes, eroded	55	95	9.5	15.5	50	80	2.25	4.0
Knowles silt loam, 0 to 2 percent slopes	60	85	10.0	14.0	50	70	2.5	3.5
Knowles silt loam, 2 to 6 percent slopes	60	85	10.0	14.0	50	70	2.5	3.5
Lamartine silt loam, 1 to 4 percent slopes	75	115	12.0	18.0	55	65	2.5	4.0
Lawson silt loam 3/	70	110	12.0	18.0	45	65	2.0	4.0
Lorenzo loam, 2 to 6 percent slopes, eroded	45	70	7.0	11.0	40	55	1.75	2.75
Lorenzo loam, 6 to 12 percent slopes, eroded	40	65	6.0	10.0	35	50	1.5	2.5
Lorenzo loam, 12 to 20 percent slopes, eroded	--	---	----	----	30	40	1.25	2.25

See footnotes at end of table.

TABLE 2.--PREDICTED AVERAGE ACRE YIELDS OF PRINCIPAL CROPS UNDER TWO LEVELS OF MANAGEMENT--Continued

Soil	Corn				Oats		Alfalfa-brome hay 1/ (dry weight)	
	Grain		Silage					
	A	B	A	B	A	B 2/	A	B
	Bu.	Bu.	Tons	Tons	Bu.	Bu.	Tons	Tons
Manawa silt loam, 1 to 3 percent slopes---	60	90	10.0	15.0	50	75	2.5	4.0
Markham silt loam, 2 to 6 percent slopes--	65	100	12.0	17.0	50	70	3.0	4.5
Martinton silt loam, 1 to 3 percent slopes----------	70	105	12.0	17.0	50	65	3.0	4.5
Matherton sandy loam, 1 to 3 percent slopes----------	60	85	10.0	14.0	40	55	2.0	3.0
Matherton silt loam, 1 to 3 percent slopes----------	65	90	11.0	15.0	45	60	2.5	3.5
Mayville silt loam, 0 to 2 percent slopes-	80	105	13.0	17.0	60	75	3.0	4.5
Mayville silt loam, 2 to 6 percent slopes-	80	105	13.0	17.0	60	75	3.0	4.5
Mequon silt loam, 1 to 3 percent slopes---	65	100	12.0	17.0	50	65	2.5	4.0
Miami sandy loam, sandy loam substratum, 2 to 6 percent slopes----------	60	80	10.5	13.5	48	60	2.0	3.0
Miami sandy loam, sandy loam substratum, 6 to 12 percent slopes, eroded----------	55	75	9.0	12.0	40	50	2.0	2.5
Miami loam, sandy loam substratum, 2 to 6 percent slopes----------	70	90	12.0	15.0	55	70	2.5	3.5
Miami loam, sandy loam substratum, 6 to 12 percent slopes, eroded----------	60	80	10.0	13.0	45	60	2.0	3.0
Miami loam, sandy loam substratum, 12 to 20 percent slopes, eroded----------	55	75	9.0	12.0	40	55	1.75	2.75
Miami loam, sandy loam substratum, 20 to 30 percent slopes----------	--	---	----	----	--	--	1.25	2.0
Montgomery silty clay loam----------	65	100	11.0	17.0	40	60	----	4.0
Morley silt loam, 2 to 6 percent slopes---	65	100	12.0	17.0	50	70	3.0	4.5
Morley silt loam, 2 to 6 percent slopes, eroded----------	62	95	11.5	16.5	45	65	2.75	4.25
Morley silt loam, 6 to 12 percent slopes, eroded----------	55	85	10.0	15.0	37	57	2.25	3.75
Morley silt loam, 12 to 20 percent slopes, eroded----------	--	---	----	----	35	50	2.0	3.5
Mundelein silt loam, 1 to 3 percent slopes----------	75	100	12.0	17.0	45	65	3.0	4.0
Mussey loam----------	55	80	9.0	13.0	40	55	----	2.5
Navan silt loam----------	65	115	12.0	18.0	45	65	----	4.0
Ogden muck----------	--	---	15.0	19.0	--	--	----	----
Oshtemo loamy sand, 1 to 6 percent slopes-	45	65	8.0	11.0	35	50	1.5	2.5
Oshtemo sandy loam, 1 to 6 percent slopes-	45	65	8.0	11.0	35	50	1.5	2.5
Ozaukee silt loam, 2 to 6 percent slopes--	65	100	12.0	17.0	50	70	3.0	4.5
Ozaukee silt loam, 2 to 6 percent slopes, eroded----------	62	95	11.5	16.5	45	65	2.75	4.25
Ozaukee silt loam, 6 to 12 percent slopes, eroded----------	55	85	10.5	15.0	40	60	2.25	3.75
Ozaukee silt loam, 12 to 20 percent slopes, eroded----------	--	---	----	----	35	50	2.0	3.5
Palms muck----------	--	---	15.0	19.0	--	--	----	----
Pella silt loam----------	75	115	12.0	18.0	55	65	----	----
Pella silt loam, moderately shallow variant 4/----------	65	105	11.0	17.0	55	65	----	4.0
Pistakee silt loam, 1 to 3 percent slopes 3/----------	70	105	12.0	16.0	50	75	3.0	4.0
Ritchey silt loam, 1 to 6 percent slopes--	50	70	8.0	12.0	40	55	1.5	2.5

See footnotes at end of table.

TABLE 2.--PREDICTED AVERAGE ACRE YIELDS OF PRINCIPAL CROPS UNDER TWO LEVELS OF MANAGEMENT--Continued

Soil	Corn				Oats		Alfalfa-brome hay 1/ (dry weight)	
	Grain		Silage					
	A	B	A	B	A	B 2/	A	B
	Bu.	Bu.	Tons	Tons	Bu.	Bu.	Tons	Tons
Ritchey silt loam, 6 to 12 percent slopes, eroded	45	65	7.5	11.5	35	50	1.25	2.25
Ritchey silt loam, 12 to 30 percent slopes	--	---	----	----	--	--	1.0	2.0
Ritchey silt loam, mottled subsoil variant, 1 to 3 percent slopes 4/	50	80	8.0	13.0	45	70	2.0	3.5
Rollin muck, deep	--	---	12.0	17.0	--	--	----	----
St. Charles sandy loam, gravelly substratum, 1 to 3 percent slopes	75	110	11.0	17.0	55	70	3.0	4.0
St. Charles silt loam, 0 to 2 percent slopes	80	115	14.0	18.0	65	75	3.0	4.5
St. Charles silt loam, 2 to 6 percent slopes	80	115	14.0	18.0	65	75	3.0	4.5
St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes	80	115	12.0	18.0	60	75	3.0	4.5
St. Charles silt loam, gravelly substratum, 2 to 6 percent slopes	80	110	12.0	18.0	60	75	3.0	4.5
Sawmill silt loam, calcareous variant 3/	--	110	----	18.0	--	--	----	----
Saylesville silt loam, 0 to 2 percent slopes	65	85	12.0	14.0	50	70	3.0	4.5
Saylesville silt loam, 2 to 6 percent slopes	65	85	12.0	14.0	50	70	3.0	4.5
Saylesville silt loam, 2 to 6 percent slopes, eroded	60	80	11.0	13.0	45	65	2.75	4.25
Saylesville silt loam, 6 to 12 percent slopes, eroded	55	75	10.0	12.0	40	60	2.5	4.0
Sebewa silt loam	65	90	11.0	15.0	45	65	----	4.0
Theresa silt loam, 0 to 2 percent slopes	70	105	12.0	16.5	50	70	2.75	4.5
Theresa silt loam, 2 to 6 percent slopes	70	100	12.0	16.0	50	65	2.5	4.5
Theresa silt loam, 2 to 6 percent slopes, eroded	65	95	11.5	15.5	45	63	2.25	4.25
Theresa silt loam, 6 to 12 percent slopes, eroded	60	90	10.5	14.5	40	60	2.0	4.0
Virgil silt loam, gravelly substratum, 0 to 3 percent slopes	80	115	12.0	18.0	55	70	3.0	4.5
Wallkill silt loam 3/	80	105	13.0	17.0	40	60	----	----
Warsaw sandy loam, 2 to 6 percent slopes	55	80	9.0	13.0	40	55	2.0	3.0
Warsaw loam, 0 to 2 percent slopes	65	90	11.0	15.0	50	65	2.5	3.5
Warsaw loam, 2 to 6 percent slopes	60	85	10.0	14.0	45	60	2.25	3.25
Warsaw loam, 6 to 12 percent slopes, eroded	55	80	9.0	13.0	40	55	2.0	3.0
Warsaw silt loam, 0 to 2 percent slopes	70	95	11.0	15.0	55	70	2.0	3.0
Wasepi sandy loam, 1 to 3 percent slopes	60	80	10.0	13.0	40	60	2.0	3.0

1/ Yields are for hay cut during the first or second years after the stand is adequately established.

2/ Yields are for oats seeded with a grass-legume mixture.

3/ Yields are for areas of this soil that are protected from flooding.

4/ Drainage suitable for a high level of management cannot be installed in some places, because of bedrock.

columns B are obtained under improved management. Under the kind of management used to obtain the yields shown in columns A, soils are limed to maintain soil reaction at a favorable level, but inadequate fertilizer is applied and drainage of wet areas is not improved enough for maximum yields.

For corn grown under average management, the seedbed is prepared in the usual manner by plowing and harrowing; about 12,000 plants of hybrid corn per acre are seeded; about 8 tons of barnyard manure and about 150 to 200 pounds per acre of a commercial fertilizer that is high in content of phosphorus and potash are applied as a starter; the crop is cultivated two or three times; and a minimum of chemical weed control practices is applied. For oats seeded with alfalfa and bromegrass, the seedbed is prepared by plowing and harrowing, and about 150 pounds per acre of a commercial fertilizer that is high in content of phosphorus and potash is broadcast just before the crop is planted or at planting time. Hay is cut twice each year, generally when the forage is overmature, and the field is grazed in fall. Little or no fertilizer is applied to meadows.

The management needed to obtain the yields shown in columns B is considerably better than that practiced to obtain yields shown in columns A. Under this high level of management, wet soils are adequately drained and adequate drainage is maintained; lime and fertilizer are applied according to the needs indicated by the results of soil tests; good varieties of hybrid grains are seeded; tillage is timely; chemical weed control is commonly used; and forage crops are cut at a time when they will yield hay of good quality.

For corn, a high level of management consists of preparing the seedbed in the usual way; delaying tillage after periods of rain until the soils have dried enough that they do not puddle; applying manure at the rate of about 10 tones per acre, where manure is available; broadcasting a fertilizer high in content of phosphorus and potash before the crop is planted; seeding an adapted hybrid variety at the rate of 14,000 to 18,000 plants per acre; and applying a starter fertilizer, followed later by a sidedressing of nitrogen. Chemical weed control is also generally used.

For oats seeded with a mixture of alfalfa and bromegrass, the high level of management needed for obtaining the yields shown in columns B consists of preparing the seedbed in the usual manner, but not when the soil is wet; planting seed of a good variety that is suited to the soil; and applying a fertilizer that is high in content of phosphorus and potash prior to the time the crop is seeded or at planting time. Both lime and fertilizer are applied in amounts indicated by the results of soil tests.

For hay, especially alfalfa hay, a high level of management consists of applying lime according to the needs indicated by the results of soil tests; growing varieties of grasses and legumes that are resistant to wilt and winterkill; cutting the hay three times during the season at times when the forage will be of good quality; allowing little or no grazing of the meadow in fall; and applying a fertilizer that is high in content of phosphorus and potash as a topdressing.

Yields of pasture are not included in table 2, because many of the better farmers prefer to feed chopped green forage or silage instead of allowing their livestock to graze the pastures.

The yields shown in table 2 may vary greatly from year to year on a particular soil because of differences in the intensity and distribution of rainfall, variations in temperature, and other factors. For most soils, crop yields need to be averaged over a 10-year period if an accurate estimate of a soil's capability under a given level of management is to be obtained. Yields on the sandy and shallow soils are more variable from year to year than are those on the deeper soils that have higher available moisture capacity.

Yields higher than those shown in table 2 can be obtained through use of a larger quantity of a suitable fertilizer and more careful management. The county agent or a representative of the Soil Conservation Service can supply information on seeding mixtures and on the amounts of lime and the kinds and amounts of fertilizer to use.

The estimates in table 2 can be used to learn if farm management is adequate and to determine which level of management will net the farm operator the greatest returns. If average yields obtained in recent years have been lower than those shown for the same soil in table 2, the management and cropping system probably need a careful review.

Woodland and Community Planting [2/]

Originally, about 84 percent of the survey area was in forest. The main species of trees were sugar maple, basswood, beech, red oak, elm, and ash. Land clearing began about 1850, and it reached its peak early in the 1900's. Clearing continues even today, but it is much less intensive than it was formerly. Woodland now occupies only about 9 percent (42,000 acres) of the survey area. Oak is the principal species, accounting for about two-thirds of the tree volume in wooded areas. Other woodland species are elm, hickory, red maple, sugar maple, basswood, and cherry.

The largest tracts of woodland are in the western part of Waukesha County, mainly in the townships of Eagle, Ottawa, Summit, and Delafield. Woodland in public ownership, amounting to 6,800 acres and mainly in the Kettle Moraine State Forest, is within these four townships. Most areas of woodland in the survey area are rather small and are in private ownership. Less than half of the acreage in these small areas of woodland is heavily grazed, but grazing should be discontinued, even in those places, so that the maximum production of wood can be obtained.

Most wooded areas contain too many poor trees and not enough good trees. In these understocked areas,

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2/ By ROBERT E. GREENLAW, woodland conservationist, Soil Conservation Service.

the average annual growth rate is only about 0.15 cord per acre. The growth rate in understocked wooded areas that occupy the better soils can be accelerated to about 0.45 cord per acre per year through improved management and the planting of enough seedlings that will grow to trees of high quality and will fully stock the stand. Some poorly stocked wooded areas, however, are so brushy, wet, rocky, or steep that they are not favorable for planting.

About 1,900 acres in the Kettle Moraine State Forest has been planted to red and white pines since 1947. Many wooded areas in private ownership have also been established since that time, but they account for only a small part of the total acreage in trees.

Good veneer logs and saw logs of the principal species of trees are nearly always in demand. The demand for fuelwood has greatly declined in recent years. Therefore, most owners have little or no incentive to cut the poor trees and market the wood as a business venture. Because many new homes have fireplaces, the demand for fireplace wood probably will increase in the future. The growing of Christmas trees has increased in popularity. Production of these trees appears to be a land use that may also increase in the future.

The wood-producing value of wooded tracts may decline to secondary importance in some places as the pressure to convert these areas to other uses is increased. In great demand are the esthetic values of wooded tracts for parkways, campgrounds, recreational areas, and estate-type homes. For these uses, the values for shade and beautification are greater than the value of the wood that could be harvested. Conversion of the areas to other uses requires careful planning to prevent the unnecessary destruction of wooded tracts.

Woodland Suitability Groups

The soils of Milwaukee and Waukesha Counties have been placed in woodland suitability groups to assist owners in planning use of their woodland. Soils that give similar response to use and management have been grouped together. In discussing these groups, the productivity of the soils (site index) and the various factors that affect management have been considered. Factors that affect management are the hazards to the survival of seedlings, the hazards of windthrow and erosion, suitability of the soils for a given species, limitations to the use of woodland equipment, and the effects of soil-associated diseases, insects, and animals.

Among the best indicators of soil productivity for trees is the site index. This index is merely the height, in feet, attained by the tallest trees in the stand at the age of 50 years. The site index can be used in conjunction with available tables of normal yields, supplied by research foresters, to predict yields from wooded tracts. Site indexes for many of the soils used as woodland in Milwaukee and Waukesha Counties were determined from measurements made by a forester and a soil scientist working together. Suitable areas of woodland were not available for measurement on all the soils, and for those areas site quality was estimated by comparison with similar soils.

Information given in the descriptions of the suitability groups can be used with other information in this soil survey to determine the kinds of trees that grow best on a given soil. The soils in a group are identified only by the name of the series. Listing of the series name does not necessarily mean, however, that all the soils of that series are in this particular group. The "Guide to Mapping Units," at the back of this publication, gives the woodland group in which each soil mapped in the survey area has been placed.

Estimates of average annual yields per acre of usable timber that can be obtained from fully stocked wooded tracts consisting of representative soils of this survey area are shown in table 3. Because of seedling mortality and the presence of cull trees and the lack of enough good trees, the high yields shown in table 3 generally are not obtained on unmanaged wooded tracts.

TABLE 3.--ESTIMATED YIELDS FROM WOODLAND ON SOILS OF MILWAUKEE AND WAUKESHA COUNTIES

[Dashes indicate the soil is not suited to or is not used for the class of trees specified. Soils seldom used or not suitable for woodland are omitted from table]

Soil type	Woodland group	Board feet per acre per year, Scribner rule 1/			
		Mixed hardwoods	Oak	Red pine	White pine
Adrian muck	10	100-200	---	---	---
Ashkum silty clay loam	7	---	80-120	---	---
Blount silt loam	7	---	160-190	---	---
Boyer loamy sand	4	---	60-90	---	---
Boyer sandy loam	3	---	80-120	---	400-450
Brookston silt loam	7	---	80-120	---	---
Casco loam	5	---	100-150	---	300-375
Casco sandy loam	5	---	80-210	---	---
Casco-Rodman complex	5	---	80-120	---	---

TABLE 3.--ESTIMATED YIELDS FROM WOODLAND ON SOILS OF MILWAUKEE AND WAUKESHA COUNTIES--Continued

Soil type	Woodland group	Board feet per acre per year, Scribner rule 1/			
		Mixed hardwoods	Oak	Red pine	White pine
Chelsea fine sand	4	---	80-120	---	---
Colwood silt loam	7	100-150	---	---	---
Dodge silt loam	1	200-250	180-220	450-500	500-600
Drummer silt loam, gravelly substratum	7	80-120	---	---	---
Fox loam	1	160-190	135-165	325-400	400-450
Fox sandy loam	3	135-165	135-165	325-400	400-450
Fox sandy loam, loamy substratum	3	135-165	135-165	325-400	400-450
Fox silt loam	1	180-220	135-165	325-400	400-450
Fox silt loam, loamy substratum	1	180-220	135-165	325-400	400-450
Gilford loam	7	80-120	---	---	---
Granby fine sandy loam	8	80-120	---	---	---
Grays silt loam	1	200-250	---	400-450	450-500
Hebron loam	1	---	135-165	---	---
Hochheim loam	1	130-220	135-165	---	400-450
Hochheim soils	5	80-120	80-120	---	---
Houghton muck	10	100-200	---	---	---
Juneau silt loam	1	180-220	180-220	---	---
Kendall silt loam	7	135-165	135-165	---	400-450
Kewaunee silt loam	2	225-275	225-275	---	450-500
Knowles silt loam	1	135-165	160-190	275-350	350-400
Lamartine silt loam	7	135-165	---	---	---
Manawa silt loam	7	160-190	160-190	---	---
Markham silt loam	1	160-190	160-190	---	---
Matherton sandy loam	7	135-165	135-165	---	---
Matherton silt loam	7	135-165	135-165	---	---
Mayville silt loam	1	180-220	160-190	---	300-375
Mequon silt loam	7	---	160-190	---	---
Miami loam, sandy loam substratum	1	180-220	180-220	450-500	450-500
Miami sandy loam, sandy loam substratum	3	---	100-150	---	---
Morley silt loam	2	160-190	100-150	---	---
Mundelein silt loam	7	225-275	225-275	---	---
Muskego muck	10	100-200	---	---	---
Mussey loam	7	80-120	---	---	---
Navan silt loam	7	60-90	---	---	---
Ogden muck	10	100-200	---	---	---
Oshtemo loamy sand	4	---	100-150	350-450	400-500
Oshtemo sandy loam	3	---	135-165	350-450	500-600
Ozaukee silt loam	2	160-190	160-190	---	---
Palms muck	10	100-200	---	---	---
Pella silt loam	7	80-120	---	---	---
Pella silt loam, moderately shallow	7	80-120	---	---	---
Pistakee silt loam	7	180-220	180-220	---	---
Ritchey silt loam	5	100-150	135-165	---	---
Rollin muck, deep	10	100-200	---	---	---
Rollin muck, shallow	10	100-200	---	---	---
Rough broken land	11	135-250	135-250	---	---
St. Charles silt loam	1	180-220	180-220	---	---
St. Charles sandy loam, gravelly substratum	1	200-250	225-275	450-500	450-550
St. Charles silt loam, gravelly substratum	1	200-250	225-275	450-500	450-550
Sawmill silt loam, calcareous variant	9	100-150	---	---	---
Saylesville silt loam	2	225-275	225-275	---	---
Sebewa silt loam	7	80-120	---	---	---
Theresa silt loam	1	200-250	180-220	300-350	350-400
Virgil silt loam, gravelly substratum	7	180-220	180-220	---	---
Wallkill silt loam	9	135-165	---	---	---
Wasepi sandy loam	8	80-120	80-120	---	---

1/ No deductions have been made for culls or defective trees.

Woodland Group 1

This woodland group consists of Alluvial land and soils of the Dodge, Fox, Grays, Hebron, and Hochheim series. These soils are deep enough that roots develop well, and they have high available water capacity, moderate to high fertility, and moderate permeability. Their potential for production of timber is higher than that of other soils in the survey area. Because these soils are also highly desirable for farming, only small, isolated areas are used as woodland.

Northern hardwoods, such as red oak, white oak, maple, hickory, and basswood, are the principal native trees, but some elm and ash grow on the more moist sites. The trees are generally tall and well formed.

The average site index for red oak is about 63 on representative soils of this group, and the average annual yield from red oak is 140 to 225 board feet per acre. The average annual yield from northern hardwoods is as high as 250 board feet per acre in some years. Yields are somewhat lower on ridgetops, on south-facing slopes, and on other hot, dry sites than they are on moist sites and on north-facing slopes.

Planted white pine and red pine do well on the soils of this group if grass, brush, and weeds are controlled. Competition from grass, brush, and weeds is severe. The planting of hardwoods has generally been unsuccessful. Existing stands of hardwoods can be managed so that sawtimber or veneer of high quality can be produced. Saw logs and fenceposts of poor quality are generally produced on eroded sites and on the upper slopes. Basswood, ash, red oak, and other species that have high value should be favored in coves, on north- and east-facing slopes, and on other more favorable sites. Red oak should be favored on south-facing and west-facing slopes.

Temporary soil wetness caused by heavy rains or spring thaws, and slopes that are steeper than 12 percent, are the only limitations to use of equipment needed for fire control, machine planting, and harvesting of trees. Using heavy equipment for logging can damage the soils by compacting them. Logging causes less damage in winter than at other times. Locating logging roads and fire accessways on ridgetops or establishing them on the contour is desirable. Skidding the logs uphill reduces the hazard of erosion.

Woodland Group 2

This woodland group consists of moderately deep and deep, moderately well drained and well drained soils of the Kewaunee, Morley, Ozaukee, and Saylesville series. These soils have a surface layer of silt loam. They have high available water capacity, moderate to high natural fertility, and slow or moderately slow permeability. Slopes range from 0 to 20 percent.

Red oak, white oak, maple, hickory, basswood, and other northern hardwoods are the principal native trees in most stands, but some elm and ash grow on the more moist sites. The trees are generally well formed, and they produce sawlogs and veneer of high quality.

The site quality is high for hardwoods and medium for conifers. Measurements of individual trees growing on representative soils indicate that the site index is about 70 for sugar maple and 62 to 74 for red oak. The average yield from red oak is 150 to 240 board feet per acre per year, but the yield can be as much as 275 board feet per acre in some years. Yields are somewhat lower on ridgetops, on south-facing slopes, and on other hot, dry sites than they are on north-facing and east-facing slopes.

White pine and white spruce are suitable species for planting. Competition from grass, brush, and weeds is severe, however, unless adequate measures are taken to control these plants. Planting of trees is often delayed because the soils are wet. Losses of planted seedlings are common during droughty periods, and frost heaving is a severe hazard in most places. White grubs cause considerable damage to roots in sodded areas. White pine blister rust is likely to cause damage to trees in areas where large numbers of currants and gooseberries (*Ribes* spp.) are grown.

Stands of hardwoods can be managed so that saw logs and veneer logs of high quality are produced. Trees that have the highest market value should be grown. In natural stands the preferred species are sugar maple, basswood, white ash, and red and white oaks. The planting of hardwoods has generally been unsuccessful on these soils.

Wheeled equipment needed for planting and harvesting trees ought to be used only when the soils are dry or frozen. Compaction occurs if heavy equipment is used on wet soils, and the equipment is likely to bog down. Where slopes are steeper than 12 percent, roads and fire access lanes should be located on ridgetops or on the contour if feasible. Skidding the logs uphill reduces the hazard of erosion.

Woodland Group 3

In this woodland group are well drained, moderately deep and deep soils of the Boyer, Fox, Miami, and Oshtemo series. These soils have a surface layer of sandy loam. Most of them have medium available water capacity. Slopes range from 0 to 12 percent.

The principal native trees are black oak, bur oak, hickory, and aspen. Principal forest products are fuelwood and sawtimber.

On these soils the site quality is poor for oak and other hardwoods and good for pine. Hardwoods are generally not tall, are poorly formed, and are of inferior quality.

Planted pines grow well on these soils. Competition from other plants is generally not a hazard,

except in a few places on north-facing slopes, where brush competes with the pines. In eroded areas and on south-facing slopes, damage to seedlings from heat or drought can be severe, but such damage is generally only moderate in other places.

Species that have the highest value should be favored in existing stands. Because pines normally are more productive than hardwoods on these soils, they should be favored in managing woodland.

Logging roads and fire access ways ought to be located on ridgetops or on the contour if feasible. Skidding the logs uphill, where practical, helps to reduce erosion.

Woodland Group 4

Droughty soils of the Boyer, Chelsea, and Oshtemo series are in this woodland group. Most of these soils are somewhat excessively drained, and they are underlain by calcareous sand in most places. Only one of the soils is eroded. Slopes range from 1 to 20 percent.

The principal native trees are northern pin oak, black oak, bur oak, and scattered white pines. The hardwoods are not tall, are poorly formed, and are of poor quality.

Measurements of a limited number of individual trees growing on representative soils of this group show that the site index for oak is 40 or less. Yields of all hardwoods are very low on ridgetops and on hot, dry, south-facing and west-facing slopes.

Redcedar can be planted on the eroded sites and on the steeper slopes, but the trees do not grow well. White pine generally does fairly well if it is underplanted in poor stands of oak. Red pine generally grows poorly where the soils are underlain by calcareous material.

Seedling mortality from heat and drought is severe. In most places competition from other plants is not a hazard, and losses caused by plant diseases are slight.

Species that have the highest market value should be favored on all sites. The fact that pines grown on these soils are normally more productive than hardwoods should be considered in managing woodland.

Use of equipment needed for planting and harvesting trees generally is limited only where the slopes are steeper than 12 percent. Maneuvering wheeled equipment is difficult where the soils are bare and are loose and sandy. Logging roads and fire access lanes are best located on ridgetops, and they should be run on the contour in the steeper areas. Skidding logs uphill, where practical, helps to reduce erosion.

Woodland Group 5

This woodland group consists of soils of the Casco, Hochheim, Miami, Ritchey, and Rodman series. Most of these soils are well drained. Some of them have a surface layer of sandy loam, and others have a surface layer of loam, clay loam, or silt loam. The soils are rather shallow over glacial material or bedrock. As a result, development of tree roots is restricted, and the available water capacity is lower than in deeper soils. Slopes range from 1 to 30 percent. Some of the soils are moderately or severely eroded.

The principal native trees are mixed oaks, maple, basswood, hickory, and aspen. Bur oak, black oak, and redcedar are also common on some of the hot, dry sites and in eroded areas. Few of the hardwoods are well formed and of high quality. Trees on the south-facing slopes and on other dry sites generally are of poor quality.

Measurements of individual trees on one representative soil of this group shows that the site index for red oak is 48 and that the site index for sugar maple is 47 to 59. Yields of northern hardwoods are lowest on the ridgetops, on south-facing slopes, and on other hot, dry sites.

Planted white pines grow well on north-facing and east-facing slopes and where they are underplanted among hardwoods of poor quality. Redcedar is an acceptable species for severely eroded areas and for south-facing and west-facing slopes, although the trees do not grow well.

Oaks reproduce naturally on these soils, but heat and lack of moisture are limiting factors to their reproduction in hot, dry areas. Rabbits and meadow mice are a hazard to seedlings in some grassy areas. In a few places, brushy plants overshadow the young seedlings and prevent them from receiving enough sunlight.

Use of equipment needed for planting and harvesting trees is limited by gullies, rockiness, or slopes that are steeper than 12 percent. Timber should be harvested only when the soils are dry or frozen. Erosion and compaction are likely to occur if harvesting is done when the soils are wet. Machine planting and fire control activities are limited where the slopes are steeper than 12 percent. They are also limited by bedrock near the surface in areas of Ritchey soils. Logging roads and fire access lanes should be located on ridgetops or run on the contour wherever feasible. Skidding the logs uphill, where practical, helps to reduce the risk of erosion.

Woodland Group 6

In this woodland group are soils of the Casco and Rodman series. For the most part, these soils are very droughty. Depth to the underlying sand and gravel is less than 18 inches in most places, and some areas contain cobblestones. Some of the Casco soils are severely eroded. Slopes range from 6 to 45 percent.

The principal native trees on ridgetops and on steep, convex slopes are bur oak and redcedar. These trees are generally scrubby, short boled, and limby. Because of the limited supply of moisture, growth of trees is very slow, and practically no forest products are harvested. Redcedar is the only species suitable for planting in these places, and the

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changes of obtaining merchantable products during a lifetime are slight.

In coves and on the lower slopes, the soils are somewhat deeper than in other areas, and they are more favorable for the growth of trees. The principal native trees in those places are mixed oaks, hickory, maple, and basswood. Planted white pines grow well where they are underplanted in open stands of hardwoods.

Regeneration of trees is slow because of the lack of moisture and damage from heat on some exposed slopes. Where the slopes are steep, or where cobblestones are numerous, these soils are unsuitable for use of equipment needed for planting and harvesting trees. Maintaining the present woodland stands is the principal objective of management. Because the soils of this group are poorly suited to most species of trees, all trees presently on sites intended for residential or recreational purposes should be carefully preserved.

Woodland Group 7

This woodland group consists of Ashkum, Blount, Brookston, Colwood, Drummer, Gilford, Kendall, Lamartine, Manawa, Matherton, Mequon, Montgomery, Mundelein, Mussey, Navan, Pella, Pistakee, Ritchey, Sebewa, and Virgil soils. These soils are somewhat poorly drained or poorly drained, and they are medium textured to moderately fine textured. Slopes range from 0 to 4 percent.

The principal native trees on the somewhat poorly drained soils of this group are mixed northern hardwoods and stands of oak and aspen. Common species on the poorly drained soils are soft maple, ash, and elm. On the somewhat poorly drained soils, the site quality is medium to good for mixed hardwoods, white pine, white-cedar, and white spruce. On the poorly drained soils, the site quality is only fair. Saw logs of good quality are harvested from trees growing on all soils of this group.

White spruce, white pine, and white-cedar are acceptable species for planting, though competition from other plants is a severe hazard to recently planted seedlings in some areas. Unless grasses, sedges, and brush are adequately controlled, competition from those plants is severe. Drowning is a moderate hazard to seedlings on the somewhat poorly drained soils, and it is a severe hazard on the poorly drained soils. In many places surface drainage is needed before trees are planted. Heat and lack of moisture are not hazards or are only slight hazards during dry periods, but damage from frost is a hazard in some depressional areas.

Windthrow is a severe hazard in the older woodlots. In these woodlots only the mature and defective trees should be harvested and those on the edges should be left to form a barrier to the wind. Root rot is a serious hazard, and the Dutch elm disease is a serious threat to elm trees. Rabbits and deer can cause severe damage to trees in some areas. They are especially likely to damage young trees in plantations.

Woodland Group 8

This woodland group consists of somewhat poorly drained and poorly drained soils of the Granby and Wasepi series. These soils have a surface layer of sandy loam or fine sandy loam. Their slopes range from 1 to 3 percent.

Oak, elm, ash, hickory, soft maple, and willow are the principal native trees growing on these soils. In most places these trees are of poor quality and are not tall.

Seedling mortality is moderate to severe as the result of excess water and competition from other plants. Fungi that cause rotting of the wood are troublesome in many places. Trees are also damaged or killed by oak wilt and by the Dutch elm disease.

These soils have limitations to use of equipment needed for planting and harvesting trees, especially during wet periods. When the soils are wet, the equipment is likely to bog down. Even though the trees are shallow rooted, the hazard of windthrow is moderate because the wet sand generally provides a good anchorage for roots.

Woodland Group 9

In this woodland group are Wet alluvial land and Sawmill and Wallkill soils. These soils are on alluvial flood plains. They are somewhat poorly drained to very poorly drained.

The principal native trees are elm, red maple, swamp white oak, cottonwood, and ash. The site quality for hardwoods growing on these soils ranges from poor to good. Cottonwood grows well on the better drained sites.

Flooding is frequent. Therefore, drowning is a severe hazard to seedlings. Plant competition is also a severe hazard, because tall weeds and brush grow profusely in openings between the trees. Insects normally cause little damage, but the risk of damage from root rot and stem rot is moderate to severe. Dutch elm disease is a serious threat to elm trees. The hazard of windthrow is generally moderate, but it is severe if the water table has remained high for a long period of time. Willow and cottonwood can be used along streambanks to provide some protection from erosion.

Wetness is a severe limitation to use of equipment needed for planting and harvesting trees. Timber should be harvested only when the soils are frozen or during prolonged dry periods. Suitable fire access lanes are generally difficult to establish, but fires occur infrequently on these soils.

In managing woodlots, species that have the highest market value are the ones to favor. The original cover of hardwoods should also be maintained.

Woodland Group 10

This woodland group consists of organic soils of the Adrian, Houghton, Muskego, Ogden, Palms, and Rollin series. These soils are very poorly drained.

Red maple, silver maple, elm, ash, white-cedar, and willow are the principal native trees growing on them.

The site quality for trees ranges from poor to good, depending on how well the soils are drained. Saw logs and fuelwood are the principal woodland products.

Tree planting machines are impractical on these soils, and hand planting is difficult. Therefore, trees are generally not planted, but white-cedar does well after it becomes established. Late frosts are common, and they are a serious hazard to seedlings. Many tree seedlings are drowned when the water table is high. Because the hazard of windthrow is severe, cutting should be limited. In some places white-cedar is damaged by the browsing of deer. Willows, established in windbreaks, are useful for protecting cultivated areas of these soils from blowing.

Woodland Group 11

In this woodland group are six miscellaneous land types--Clayey land, Loamy land, Marsh, Rough broken land, Sandy and gravelly land, and Sandy lake beaches. These land types are not suitable for trees, or they have severe limitations to use for trees. Rough broken land is better suited than the others. In places Rough broken land occupies side slopes that have a cover of trees, mainly maple, basswood, ash, and oak. This land type is so steep, however, that managing the wooded areas and harvesting the trees are difficult. The native vegetation on the other land types is small shrubs, grasses, and scattered small trees.

Land types of this unit have scenic value, but they are mainly of importance for use as wildlife habitat, watershed protection, and recreational uses. All management practices should be directed toward maintaining the present cover of plants.

Woodland Group 12

In this woodland group are well-drained to somewhat poorly drained soils of the Aztalan, Elliott, Fabius, Griswold, Kane, Lawson, Lorenzo, Martinton, and Warsaw series. These are prairie soils. They have a surface layer of loam, silt loam, or sandy loam, and they have slopes of 0 to 20 percent.

The principal native vegetation on these soils is prairie grasses, but a few scattered oaks and redcedars grow in places. No commercial forest products are harvested, but the trees produce some fuelwood and fenceposts.

The site quality is poor for all species of trees. Except where trees are planted for windbreaks, the planting of trees is generally unsuccessful. Table 4 gives the names of trees suitable for windbreaks on the soils of this group. Of the trees listed, white pine, white-cedar, Norway spruce, European larch, and redcedar are the most suitable for planting on the well-drained Griswold, Lorenzo, and Warsaw soils. White spruce, white-cedar, and cottonwoods are suitable for windbreaks on the somewhat poorly drained soils. Cultivating the areas used for windbreaks is desirable for the first 2 or 3 years. Cultivation reduces the severe competition from weeds and grasses and limits the damage caused by field mice. White grubs sometimes cause serious damage to trees. The use of an insecticide may be necessary to control them.

Selection of Trees for Ornamental Planting

Many trees are grown to provide shade along streets and in parks, to beautify lawns and homes, and to provide privacy or to protect property by functioning as a screen, a hedge, or a windbreak. Table 4, intended as a general guide, suggests the species of trees that are suitable for ornamental and protective plantings on the soils of the various woodland suitability groups described in the preceding pages.

Color of foliage, flowering and fruiting characteristics, resistance to injury from smoke, and susceptibility to disease have been considered in determining the species suitable for uses stated in table 4. Many horticultural varieties of trees that also are well adapted to the climate of Milwaukee and Waukesha Counties are not included in the table. Information on horticultural varieties is generally available from nurserymen.

American elm, which is suited to many different soils and climates and was formerly used extensively as a shade tree, is not listed in table 4, because of its susceptibility to the Dutch elm disease. This disease is prevalent in the survey area.

Shrub and Vine Planting Guide[3/]

Table 5 is a guide to the selection of shrubs and vines intended for use as hedges, ground cover, roadside beautification, and food and cover for wildlife. In this table the soils of Milwaukee and Waukesha Counties are placed in three groups according to their suitability for shrubs and vines. A fourth group, not shown in table 5, consists of miscellaneous land types that are not suitable for shrubs and vines. The shrub and vine group in which the mapping unit has been placed is given at the end of the description of the mapping unit and also in the "Guide to Mapping Units" at the back of this survey.

Only the more commonly used plants are listed in table 5, and all vines and shrubs shown are adapted to the climate of Milwaukee and Waukesha Counties. Shrubs and vines suited to the better drained soils are also suited to soils that have poor natural drainage if those soils are improved through artificial drainage. Organic soils have severe limitations for many plants, even after they are drained.

3/ By W. M. BRIGGS, agronomist, Soil Conservation Service.

TABLE 4.--TREE

Woodland suitability group, soil series, and map symbols	Brief description of soils	Tree species suitable for--
		Shade
Group 1---------- Alluvial land (Am). Dodge (DdA, DdB). Fox (FoA, FoB, FoC2, FsA, FsB, FsC2, FtB). Grays (GrA, GrB). Hebron (HeA, HeB, HeC2). Hochheim (HmB, HmB2, HmC2, HmD2, HmE2). Juneau (JuA). Knowles (KwA, KwB). Markham (MeB). Mayville (MoA, MoB). Miami (MxB, MxC2, MxD2). St. Charles (SaA, ScA, ScB, SeA, SeB). Theresa (ThA, ThB, ThB2, ThC2).	Moderately deep and deep, well drained and moderately well drained, loamy soils.	Sugar maple, red maple, American beech, northern red oak, white oak, basswood, hackberry, white ash, sycamore, bur oak.
Group 2---------- Kewaunee (KnB, KnC2). Morley (MzdB, MzdB2, MzdC2, MzdD2). Ozaukee (OuB, OuB2, OuC2, OuD2). Saylesville (ShA, ShB, ShB2, ShC2).	Deep, moderately well drained and drained soils that have a clayey subsoil.	Sugar maple, red maple, basswood, American beech, white oak, white ash, bur oak, northern catalpa, hackberry, sycamore, green ash, swamp white oak.
Group 3---------- Boyer (BnB). Fox (FmA, FmB, FmC2, FnB). Miami (MvB, MvC2). Oshtemo (OnB).	Moderately deep and deep soils that are well drained.	Scarlet oak, bur oak, hackberry, black oak.
Group 4---------- Boyer (BmB, BmC2). Chelsea (CtB, CtD). Oshtemo (OmB).	Sandy, excessively drained soils that are droughty.	Black oak, scarlet oak----
Group 5---------- Casco (CcB, CcC2, CcD2, CeB, CeC2, CeD2). Casco-Rodman (CrC2, CrD, CrE). Hochheim (HoC3, HoD3, HoE3). Miami (MxE). Ritchey (RkB, RkC2, RkE).	Thin, sloping to steep, loamy soils.	Northern red oak, white oak, bur oak, sugar maple, American beech, red maple.
Group 6---------- Casco (CfC3). Casco-Rodman (CrF).	Very thin, droughty soils-----	(1/)----------

See footnotes at end of table.

Tree species suitable for--Continued		
Lawns	Street borders	Hedges, screens, or windbreaks
Mountain-ash, blue beech, white ash, paper birch, river birch, Russian-olive, southern pin oak, juneberry, Kentucky coffeetree, red pine, white pine, white spruce, black cherry, ironwood.	Norway maple, southern pin oak, thornless honeylocust, ironwood, basswood, white ash, bitternut hickory.	Redcedar, Lombardy poplar, white-cedar, white pine, white spruce.
Paper birch, blue beech, mountain-ash, black cherry, white pine, white-cedar, ironwood, southern pin oak, white spruce.	Bitternut hickory, southern pin oak, thornless honeylocust, green ash, ironwood.	White-cedar, redcedar, Lombardy poplar, white spruce.
Paper birch, redcedar, red pine, white pine.	Ironwood----------	Redcedar.
Red pine, white pine----------	Hackberry----------	Redcedar, jack pine.
White pine, paper birch, Russian-olive, juneberry.	Bitternut hickory, Norway maple, green ash, ironwood.	Redcedar, white pine, white-cedar, white spruce.
(1/)----------	(1/)----------	Redcedar.

TABLE 4.--TREE

Woodland suitability group, soil series, and map symbols	Brief description of soils	Tree species suitable for---
		Shade
Group 7----------	Somewhat poorly drained to very poorly drained, loamy soils.	Swamp white oak, hackberry, red maple, basswood, green ash, white ash.
Ashkum (AsA).		
Blount (BlA).		
Brookston (BsA).		
Colwood (Cw).		
Drummer (Dt).		
Gilford (Gd).		
Kendall (KlA).		
Lamartine (ImB).		
Manawa (MaA).		
Matherton (MhA, MmA).		
Mequon (MtA).		
Montgomery (Mzb).		
Mundelein (MzfA).		
Mussey (Mzk).		
Navan (Na).		
Pella (Ph, Pm).		
Pistakee (PrA).		
Ritchey (RlA).		
Sebewa (Sm).		
Virgil (VsA).		
Group 8----------	Somewhat poorly drained and poorly drained, sandy loam and loamy sand soils.	Silver maple, swamp white oak.
Granby (Gf).		
Wasepi (WmA).		
Group 9----------	Poorly drained soils on flood plains.	Swamp white oak, red maple, basswood, hackberry, green ash, sycamore.
Sawmill (Sg).		
Wallkill (Wa).		
Wet alluvial land (Ww).		
Group 10----------	Organic soils----------	Silver maple, red maple, white ash.
Adrian (Ac).		
Houghton (HtA, HtB).		
Muskego (Mzg).		
Ogden (Oc).		
Palms (Pa).		
Rollin (Ru, Rv).		
Group 11----------	Miscellaneous land types-----	(2/)----------
Clayey land (Cv).		
Loamy land (Lu).		
Marsh (Mf).		
Rough broken land (Ry).		
Sandy and gravelly land (Sf).		
Sandy lake beaches (SfB).		
Group 12----------	Well-drained to somewhat poorly drained, loamy soils that have a thick, dark-colored surface layer.	Sugar maple, red maple, American beech, northern red oak, white oak, basswood, hackberry, white ash, sycamore, bur oak.
Aztalan (AzA, AzB).		
Elliott (EsA).		
Fabius (FaA).		
Griswold (GtB, GtC2, GwB).		
Kane (KeA).		
Lawson (Lo).		
Lorenzo (LyB2, LyC2, LyD2).		
Martinton (MgA).		
Warsaw (WdB, WeA, WeB, WeC2, WhA).		

1/ Soils in this group are poorly suited to most trees, but native trees, except those requiring naturally wet soils, may be considered for planting.

PLANTING GUIDE--Continued

Tree species suitable for--Continued		
Lawns	Street borders	Hedges, screens, or windbreaks
White spruce, hemlock, paper birch, mountain-ash.	Green ash, basswood, red maple----	White-cedar, white spruce.
White spruce----------	Black ash----------	White-cedar, white spruce.
Paper birch, white-cedar, balsam fir, white spruce, mountain-ash.	Southern pin oak, red maple-------	White-cedar.
White-cedar, balsam fir, white spruce.	----------	White-cedar.
(2/)----------	(2/)----------	(2/).
Mountain-ash, blue beech, white ash, paper birch, river birch, Russian-olive, southern pin oak, juneberry, Kentucky coffeetree, red pine, white pine, white spruce, black cherry, ironwood, Norway spruce, European larch.	Norway maple, southern pin oak, thornless honeylocust, bitternut hickory, ironwood, basswood, white ash.	Redcedar, Lombardy poplar, white-cedar, white pine, white spruce, Norway spruce.

2/ The land types in this group are not suited to the stated uses for trees.

TABLE 5.--SHRUB AND VINE PLANTING GUIDE

[The letter "x" means that the plant has the kind of characteristics,

Common name	Botanical name	Vine and shrub group	Type of plant	Growth characteristics			
				Potential height (feet)	Thorns	Shade tolerant	Thicket forming
Arborvitae (shrub type)--	Thuja spp.----------	1, 2, 3	Shrub---	3-7	---	---	---
Barberry, Japanese-------	Berberis thunbergi-----	1, 2	Shrub---	6	x	x	---
Bittersweet--------------	Celastrus scandens-----	1, 2	Vine----	---	---	x	---
Blackberry, dewberry, blackcap raspberry.	Rubus spp.----------	1, 2	Bramble-	1-5	x	---	x
Chokeberry, black--------	Aronia melanocarpa-----	1, 3	Shrub---	1-3	---	x	x
Cotoneaster--------------	Cotoneaster spp.-------	1, 2	Shrub---	4-8	---	---	---
Crab apple---------------	Malus spp.----------	1, 2	Shrub---	---	---	---	---
Currant, alpine----------	Ribes alpinum----------	1, 2	Shrub---	6-7	---	x	---
Dogwood, gray------------	Cornus racemosa--------	1, 2, 3	Shrub---	6-10	---	x	---
Dogwood, pagoda----------	C. alternifolia--------	1, 3	Shrub---	10-15	---	x	---
Dogwood, red-osier-------	C. stolonifera---------	1, 3	Shrub---	3-9	---	x	x
Dogwood, roundleaf-------	C. rugosa--------------	1, 3	Shrub---	3-9	---	x	---
Dogwood, silky-----------	C. amomum--------------	1, 3	Shrub---	6-10	---	x	---
Elder, American----------	Sambucus canadensis----	1, 3	Shrub---	3-10	---	---	x
Filbert (hazelnut)-------	Corylus americana------	1, 2	Shrub---	5-8	---	x	x
Forsythia----------------	Forsythia spp.---------	1, 2	Shrub---	4-8	---	x	---
Grape, wild--------------	Vitis spp.----------	1, 2	Vine----	---	---	x	---
Hawthorn (thornapple)----	Crataegus spp.---------	1, 2, 3	Shrub---	5-15	x	x	---
Honeysuckle, shrub type--	Lonicera spp.----------	1, 2, 3	Shrub---	6-12	---	x	---
Juniper, creeping--------	Juniperus spp.---------	1, 2	Shrub---	1-2	---	---	---
Juniper, Pfitzer---------	J. chinensis pfitzeria-	1, 2	Shrub---	8-10	---	---	---
Lilac--------------------	Syringa spp.----------	1, 2	Shrub---	8-10	---	---	---
Maple, Amur--------------	Acer ginnala-----------	1, 2	Shrub---	15+	---	---	---
Mockorange---------------	Philadelphus spp.------	1, 2	Shrub---	6-9	---	---	---
Myrtle (periwinkle)------	Vinca minor------------	1, 2	Herb----	1	---	x	---
Ninebark, common---------	Physocarpus opulifolius.	1, 2, 3	Shrub---	6-9	---	x	x
Olive, autumn------------	Elaeagnus umbellata----	1, 2, 3	Shrub---	10-15	---	x	---
Peashrub, Siberian-------	Caragana arborescens---	1, 2	Shrub---	10-15	---	---	---
Pine, mugho--------------	Pinus mugo mughus------	1, 2	Shrub---	6-9	---	---	---
Plum, American-----------	Prunus americana-------	1, 2, 3	Shrub---	10-15	---	x	x
Privet, Amur-------------	Ligustrum amurense-----	1, 2	Shrub---	10	---	x	---
Privet, Regels border----	L. obtusifolium regelianum.	1, 2	Shrub---	6-9	---	x	---
Redcedar, eastern--------	Juniperus virginia-----	1, 2	Shrub---	10-20	---	---	---
Rose, rugosa and horticultural varieties.	Rosa spp.--------------	1	Shrub---	2-6	---	---	---
Russian-olive------------	Elaeagnus angustifolia-	1, 2, 3	Shrub---	15	x	---	---
Snowberry----------------	Symphoricarpos spp.----	1, 2	Shrub---	3-4	---	x	x
Spirea, Anthony Waterer--	Spirea bumalda---------	1, 2	Shrub---	2-3	---	---	---
Spirea, van houtte-------	S. van houttei---------	1, 2, 3	Shrub---	5-6	---	x	---
Sumac, fragrant----------	Rhus aromatica---------	1, 2	Shrub---	3	---	x	x
Sumac, smooth------------	R. glabra--------------	1, 2	Shrub---	6-10	---	---	---
Sumac, staghorn----------	R. typhina-------------	1, 2	Shrub---	10-15	---	---	x
Viburnum, American cranberrybush.	Viburnum trilobum------	1, 3	Shrub---	7-9	---	x	---
Viburnum, arrowwood------	V. dentatum------------	1	Shrub---	10-12	---	x	---

features, or suitability indicated by the column heading]

Esthetic features			Suitable for--					Remarks
Flowers	Berries	Leaves color in fall	Land-scaping	Hedge, screen, wind-break	Wild-life food and cover	Road-side planting	Ground cover	
---	---	x	x	x	x	---	---	Slightly shade tolerant.
---	x	x	x	x	x	---	---	
---	x	x	---	---	x	x	x	Native; climbs; fall color; some landscape value.
x	x	x	---	---	x	x	x	Native; fall color.
---	x	x	x	---	x	x	x	Native; fall color.
---	x	x	x	x	x	---	---	
x	x	x	x	x	x	x	---	Taller species 25 feet high.
x	---	---	x	x	---	---	---	Attractive foliage.
x	x	x	---	---	x	x	---	Native; fall color.
x	x	x	---	---	x	x	---	Native; fall color.
x	x	x	---	---	---	---	---	Native; fall color; some landscape value.
x	x	x	---	---	x	x	x	Native; fall color.
x	x	x	---	x	x	x	---	Native; fall color.
x	x	---	---	---	x	x	---	Native; fall color.
---	x	x	---	---	x	x	---	Native; fall color.
x	---	---	x	---	---	---	---	
---	x	x	---	---	x	x	x	Native; climbs; fall color.
---	x	x	x	---	x	x	---	Fall color.
x	x	x	x	x	x	---	---	
---	x	x	x	---	x	x	x	Native; short, sharp-pointed leaves; fall color.
---	---	x	x	---	x	---	---	Fall color.
x	---	---	x	x	---	x	---	Slightly thicket forming.
---	---	x	x	x	---	---	---	Tall shrub; potential height more than 15 feet.
x	---	---	x	x	---	---	---	
x	---	---	x	---	---	x	x	Forms mat on ground.
x	---	x	x	x	---	x	---	
---	x	x	x	x	x	---	---	
---	x	x	---	x	x	x	---	
---	---	x	x	---	x	---	---	
x	x	x	---	---	x	x	---	Native; some thorns; fall color.
x	x	x	---	x	x	---	---	Some landscape value.
---	x	x	---	x	x	---	---	Some landscape value.
---	x	x	---	x	x	x	---	Native; short, sharp-pointed leaves; fall color.
x	x	---	x	---	x	x	---	
---	x	x	x	x	x	---	---	
---	x	x	x	---	x	x	x	Native; fall color.
x	---	x	x	---	---	---	---	
x	---	---	x	x	---	---	---	
---	x	x	x	---	x	x	x	Native; fall color.
---	x	x	---	---	x	x	---	Native; fall color.
x	x	x	---	---	x	x	---	Native; fall color; some landscape value.
x	x	x	x	x	x	x	---	Native; fall color.
x	x	x	x	x	x	---	---	

TABLE 5.--SHRUB AND VINE PLANTING GUIDE

Common name	Botanical name	Vine and shrub group	Type of plant	Growth characteristics			
				Potential height (feet)	Thorns	Shade tolerant	Thicket forming
Viburnum, blackhaw-------	V. prunifolium---------	1, 2	Shrub---	8-10	---	x	---
Viburnum, mapleleaf------	V. acerifolium---------	1, 3	Shrub---	3-5	---	x	---
Viburnum, nannyberry-----	V. lentago-------------	1, 2, 3	Shrub---	9-12	---	x	---
Viburnum, rafinesque-----	V. rafinesquianum------	1, 2	Shrub---	2-4	---	x	---
Viburnum (wayfaringtree)-	V. lantana-------------	1, 2, 3	Shrub---	4-9	---	x	---
Virginia-creeper---------	Parthenocissus quinquefolia.	1, 2	Vine----	---	---	x	---
Wahoo, eastern-----------	Euonymus atropurpureus-	1	Shrub---	4-9	---	x	---
Weigela-----------------	Weigela spp.-----------	1	Shrub---	4-8	---	---	---
Willow, pussywillow and other shrub types.	Salix spp.-------------	1, 2, 3	Shrub---	2-8	---	---	---
Winterberry, common------	Ilex verticillata------	1, 3	Shrub---	6-9	---	x	---
Yew, shrub type----------	Taxus spp.-------------	1	Shrub---	3-10	---	x	---

FOR MILWAUKEE AND WAUKESHA COUNTIES--CONTINUED

Esthetic features			Suitable for--					Remarks
Flowers	Berries	Leaves color in fall	Land-scaping	Hedge, screen, wind-break	Wild-life food and cover	Road-side planting	Ground cover	
x	x	x	---	x	x	x	---	Native; fall color.
x	x	x	---	---	x	x	---	Native; fall color.
x	x	x	---	x	x	x	---	Native; fall color.
x	---	x	---	---	x	x	---	Native; fall color.
x	x	x	x	---	x	x	---	Native; fall color.
---	x	x	---	---	x	x	x	Native; climbs; fall color; some landscape value.
---	x	x	x	---	x	x	---	Native; fall color.
x	---	---	x	x	---	---	---	
---	---	---	---	x	x	---	---	Native; fall color.
---	x	x	---	---	x	x	---	Native; fall color.
---	x	x	x	---	x	---	---	

Growth habits, shade tolerance, and esthetic features determine the suitability and use of plants for various functions and locations. Most plantings can accomplish more than one useful purpose if suitable plants are selected. For example, some shrubs and vines that have colorful foliage or berries can be as useful for wildlife food and cover as they are for hedges, screens, or beautification of the landscape.

Wildlife Uses of Soils

Kinds of wildlife and general facts about the habitat for wildlife in Milwaukee and Waukesha Counties are discussed in this subsection. In addition, the soils are placed in groups, according to their suitability for specific kinds of wildlife.

In the eastern part of Milwaukee County, the natural habitat of deer and many other species of wildlife has been changed or destroyed as the result of development and industrialization. The well-drained soils of uplands in Milwaukee and Waukesha Counties were formerly well suited to wildlife, but much of the natural food and cover was destroyed when these areas were cleared for farming. Stands of trees can now be found only in woodlots or other areas that generally are too small for deer and other large game animals. Small areas in trees do support some species of small mammals and upland game birds.

A fairly large acreage, consisting mainly of wetlands and of the steeper wooded tracts in the western part of Waukesha County, is used as habitat for wildlife. The soils in this acreage are not well suited to farming, and some areas, such as the Kettle Moraine State Forest, are publicly owned.

The kinds of wildlife in Milwaukee and Waukesha Counties are duck, geese, and other species of migratory waterfowl; beaver, mink, muskrat, and other small fur-bearing animals that inhabit water areas; grouse, quail, pheasant, and other upland game birds; songbirds; rabbit, squirrel, and other small mammals; and deer.

Wildlife Groups

All birds and animals require water, food, protective cover, and escape routes. The capacity of the soils to fulfill these requirements determines, to a great extent, the kinds and amounts of wildlife in an area. Because the wildlife population of an area depends on suitability of the habitat, one area may be able to support a large number of deer, but another area can support only a small number of these animals. A different area that can support fur-bearing animals may not be suitable for game birds, deer, or other large game animals. Areas that support only a few birds or animals may be capable of supporting more species and greater numbers of wildlife if the habitat is improved.

The kinds and numbers of wildlife that live in a given area are also closely related to land use, to the types and patterns of vegetation, and to the availability of water. Because wild animals are mobile, they can make use of the most desirable habitat on a number of different soils. An upland game bird, for example, may nest in one area, feed in another, and find protective cover in still another. A variety of soils within the home range of a given species of wildlife normally provides the most productive habitat.

The soils of Milwaukee and Waukesha Counties have been grouped according to their suitability for specified kinds of wildlife habitat. Each group consists of soils that require similar management, that respond to management in about the same way, and that are similar with respect to the hazards and limitations that affect their use. Limitations of the soils in each group are rated slight, moderate, severe, or very severe. A rating of slight indicates that the soils are nearly free of limitations or have limitations that are easily overcome. A rating of moderate means that the soils can be readily used if well managed, but generally they are less productive than soils having only slight limitations. A rating of severe indicates that the soils will support only limited numbers of any one species and that there are hazards or restrictions that are difficult to overcome. A rating of very severe means that the soils can provide few or none of the requirements for a satisfactory habitat. In evaluating use of the soils for wildlife, no consideration was given to the size and shape of soil areas or to the pattern that these areas form with areas of other soils on the landscape.

Discussed in the following pages are the eight wildlife groups in the survey area. It is not intended that these discussions will eliminate the need for evaluating the suitability of each site as wildlife habitat. Only the major limitations are described, and they are based on information presently available. As more information about the soil becomes available, evaluations of suitability of the soils for wildlife may change. The names of soil series represented are mentioned in the description of the wildlife group. To find the names of all the soils in any given wildlife group, refer to the "Guide to Mapping Units" at the back of this survey.

Wildlife Group 1

This wildlife group consists of well drained and moderately well drained soils and land types that are loamy throughout and are not subject to flooding. These are Loamy land and soils of the Boyer, Casco, Dodge, Fox, Grays, Hebron, Hochheim, Knowles, Mayville, Miami, Oshtemo, St. Charles, and Theresa series. These soils have a surface layer of loam, silt loam, or sandy loam, and they are moderately permeable. Because the soils are highly desirable for crops, their use for wildlife is generally limited to species that live in open areas and small woodlots.

For use of these soils by migratory waterfowl and fur bearers, limitations are severe on slopes of 0 to 2 percent and very severe on slopes greater than 2 percent. Wetland food and cover plants do not grow well, and the steeper soils are poorly suited

to intensive use for grain and seed crops. Water is generally not available to furnish suitable habitat for fur bearers and a resting place for migratory waterfowl. Developing small areas of shallow water is difficult.

For use by upland game birds, small mammals, and deer, limitations are slight to moderate on slopes of 0 to 20 percent, and moderate to severe on slopes of more than 20 percent. These soils have good potential for the production of grain, seed crops, legumes, and wild herbaceous and woody plants that could be used by upland wildlife. The most limiting factor for these uses is generally the steepness of the slopes. Erosion is a hazard if the steeper soils are intensively used for growing grain and seed crops.

Wildlife Group 2

This wildlife group consists of Clayey land, a land type, and well drained or moderately well drained soils of the Kewaunee, Morley, Ozaukee, and Saylesville series. These soils have a silt loam surface layer and a clayey subsoil. Their permeability is moderately slow or slow.

These soils have slight limitations for grain and seed crops, grasses and legumes, wild herbaceous upland plants and woody plants. Limitations are severe for wetland food and cover plants, and they are moderate for water development.

The soils have slight limitations for upland game birds, such as pheasant and partridge, and for animals, such as deer, raccoon, fox, cottontail rabbit, and squirrel. They have moderate to severe limitations for duck, muskrat, and other kinds of wetland wildlife.

Wildlife Group 3

This wildlife group consists of excessively drained soils that are sandy throughout and of soils in which rooting depth is shallow. These soils are of the Casco, Chelsea, Ritchey, and Rodman series. They have low available water capacity and very low natural fertility. They are droughty and are generally not used for crops. A large part of the acreage is in the vicinity of the Kettle Moraine, and it is used mainly as woodland, for wildlife, and for recreational purposes. Slopes range from 1 to 45 percent.

The soils of this group are poorly suited to grain crops, seed crops, grasses, and legumes, and they are also poorly suited to wetland food and cover plants. Woody plants that would provide cover and escape routes are lacking in many places.

Limitations to use of these soils for migratory waterfowl and fur bearers are very severe. Developing small areas of shallow water suitable for migratory waterfowl and a water habitat suitable for fur bearers is so difficult that it is generally not feasible.

Limitations to use of these soils for upland game birds, small mammals, and deer are moderate to severe. Grain crops, grasses, and legumes are not abundant enough to provide much food and cover, and herbaceous and woody plants that would provide food and protective cover are lacking in many places. Because of a lack of shrubs, thickets, and trees, deer cannot find much protective cover on the steeper slopes. In most places the number of squirrels is small because of a lack of den trees and of mast trees and other sources of natural foods. The number of rabbits is also limited because of the absence of thickets and of natural foods.

Wildlife Group 4

In this wildlife group are well drained and moderately well drained soils of the Griswold, Lorenzo, Markham, and Warsaw series. These soils have formed under prairie grasses. They have a surface layer of silt loam, loam, or sandy loam, and they are moderately permeable. These soils are highly desirable for crops, and their use for wildlife is generally limited to those species that can live in open areas where trees are scarce. Slopes range from 0 to 20 percent. Some of the soils are eroded.

For use of these soils by migratory waterfowl, limitations are severe on slopes of 0 to 2 percent and very severe on slopes that exceed 2 percent. Developing areas of shallow water is very difficult. A good supply of grain, grasses, legumes, and wild herbaceous food plants is available, but providing a supply of wetland food and cover crops is difficult. The more sloping soils are subject to erosion if they are cultivated.

For use by fur bearers, limitations are severe on slopes of 0 to 2 percent and very severe on slopes of more than 2 percent. Fur bearers prefer a habitat where water is abundant, but in only a few areas of these soils is the supply of water adequate or dependable. Therefore, a suitable water habitat generally cannot be provided. Growing aquatic plants for food and woody plants for food and cover is difficult.

For use by upland game birds, limitations are slight to moderate. An abundance of grain, seed crops, and legumes suitable as food for upland game birds can be grown on these soils. Planting of wild herbaceous plants and woody plants is necessary in most places, but many kinds of plants suitable for providing food, cover, and nesting sites for upland game birds grow well in fence rows and along the edges of fields.

For use by deer and by cottontail rabbits and other small mammals, limitations are moderate. On the soils of this group, shrubs, thickets, mast trees, den trees, and woodland plants that provide food and cover are generally scarce or lacking. Except for a few widely spaced oak trees, deer find no protective cover unless they can obtain cover in areas of adjacent soils.

Wildlife Group 5

This wildlife group consists of somewhat poorly drained and poorly drained soils and land types.

These soils are of the Ashkum, Aztalan, Blount, Brookston, Colwood, Drummer, Elliott, Fabius, Gilford, Granby, Griswold, mottled subsoil variant, Kane, Kendall, Lamartine, Lawson, Manawa, Martinton, Matherton, Mequon, Montgomery, Mundelein, Mussey, Navan, Pella, Pella, moderately shallow variant, Pistakee, Ritchey, mottled subsoil variant, Sawmill, Sebewa, Virgil, Wallkill, and Wasepi series. Also in the group is Wet alluvial land.

Use of these soils for crops is restricted by wetness in many places, but a large acreage has been drained and is used for crops. Many small woodlots and some large areas are used as woodland and for wildlife. Slopes range from 1 to 6 percent.

Many kinds of shrubs, vines, and mast and den trees grow well on these soils, but improved drainage is needed for the best growth of grain crops, seed crops, grasses, and legumes. Cover is available for most birds and animals, but occasional flooding or ponding is a hazard to birds and mammals that nest or bed on the ground.

Because excess water is a hazard at times, limitations to use of these soils by upland game birds are moderate. Wet alluvial land and soils of the Lawson, Pistakee, Sawmill, and Sebewa series are subject to flooding.

Limitations to use by migratory waterfowl, fur bearers, songbirds, small mammals, and deer are slight to moderate. Many kinds of wild herbaceous plants and woody plants can be produced on these soils. In most places small developments of shallow water are fairly easy to provide for migratory waterfowl, and the desired water level generally is not difficult to maintain.

Wetland food and cover plants can be expected to grow well. As a rule, nesting boxes or trees are needed for wood ducks. Enough water is available in some places to furnish suitable habitat for furbearing animals. These soils do not provide good places for bedding or nesting sites for deer and rabbit during wet periods.

Wildlife Group 6

In this wildlife group are very poorly drained organic soils of the Adrain, Houghton, Muskego, Ogden, Palms, and Rollin series and Marsh. Many areas of these soils are cropped, but most of the acreage is covered with native plants and is used as wildlife habitat or woodland.

Improved drainage is needed for the satisfactory growth of grain crops, seed crops, and legumes. Even after the soils are drained, however, they are poorly suited to many kinds of legumes. At times, when rainfall is heavy or the water table is high, burrows and nesting sites on the ground are flooded. Trees, shrubs, and woody vines are so scarce in many places that little woodland food is produced and birds cannot nest.

Limitations to use of these soils by migratory waterfowl and fur bearers are only slight. Shallow water developments and suitable water habitat are easily provided, and water can be maintained at a desired level without difficulty. Wetland food and cover plants can be expected to grow well. Nesting boxes or trees are needed for wood ducks.

Limitations to use by upland game birds, small mammals, and deer are moderate. Unless drainage is improved, wild food plants grow poorly. In most places only a small number of den trees is available for squirrels, and few or no acorns are produced. Because of the scarcity of natural food and the frequent flooding of the burrows, the rabbit population is small.

Wildlife Group 7

This wildlife group consists of well drained and moderately well drained Juneau silt loam and a land type, Alluvial land. These areas are subject to occasional flooding but have only slight limitations for grain and seed crops, grasses and legumes, and wild herbaceous plants that provide food and cover for wildlife. They have moderate limitations for woody plants and severe limitations for wetland food and cover plants and water developments.

Because flooding is only occasional and of short duration, most upland game birds and small animals can use these sites for food and cover.

Wildlife Group 8

This wildlife group consists of thin, droughty, or stony and rocky land types. These land types are Rough broken land, Sandy and gravelly land, and Sandy lake beaches. Although they differ greatly in characteristics, all are in the extreme eastern part of Milwaukee County, near Lake Michigan.

Limitations to use of these land types by migratory waterfowl are severe. Much of the land is too steep for shallow water developments and other water habitat, or it is too infertile or too intensively used by man for the production of adequate food and cover.

Limitations to use of these land types by fur bearers are very severe. Slopes are generally too steep for a suitable water habitat, or they are not suitable for producing the required food and cover.

Limitations to use by upland game birds, small mammals, and deer are very severe. Food and protective cover generally are inadequate or lacking, and in many places no habitat is available for nesting. A few squirrels inhabit some areas of Rough broken land, where old trees provide dens and acorns or other mast. In most places, however, few trees are available that will provide satisfactory dens for squirrels, and seldom are acorns produced on most of the land types. Natural food for rabbits is scarce.

Recreational Uses of Soils

The rapidly expanding population in Milwaukee and Waukesha Counties has made the need for recreation increasingly important. Not only are larger numbers

of facilities needed, but also facilities that can accommodate a greater number of people. Because a large acreage is already used for recreational purposes, and this acreage is increasing in size, understanding soil properties and limitations that affect use and management of soils used for recreational purposes is important. Among these soil properties are texture, permeability, slope, depth to bedrock, wetness, and susceptibility to erosion and flooding. Facilities for outdoor recreation that depend a great deal on these soil properties are playgrounds, athletic fields, and other intensive play areas; picnic areas, parks, and other extensive play areas; bridle paths, nature trails, and hiking trails; golf fairways; cottages, service buildings, and utility buidlings; and tent sites and trailer campsites.

To help in planning the management of areas used for recreation, the soils of these two counties have been placed in 10 recreation groups. Each group is made up of soils that have similar limitations affecting their use and that require similar management. The limitations are rated slight, moderate, severe, or very severe. The ratings are only general. Onsite investigation is needed if development of a recreational facility is planned.

A rating of slight means that the soils are free of limitations or have limitations for a given use that are easy to overcome. A rating of moderate indicates that the soils have limitations for a given use that can be overcome by average management and careful design. A rating of severe means that the soils have limitations for a given use that are difficult to overcome. This rating for a particular use, however, does not imply that soils so rated cannot be put to that use. A rating of very severe indicates that the soils have limitations that generally preclude use for a given purpose.

Not considered in the ratings are the esthetic qualities of a specific area, the size and shape of areas occupied by a specific soil, and the pattern that these areas form with areas of other soils in the landscape. Nevertheless, all of these features may be important in selecting a site. The ratings also do not apply to severely eroded soils but are for soils that range from not eroded through moderately eroded. In general, limitations for severely eroded soils are more restrictive than for similar, but less eroded, soils.

The ratings for the poorly drained soils are for soils in their natural state without adequate drainage. If their drainage is improved, these soils can be used for one or more kinds of recreational development.

The degree of limitation for recreational use varies considerably in soils subject to flooding. It depends not only on the length and duration of flooding, but also on the season in which flooding occurs. Flooding that takes place during a season in which the recreational facility is not used is much less restrictive than flooding that occurs during the season of use.

The 10 recreation groups of Milwaukee and Waukesha Counties are discussed in the following pages. The names of soil series represented are mentioned in the description of each recreation group, but this does not mean that all the soils of a given series are in the group. To find the names of all the soils in any given recreation group, refer to the "Guide to Mapping Units" at the back of this survey.

Recreation Group 1

This group consists of well drained and moderately well drained soils that have a surface layer of silt loam. These are soils of the Dodge, Grays, Mayville, and St. Charles series. They are limited by excess water in only a few places, and generally they are highly desirable for farming. Slopes range from 0 to 6 percent.

The soils of this group are well suited to many kinds of plants, and they can support a firm turf that withstands heavy foot traffic. Extensive leveling exposes the substratum, however, and this layer cannot support turf of sufficient quality to withstand heavy foot traffic. The surface of these soils remains wet and soft after rains. Areas that do not have a cover of plants are slippery, muddy, and easily compacted when wet. Commonly, the heavily traveled areas are very dusty when dry. Erosion is a hazard in sloping areas.

Following are limitations for various recreational uses:

For playgrounds, athletic fields, and other intensive play areas, limitations are slight on slopes of 0 to 2 percent and moderate on slopes of 2 to 6 percent.

For bridle paths, nature trails, and hiking trails, and for tent sites and trailer campsites, limitations are moderate on slopes of 0 to 6 percent. Paths and trails in sloping areas are less likely to erode if they are placed on the contour than if they are run up and down the slope.

For picnic areas, parks, and other extensive play areas; for golf fairways; and for cottages, service buildings, and utility buildings, limitations are slight on slopes of 0 to 6 percent. These soils are not subject to flooding, and they are suitable for absorbing effluent from domestic sewage disposal systems.

Recreation Group 2

In this group are excessively drained soils of the Rodman series and well-drained soils of the Boyer, Casco, Fox, Griswold, Hochheim, Knowles, Lorenzo, Miami, Oshtemo, Ritchey, St. Charles, Theresa, and Warsaw series. The surface layer of these soils is silt loam to sandy loam. Most of the soils are underlain by glacial material, but the Knowles soils are underlain by dolomite bedrock within 40 inches of the surface. The Ritchey soils are underlain by dolomite bedrock within 20 inches of the surface. The soils are limited by excess water in only a few places, and they are well suited to many kinds of grasses, shrubs, trees, and other plants.

Some of the soils are eroded. Slopes range from 0 to 30 percent.

The soils of this group can support a good turf capable of withstanding heavy foot traffic. Where leveling is extensive, however, the substratum is exposed, and it generally cannot support a good turf. In places bedrock near the surface limits the depth to which cuts can be made during leveling. Areas that have a silt loam surface layer are muddy and slippery when wet, and sloping areas are subject to erosion.

Following are limitations for various recreational uses:

For playgrounds, athletic fields, and other intensive play areas, limitations are slight on slopes of 0 to 2 percent, moderate on slopes of 2 to 6 percent, and severe on slopes of more than 6 percent.

For bridle paths, nature trails, and hiking trails, limitations are slight on slopes of 0 to 12 percent, moderate on slopes of 12 to 20 percent, and severe on slopes of more than 20 percent. Locating trails and paths on the contour lessens the risk of erosion.

For picnic areas, parks, and other extensive play areas; for golf fairways; for tent sites and trailer campsites; and for cottages, service buildings, and utility buildings, limitations are generally slight on slopes of 0 to 6 percent, moderate on slopes of 6 to 12 percent, and severe on slopes of more than 12 percent. Use of the Ritchey soils for tent sites and trailer campsites is restricted, however, because bedrock is so near the surface in places that using tent stakes and pins would be difficult. Most of the soils of this group are suitable for absorbing the effluent from domestic sewage disposal systems. Where bedrock is within 40 inches of the surface, as in both the Knowles and Ritchey soils, the use of domestic sewage disposal systems is restricted and the effluent can contaminate the ground water.

Recreation Group 3

This group consists of well drained and moderately well drained soils that have formed in moderately fine textured material. These soils are in the Hebron, Kewaunee, Markham, Morley, Ozaukee, and Saylesville series. Most of them have a surface layer of silt loam, but the Hebron soils have a surface layer of loam. The soils are desirable for farming, but most of the acreage is within or near large areas used for industry or housing. Some of the soils are eroded. Slopes range from 0 to 20 percent.

The soils of this group are well suited to many kinds of plants, and they can support a firm turf that can withstand heavy foot traffic, except when the soils are wet. Because permeability is moderately slow or slow, the soils stay wet for short periods after rains. Bare areas are muddy, slippery, and easily compacted when wet, and these soils are commonly very dusty when dry. Erosion is a hazard in sloping areas.

Following are limitations for various recreational uses:

For playgrounds, athletic fields, and other intensive play areas; for bridle paths, nature trails, and hiking trails; and for tent sites and trailer campsites, limitations are moderate on slopes of 0 to 6 percent and severe on slopes of more than 6 percent. Surfacing of walks and roads is desirable in most places.

For picnic areas, parks, and other extensive play areas, limitations are slight on slopes of 0 to 6 percent, moderate on slopes of 6 to 12 percent, and severe on slopes of more than 12 percent.

For cottages, service buildings, and utility buildings, limitations are severe on all slopes. Because of the moderately slow or slow permeability, these soils cannot absorb effluent rapidly enough to permit the satisfactory operation of domestic sewage disposal systems. Foundations may crack or shift, for the soils swell when wet and shrink as they dry.

Recreation Group 4

In this group are well-drained Boyer and Oshtemo soils that have formed in deep, sandy material on outwash plains in the western part of Waukesha County. These soils have a surface layer of loamy sand. They are droughty, are low in natural fertility, and have only moderate available water capacity. Some areas are eroded. Slopes range from 1 to 12 percent.

Maintaining a good turf that will withstand heavy foot traffic is difficult, especially during dry periods. The only plants to which the soils are suited are those that can grow in droughty places. Extensive leveling can expose the sandy substratum, and that layer is even less capable of supporting a satisfactory cover of plants than are the surface layer and the subsoil. Soil blowing is a hazard where the surface is bare, and water erosion is a hazard in the sloping areas. The soils are unstable, and they become loose and soft if used for paths, trails, and roads.

Following are limitations for various recreational uses:

Limitations are moderate if these soils are used for picnic areas, parks, and other extensive play areas; for bridle paths, nature trails, and hiking trails; and for cottages, service buildings, and utility buildings.

Where the soils are used for playgrounds, athletic fields, and other intensive play areas, or for tent sites and trailer campsites, limitations are moderate on slopes of 0 to 6 percent, and severe on slopes of more than 6 percent.

Limitations are severe for golf fairways.

Recreation Group 5

This group consists of excessively drained and well drained, coarse-textured soils that have formed in deep, sandy and gravelly material on outwash plains. These soils are in the Casco, Rodman, and Chelsea series. They are droughty, have low available water capacity, and have very low natural fertility. Slopes range from 1 to 45 percent. Many

areas are stony and gravelly, and some areas are severely eroded.

Maintaining a good turf that will withstand heavy foot traffic is difficult on these soils, especially in heavily traveled areas. The only plants to which the soils are suited are those that can grow on droughty soils. The sandy areas are subject to blowing, and the sloping areas are subject to water erosion. The soils are unstable in many places, and they become loose and soft if used for paths, trails, and roads, especially in sloping areas. In other places pebbles and cobblestones are a hazard to horses and people. Many of the roads and trails need surfacing.

Following are limitations for various recreational uses:

For picnic areas, parks, and other extensive play areas, limitations are moderate on slopes of 0 to 12 percent and severe on slopes of more than 12 percent.

For bridle paths, nature trails, and hiking trails, limitations are slight on slopes of 0 to 12 percent, moderate on slopes of 12 to 20 percent, and severe on slopes of more than 20 percent.

For cottages, service buildings, and utility buildings, limitations are moderate on slopes of 0 to 12 percent and severe on slopes of more than 12 percent. The soils rapidly absorb effluent from domestic sewage disposal systems, but in some places the effluent can contaminate the ground water.

For tent sites and trailer campsites, limitations are moderate on slopes of 0 to 6 percent and severe on slopes of more than 6 percent.

Limitations are severe for golf fairways.

Recreation Group 6

This group consists of Alluvial land and of soils of the Aztalan, Blount, Elliott, Fabius, Griswold, Juneau, Kane, Kendall, Lamartine, Manawa, Martinton, Matherton, Mequon, Mundelein, Ritchey, Virgil, and Wasepi series. Most of these soils have a surface layer of silt loam or loam, and most of them are somewhat poorly drained. The Griswold soil is well drained, however, and the Juneau soil is well drained or moderately well drained and is subject to occasional overflow. The Ritchey soil is underlain by dolomite bedrock at a depth within 40 inches of the surface. Slopes range from 0 to 6 percent, but they are mainly between 1 and 3 percent.

The water table is high during wet periods, and these soils must be drained if the best use is to be made of them. They remain wet for several days after rains, and those that have a surface layer of silt loam are easily compacted when wet. The soils can support a good turf, but the turf is easily damaged when the soils are wet. Heavily traveled areas commonly become muddy and slippery if they are not protected by a good cover of turf. The soils can support many kinds of sod-forming plants, and plants that can grow on moist or wet soils do especially well. Surfacing is generally needed on trails, paths, and roads that are heavily traveled.

Following are limitations for various recreational uses:

Limitations are moderate if these soils are used for playgrounds, athletic fields, and other intensive play areas; for picnic areas, parks, and other extensive play areas; for bridle paths, nature trails, and hiking trails; for golf fairways; and for tent sites and trailer campsites.

Limitations are very severe for cottages, service buildings, and utility buildings. Domestic systems for disposing of sewage are inoperative much of the year when the soils are flooded as the result of the high water table. In addition, bedrock underlying the Ritchey soil may interfere with excavation, and the effluent from septic tanks in areas of that soil can contaminate the ground water.

Recreation Group 7

This group consists of poorly drained soils that have a surface layer of silty clay loam to fine sandy loam. These soils are in the Ashkum, Brookston, Colwood, Drummer, Gilford, Granby, Montgomery, Mussey, Navan, Sawmill, and Sebewa series, and the group also includes both a normal Pella soil and a soil of the Pella series, moderately shallow variant. Slopes range from 0 to 3 percent.

The water table is high during much of the year, and the soils must be drained if the best use is to be made of them. Even where the soils are drained, they remain wet for long periods after rains. Furthermore, the soil of the Pella series, moderately shallow variant, is difficult to drain because bedrock is so near the surface in places that it interferes with the installation of a drainage system. The soils that have a surface layer of silt loam or silty clay loam are easily compacted when wet. All the soils can support a good turf. The turf cannot withstand heavy foot traffic, however, and it is easily damaged when the soils are wet. Heavily traveled areas commonly become muddy and slippery when wet if the turf is not thick enough to protect them. Surfacing is generally needed on trails, paths, and roads that are heavily traveled. The only suitable sod-forming plants are ones that grow in wet areas.

Following are limitations for various recreational uses:

Limitations are severe for playgrounds, athletic fields, and other intensive play areas; for picnic areas, parks, and other extensive play areas; for bridle paths and nature and hiking trails; for golf fairways; and for tent and trailer campsites.

Limitations are very severe for cottages, service buildings, and utility buildings. Domestic systems for disposing of sewage are inoperative much of the year when they are flooded by high ground water.

Recreation Group 8

This group consists of somewhat poorly drained and poorly drained soils that have formed in alluvial material at the bases of upland slopes and on

bottom lands along streams. It consists of Wet alluvial land and of soils of the Lawson, Pistakee, and Wallkill series. Slopes range from 0 to 3 percent.

These soils are subject to flooding, and they stay wet much of the year. Unless protection from flooding is provided, additional alluvial material is likely to be deposited from time to time. Even where drainage is improved, excess water is a limitation for long periods after rains. If the soils are subjected to heavy foot traffic when wet, they become muddy and slippery and are readily compacted. A good sod can be established in areas that are protected from further deposition, but the sod is easily damaged. The only suitable plants are those that can grow in wet areas.

Limitations are moderate if these soils are used for bridle paths, nature trails, and hiking trails. Surfacing of paths and trails is needed in many places.

Limitations are severe for playgrounds, athletic fields, and other intensive play areas; for picnic areas, parks, and other extensive play areas; for golf fairways; and for tent sites and trailer campsites.

Limitations are very severe for cottages, service buildings, and utility buildings. Domestic systems for disposing of sewage are inoperative when the water table is high or when the soils are flooded. These soils liquefy readily when wet, and they are subject to frost heave. Therefore, cracking and shifting are hazards to foundations. Surfacing generally is needed on roads and trails.

Recreation Group 9

This group consists of very poorly drained organic soils along river bottoms and in old basins formerly occupied by glacial lakes. The soils are in the Adrian, Houghton, Muskego, Odgen, Palms, and Rollin series. They are mucky and have a high water table throughout most of the year. The soils cannot withstand heavy foot traffic when wet, and they are dusty when dry. Even where the soils are drained, they remain wet for long periods after rains. They are likely to shrink as they dry, and large cracks then form in some places. Trafficability is poor, and sod is easily damaged. The only suitable plants are those that can grow on organic soils.

Limitations are severe if these soils are used for golf fairways.

Limitations are very severe for playgrounds, athletic fields, and other intensive play areas; for picnic areas, parks, and other extensive play areas; for bridle paths, nature trails, and hiking trails; for cottages, service buildings, and utility buildings; and for tent sites and trailer campsites. The soils have low bearing capacity, and foundations may crack or shift. Because the soils are unstable, anchoring tents with pins and stakes is difficult. Paths, trails, and roads are difficult to maintain, and they become soft and loose and are readily compacted. Surfacing is needed on roads and trails, but even this may not keep these places firm.

Recreation Group 10

In this group are the miscellaneous land types Rough broken land and Sandy lake beaches, along the shores of Lake Michigan and in deep ravines that extend back from the lake, and Clayey land, Loamy land, Marsh, and Sandy and gravelly land in other parts of the survey area. Some of these land types are so frequently flooded or wet, so sandy, so compacted, or so steep and erodible that they are generally of little use for recreation. Others occur in areas too small or too intensively used for other purposes to support a desirable cover of plants. Consequently, the limitations are severe or very severe for playgrounds, athletic fields, and other intensive play areas; for picnic areas, parks, and other extensive play areas; for bridle paths, nature trails, and hiking trails; for golf fairways; for cottages, service buildings, and utility buildings; and for tent sites and trailer campsites.

Engineering Uses of Soils[4/]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, and pipelines, the foundations of buildings, facilities for storing water, structures for controlling erosion, drainage systems, and systems for disposing of sewage. Among the properties most important to engineers are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and soil reaction. Also important are depth to the water table, flooding hazard, depth to bedrock or to sand and gravel, and relief. Such information is made available in this subsection. Engineers can use it to--

1. Make soil and land use studies that will aid in selecting and developing industrial, commercial, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils in planning agricultural drainage systems, farm ponds, irrigation systems, and diversion terraces.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables and in planning detailed investigations at the selected locations.
4. Locate probable sources of gravel and other construction materials.
5. Correlate performance of engineering structures with soil mapping units, and thus develop information for overall planning that will be useful in designing and maintaining certain engineering practices and structures.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.

4/ PAUL A. JOHNSON, agricultural engineer, Soil Conservation Service, assisted in preparing this subsection.

7. Supplement information obtained from other published maps and reports and from aerial photographs.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

It should be emphasized that the interpretations made in this soil survey may not eliminate the need for sampling and testing at a site chosen for a specific engineering work that involves heavy loads or at a site where excavations are to be deeper than the depths of the layers here reported. Also, engineers should not apply specific values to the adjective ratings for bearing capacity given in this survey. Nevertheless, by using this survey, an engineer can select and concentrate on those soil units most important for his proposed kind of construction, and in this manner he can reduce the number of samples taken for laboratory testing and complete an adequate soil investigation at minimum cost.

Information of value in planning engineering work is given throughout the text, especially in the sections "Descriptions of the Soils" and "Formation and Classification of Soils." Some of the terms used by soil scientists may be unfamiliar to the engineer, and some words--for example, soil, clay, and sand--may have special meaning in soil science. These and other special terms used in the soil survey are defined in the Glossary.

Most of the information about engineering is given in tables 6, 7, 8, and 9. Table 6 contains engineering test data for several representative soils that were sampled in Milwaukee and Waukesha Counties. Table 7 gives textural classification of the major soil horizons of all the soils and their estimated properties. Table 8 contains soil interpretations for specified uses that are useful to engineering, and table 9 contains soil interpretations for farm uses.

Engineering Classification Systems

Agricultural scientists of the U.S. Department of Agriculture classify soils according to texture. In this system the textural classes of soils are based on the proportions of sand, silt, and clay in the soil (5). This system of naming textural classes is comparable, in some ways, to the two systems most commonly used by engineers for classifying soils.

Most highway engineers classify soil material in accordance with the system approved by the American Association of State Highway Officials (AASHO) (2). In this system soil materials are classified in seven principal groups, based on the gradation, liquid limit, and plasticity index of the soils. The groups range from A-1 (gravelly soils having high bearing capacity, the best soils for subgrade) to A-7 (clayey soils having low strength when wet, the poorest soils for subgrade). Within each group the relative engineering value of the soil material is indicated by a group index number. Group index numbers range from 0 for the best material to 20 for the poorest. The group index number is shown in parentheses after the soil group symbol in table 6.

Some engineers prefer to use the Unified classification system (7). In this system soil materials are identified according to texture and plasticity and performance as engineering construction material. They are identified as coarse grained (eight classes), fine grained (six classes), and highly organic. The last column in table 6 gives the classification of the tested soils according to the Unified system.

Engineering Test Data

Soil samples from major horizons of soils of several of the more extensive series in Milwaukee and Waukesha Counties were sampled at representative locations and were tested by the State Highway Commission of Wisconsin under a cooperative agreement with the U.S. Department of Commerce, Bureau of Public Roads. These samples were tested in accordance with the standard procedures of AASHO to help evaluate the soils for engineering purposes. The results of these tests and the classification of each soil sample according to both the AASHO and Unified systems are given in table 6.

The table gives optimum moisture and maximum dry density values for most of the tested soils. In the moisture density, or compaction test, a sample of the soil material is compacted several times using a constant compactive effort, each time at a successively higher moisture content. The moisture content increases until the optimum moisture content is reached. After that, the density decreases with increase in moisture content. The highest density obtained in the compaction test is termed "maximum dry density." Moisture-density data are important in construction, for as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

The engineering classifications are based on data obtained by mechanical analysis and by tests to determine liquid limits and plastic limits. The results of the mechanical analysis, obtained by combined sieve and hydrometer methods, may be used to determine the relative proportions of the different size particles that make up the soil sample. The percentage of fine-grained material, obtained by the hydrometer method, which generally is used by engineers, should not be used in determining textural classes of soils.

The tests to determine liquid limit and plastic limit measure the effect of water on consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the soil material passes from a plastic to

TABLE 6.--ENGINEERING

[Tests were performed by the State Highway Commission of Wisconsin in cooperation with the U.S. the American Association of State

Soil name and location	Depth from surface	Moisture density 1/		Mechanical analysis 2/				
		Maximum dry density	Optimum moisture	Percentage passing sieve--				
				2-in.	1-in.	3/4-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
	In.	Lb. per cu. ft.	Pct.					
Fox sandy loam:								
SW¼SE¼ sec. 2, T. 6 N., R. 17 E., Waukesha County (Modal)	12-24	120	12	100	96	94	87	84
	38-60	107	12	---	---	---	---	100
Hochheim loam:								
SE¼NE¼ sec. 23, T. 6 N., R. 19 E., Waukesha County (Modal)	8-17	106	19	---	---	100	96	93
	21-60	140	6	100	93	88	74	67
Kewaunee silt loam:								
SE¼NE¼ sec. 1, T. 8 N., R. 21 E., Milwaukee County (Modal)	10-22	99	23	---	---	---	---	100
	22-48	115	15	---	100	99	97	95
Martinton silt loam:								
SE¼SW¼ sec. 17, T. 5 N., R. 20 E., Waukesha County (Thin solum)	6-12	(4/)	(4/)	---	---	---	---	100
	22-60	(4/)	(4/)	---	---	---	---	100
NE¼SW¼ sec. 34, T. 5 N., R. 20 E., Waukesha County (Modal)	14-24	104	20	---	---	---	---	100
	26-60	107	18	---	---	---	---	100
NE¼NW¼ sec. 35, T. 5 N., R. 20 E., Waukesha County (Thick solum)	13-24	(4/)	(4/)	---	---	---	---	100
	33-60	(4/)	(4/)	---	---	---	---	100
Mequon silt loam:								
SE¼NE¼ sec. 5, T. 8 N., R. 21 E., Milwaukee County (Modal)	12-18	103	16	---	---	---	---	100
	32-48	103	15	---	---	---	---	100
SE¼SW¼ sec. 6, T. 8 N., R. 21 E., Milwaukee County (Modal)	15-24	(4/)	(4/)	---	---	---	---	100
	31-42	(4/)	(4/)	---	---	---	---	100
NE¼SE¼ sec. 33, T. 8 N., R. 20 E., Waukesha County (Thin solum)	9-19	(4/)	(4/)	---	---	---	---	100
	25-48	(4/)	(4/)	---	---	---	---	100
Miami loam, sandy loam substratum:								
SE¼NE¼ sec. 19, T. 6 N., R. 17 E., Waukesha County (Modal)	19-27	113	16	100	99	98	94	91
	34-50	135	7	100	96	95	82	76
SW¼NW¼ sec. 22, T. 5 N., R. 18 E., Waukesha County (Modal)	12-27	(4/)	(4/)	100	99	98	93	90
	33-60	(4/)	(4/)	100	94	91	77	71

See footnotes at end of table.

TEST DATA

Department of Commerce, Bureau of Public Roads, in accordance with standard test procedures of Highway Officials (AASHO) (2)]

Mechanical analysis 2/--Continued						Liquid limit	Plasticity index	Classification	
Percentage passing sieve--Continued		Percentage smaller than--						AASHO	Unified 3/
No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
51	24	23	23	17	16	39	23	A-2-6(1)	SC
80	8	7	4	2	1	(4/)	5/NP	A-3(0)	SM-SP
82	57	55	49	38	33	42	21	A-7-6(9)	CL
56	35	32	22	11	7	14	2	A-2-4(0)	SM
99	90	89	85	67	57	58	33	A-7-6(20)	CH
90	76	73	63	43	31	22	15	A-6(10)	CL
99	97	97	95	76	61	62	35	A-7-6(20)	CH
98	96	96	89	63	41	40	20	A-6(12)	CL
98	82	79	72	54	44	43	23	A-7-6(14)	CL
98	94	91	79	50	36	31	13	A-6(9)	CL
99	97	96	91	67	54	54	30	A-7-6(19)	CH
99	98	97	89	57	41	35	16	A-6(10)	CL
99	97	96	84	56	45	46	25	A-7-6(15)	CL
99	92	90	74	46	32	28	12	A-6(9)	CL
97	78	76	64	41	32	39	20	A-6(12)	CL
98	87	85	77	53	40	33	15	A-6(10)	CL
98	92	91	77	57	45	42	24	A-7-6(13)	CL
99	90	86	74	49	37	30	14	A-6(10)	CL
80	43	41	36	26	22	40	22	A-6(5)	SC
63	27	25	16	8	5	(4/)	5/NP	A-2-4(0)	SM
82	41	38	34	24	20	34	19	A-6(3)	SC
59	22	20	15	8	6	(4/)	5/NP	A-2-4(0)	SM

Soil name and location	Depth from surface	Moisture density 1/		Mechanical analysis 2/				
		Maximum dry density	Optimum moisture	Percentage passing sieve--				
				2-in.	1-in.	3/4-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
	In.	Lb. per cu. ft.	Pct.					
Montgomery silty clay loam:								
SW¼NW¼ sec. 6, T. 8 N., R. 21 E. Milwaukee County (Alkaline)	17-21	(4/)	(4/)	---	---	---	---	---
	30-48	(4/)	(4/)	---	---	---	---	100
NE¼SW¼ sec. 36, T. 5 N., R. 20 E., Waukesha County (Modal)	16-20	107	18	---	---	---	---	---
	30-60	110	18	---	---	---	---	---
NE¼SE¼ sec. 33, T. 5 N., R. 20 E., Waukesha County (Thin solum)	10-24	(4/)	(4/)	---	---	---	---	---
	24-60	(4/)	(4/)	---	---	---	---	---
Mundelein silt loam:								
NW¼NW¼ sec. 10, T. 5 N., R. 17 E., Waukesha County (Modal)	9-17	(4/)	(4/)	---	---	100	98	96
	20-60	(4/)	(4/)	---	---	---	---	---
Ozaukee silt loam:								
SW¼NW¼ sec. 36, T. 8 N., R. 20 E., Waukesha County (Modal)	14-22	98	24	---	---	---	---	100
	22-60	107	20	---	---	---	---	100
St. Charles silt loam, gravelly substratum:								
NE¼NE¼ sec. 34, T. 8 N., R. 18 E., Waukesha County (Thick silt mantle)	25-36	(4/)	(4/)	---	---	---	---	---
	40-51	(4/)	(4/)	---	---	---	---	100
NW¼NE¼ sec. 31, T. 8 N., R. 18 E., Waukesha County (Thick silt mantle)	28-41	(4/)	(4/)	---	---	---	---	100
	46-61	(4/)	(4/)	---	---	---	---	100
SE¼SE¼ sec. 9, T. 7 N., R. 18 E., Waukesha County (Modal)	26-36	102	21	---	---	---	---	---
	58-68	128	8	100	95	93	80	73
Saylesville silt loam:								
NE¼SW¼ sec. 34, T. 5 N., R. 20 E., Waukesha County (Modal)	14-26	(4/)	(4/)	---	---	---	---	---
	36-60	(4/)	(4/)	---	---	---	---	100
NE¼NW¼ sec. 25, T. 8 N., R. 20 E., Waukesha County (Thin solum)	7-15	(4/)	(4/)	---	---	---	---	---
	20-48	(4/)	(4/)	---	---	---	---	100

See footnotes at end of table.

TEST DATA--Continued

Mechanical analysis 2/--Continued						Liquid limit	Plasticity index	Classification	
Percentage passing sieve--Continued		Percentage smaller than--						AASHO	Unified 3/
No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
100	98	98	93	70	55	67	40	A-7-6(20)	CH
99	99	99	93	65	50	52	31	A-7-6(18)	CH
---	100	99	95	63	46	39	20	A-6(12)	CL
---	100	99	94	61	45	35	17	A-6(11)	CL
---	100	99	97	72	55	52	29	A-7-6(18)	CH
100	99	99	97	68	50	37	17	A-6(11)	CL
93	64	58	35	18	14	27	7	A-4(6)	CL
100	84	70	21	6	5	(4/)	5/NP	A-4(8)	ML
98	93	92	89	69	53	52	29	A-7-6(18)	CH
98	92	90	83	60	44	38	19	A-6(12)	CL
100	99	97	79	41	34	45	22	A-7-6(14)	CL
99	94	91	59	30	25	38	16	A-6(10)	CL
99	98	96	73	39	33	42	21	A-7-6(13)	CL
97	90	87	59	30	24	33	14	A-6(10)	CL
100	98	97	77	41	34	46	25	A-7-6(15)	CL
53	12	8	4	2	1	(4/)	5/NP	A-2-4(0)	SW-SM
100	92	90	83	61	49	48	26	A-7-6(16)	CL
98	95	91	76	45	29	30	12	A-6(9)	CL
100	99	98	96	81	63	53	29	A-7-6(18)	CH
99	98	98	96	79	58	46	24	A-7-6(15)	CL

TABLE 6.--ENGINEERING

Soil name and location	Depth from surface	Moisture density 1/		Mechanical analysis 2/				
		Maximum dry density	Optimum moisture	Percentage passing sieve--				
				2-in.	1-in.	3/4-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
	In.	Lb. per cu. ft.	Pct.					
Theresa silt loam:								
NW¼SE¼ sec. 16, T. 7 N., R. 18 E., Waukesha County (Modal)	15-28	105	18	100	98	98	92	89
	31-60	143	6	100	90	87	71	66

1/ Based on AASHO Designation: T 99-57 (2).

2/ Mechanical analyses according to AASHO Designation T 88-57 (2). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

TEST DATA--Continued

Mechanical analysis 2/--Continued						Liquid limit	Plasticity index	Classification	
Percentage passing sieve--Continued		Percentage smaller than--						AASHO	Unified 3/
No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
77	48	47	43	33	31	43	25	A-7-6(8)	SC
56	25	22	12	6	4	(4/)	5/NP	A-2-4(0)	SM

3/ SCS and BPR have agreed to consider that all soils having plasticity indexes within 2 points from A-line are to be given a borderline classification. An example of a borderline classification obtained by this use is SM-SP.

4/ Data not recorded.

5/ Nonplastic.

[The land types Alluvial land (Am), Clayey land (Cv), Loamy land (Lu), Marsh (Mf), Rough broken land (Ry), table because their characteristics are too variable for estimating. Bedrock is at a depth of more than the Knowles soils and at a depth of 10 to 20 inches in the Ritchey soils. Absence of data indicates

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	In.			
Adrian: Ac	0-1	0-27	Muck	Pt	--------
		27-60	Sand	SP	A-3
Ashkum: AsA	0-1	0-11	Silty clay loam	CL	A-7
		11-23	Silty clay	CH	A-7
		23-60	Silty clay loam	CL	A-6 or A-7
Aztalan: AzA, AzB	1-3	0-17	Loam	ML	A-4
		17-60	Silty clay loam	CL	A-6 or A-7
Blount: BlA	1-3	0-8	Silt loam	ML	A-4
		8-28	Silty clay	CH	A-7
		28-60	Silty clay loam	CL	A-6 or A-7
Boyer: BmB, BmC2, BnB	5+	0-15	Loamy sand	SM	A-2
		15-36	Sandy loam	SM	A-2
		36-64	Sand	SP-SM	A-3
Brookston: BsA	0-1	0-15	Silt loam	ML or OL	A-4
		15-29	Loam	CL	A-6
		29-60	Gravelly loam	SM	A-4
Casco: CcB, CcC2, CcD2, CeB, CeC2, CeD2, CfC3, CrC2, CrD, CrE, CrF. (For properties of the Rodman soils in mapping units CrC2, CrD, CrE, and CrF, refer to the Rodman series.)	5+	0-7	Loam	ML	A-4
		7-19	Clay loam	CL	A-6
		19-60	Sand and gravel	GP-GM	A-1
Chelsea: CtB, CtD	5+	0-72	Fine sand	SP-SM	A-3
Colwood: Cw	0-1	0-18	Silt loam	ML or OL	A-4
		18-25	Silty clay loam	CL	A-6
		25-62	Silt and fine sand	ML	A-4
Dodge: DdA, DdB	5+	0-16	Silt loam	ML	A-4
		16-33	Silty clay loam	CL	A-6 or A-7
		33-60	Loam	ML	A-4
Drummer: Dt	0-1	0-15	Silt loam	ML or OL	A-6
		15-46	Silty clay loam	CL	A-6 or A-7
		46-60	Sand and gravel	GP-GM	A-2
Elliott: EsA	1-3	0-13	Silt loam	ML	A-4
		13-26	Silty clay	CH	A-7
		26-60	Silty clay loam	CL	A-6 or A-7

See footnotes at end of table.

Sandy and gravelly land (Sf), Sandy lake beaches (Sfb), and Wet alluvial land (Ww) are omitted from this
5 feet in all soils except those of the Knowles and Ritchey series. It is at a depth of 3 to 5 feet in
information is not available or does not apply. >=more than]

Percentage passing sieve 1/			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.07 mm.)				
			In. per hr.	In. per in. of soil depth	pH value	
------	------	------	2.0-6.3	0.20	5.6-7.3	
100	100	2	6.3-20.0	.04	6.1-7.3	Very low.
100	95	95	0.63-2.0	.20	6.6-7.3	Moderate.
100	100	95	0.20-0.63	.18	6.6-7.3	High.
100	100	90	0.20-0.63	.18	7.4-8.4	Moderate.
100	100	60	0.63-2.0	.20	6.6-7.3	Low.
100	100	95	0.20-0.63	.18	7.4-8.4	Moderate.
100	100	85	0.63-2.0	.20	5.6-7.3	Low.
100	100	100	0.20-0.63	.18	5.6-7.3	High.
100	100	95	0.20-0.63	.16	7.4-8.4	Moderate.
100	80	15	6.3-20.0	.07	5.6-7.3	Low.
100	95	30	2.0-6.3	.10	5.1-6.5	Low.
100	95	5	>20.0	.04	7.4-8.4	Low.
100	100	95	0.63-2.0	.22	6.6-7.3	Low.
100	100	55	0.63-2.0	.18	6.6-7.3	Low.
80	75	45	0.63-2.0	.10	7.4-8.4	Low.
95	85	60	0.63-2.0	.20	6.6-7.3	Low.
95	85	70	0.63-2.0	.18	5.6-7.3	Moderate.
50	45	5	>20.0	.02	7.4-8.4	Low.
100	100	6	6.3-20.0	.06	5.1-7.8	Low.
100	100	100	0.63-2.0	.22	6.6-7.3	Low.
100	100	100	0.63-2.0	.18	5.6-7.3	Moderate.
100	100	87	0.63-2.0	.16	7.4-8.4	Low.
100	100	95	0.63-2.0	.22	5.6-7.3	Low.
100	95	90	0.20-0.63	.18	6.1-7.3	Moderate.
95	85	55	0.63-2.0	.16	7.4-8.4	Low.
100	100	100	0.63-2.0	.22	6.1-7.3	Low.
100	100	95	0.63-2.0	.18	6.1-7.3	Moderate.
50	45	5	>20.0	.02	7.4-8.4	Low.
100	100	95	0.63-2.0	.24	5.6-6.5	Low.
100	100	85	0.20-0.63	.20	6.5-7.4	High.
100	100	85	0.20-0.63	.18	7.4-8.4	Moderate.

TABLE 7.--ESTIMATED ENGINEERING PROPERTIES

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	In.			
Fabius: FaA----------	1-3	0-15	Loam----------	ML	A-4
		15-60	Sand and gravel--------	GP-GM	A-1
Fox:					
FmA, FmB, FmC2, FoA, FoB, FoC2, FsA, FsB, FsC2, FtB.	5+	0-8	Loam----------	ML	A-4
		8-33	Clay loam----------	CL	A-6
		33-62	Sand and gravel--------	GP-GM	A-1
FnB----------	5+	0-8	Sandy loam----------	SM	A-2
		8-32	Sandy clay loam--------	SC	A-6
		32-38	Sand and gravel--------	GP-GM	A-2
		38-60	Sandy loam----------	SM	A-4
Gilford: Gd----------	0-3	0-10	Loam----------	ML or OL	A-4
		10-30	Sandy loam----------	SM	A-4
		30-60	Sand----------	SP	A-3
Granby: Gf----------	0-1	0-11	Sandy loam----------	SM	A-2
		11-62	Sand----------	SP-SM	A-3
Grays: GrA, GrB----------	5+	0-9	Silt loam----------	ML	A-4
		9-26	Silty clay loam--------	CL	A-6 or A-7
		26-62	Silt and sand----------	ML	A-4
Griswold: GtB, GtC2------	5+	0-11	Silt loam----------	ML	A-7
		11-24	Clay loam----------	CL	A-6
		24-62	Loam----------	ML	A-4
Griswold, mottled subsoil variant: GwB.	1-3	0-10	Silt loam----------	ML	A-4
		10-26	Clay loam----------	CL	A-7
		26-60	Sandy loam----------	SM	A-4
Hebron: HeA, HeB, HeC2---	5+	0-9	Loam----------	ML	A-4
		9-22	Clay loam----------	CL	A-7
		22-27	Loam----------	CL	A-6
		27-60	Silty clay loam--------	CL	A-6
Hochheim: HmB, HmB2, HmC2, HmD2, HmE2, HoC3, HoD3, HoE3.	5+	0-6	Loam----------	ML	A-4
		6-17	Clay loam----------	CL	A-7 or A-6
		17-60	Gravelly loam----------	SM	A-4
Houghton: HtA, HtB-------	0-1	0-60	Muck----------	Pt	----------
Juneau: JuA----------	5+	0-33	Silt loam----------	ML	A-4
		33-44	Silty clay loam--------	CL	A-7
		44-60	Clay loam----------	CL	A-7
Kane: KeA----------	1-3	0-14	Silt loam----------	ML	A-4
		14-36	Clay loam----------	CL	A-7 or A-6
		36-60	Sand and gravel--------	GP	A-1
Kendall: KlA----------	1-3	0-15	Silt loam----------	ML	A-4
		15-45	Silty clay loam--------	CL	A-7
		45-60	Loam----------	ML	A-4

See footnotes at end of table.

OF THE SOILS--Continued

Percentage passing sieve 1/			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.07 mm.)				
			In. per hr.	In. per in. of soil depth	pH value	
100	100	80	0.63-2.0	0.20	6.1-7.3	Low.
45	25	10	>20.0	.02	7.4-8.4	Low.
100	100	55	0.63-2.0	.18	6.1-7.3	Low.
100	85	65	0.63-2.0	.18	5.1-6.5	Moderate.
50	45	5	>20.0	.02	7.4-8.4	Low.
100	87	35	2.0-6.3	.12	5.1-6.5	Low.
90	85	40	0.63-2.0	.16	5.6-7.3	Moderate.
50	45	5	>20.0	.02	7.4-8.4	Low.
85	80	40	0.63-2.0	.10	7.4-8.4	Low.
100	90	55	0.63-2.0	.20	6.1-7.3	Low.
100	100	45	0.63-2.0	.10	6.1-7.3	Low.
100	100	2	6.3-20.0	.02	7.4-8.4	Low.
100	100	45	2.0-6.3	.12	6.1-7.8	Low.
100	100	5	6.3-20.0	.04	6.6-8.4	Low.
100	100	80	0.63-2.0	.22	5.6-6.5	Low.
100	100	90	0.63-2.0	.18	6.1-7.3	Moderate.
100	100	80	0.63-2.0	.16	7.4-8.4	Low.
100	95	80	0.63-2.0	.20	5.6-7.3	Low.
100	100	80	0.20-0.63	.18	5.6-7.3	Moderate.
70	65	55	0.63-2.0	.16	7.4-8.4	Low.
100	100	95	0.63-2.0	.20	6.1-7.3	Low.
100	90	70	0.20-0.63	.18	5.6-7.3	Moderate.
80	75	45	0.63-2.0	.10	7.4-8.4	Low.
100	95	55	0.63-2.0	.20	6.6-7.3	Low.
95	90	70	0.20-0.63	.18	6.6-7.3	Moderate.
100	100	60	0.63-2.0	.16	5.6-7.3	Low.
100	100	95	0.06-0.20	.16	7.4-8.4	Moderate.
95	95	55	0.63-2.0	.20	5.6-7.3	Low.
95	80	65	0.20-0.63	.18	5.6-7.3	Moderate.
75	55	40	0.63-2.0	.12	7.4-8.4	Low.
----	----	----	2.0-6.3	.20	5.6-8.4	
100	100	95	0.63-2.0	.22	6.1-7.3	Low.
100	100	100	0.20-0.63	.20	5.6-7.3	Moderate.
100	100	95	0.20-0.63	.18	6.1-6.5	Moderate.
100	100	95	0.63-2.0	.20	6.1-7.3	Low.
95	95	60	0.63-2.0	.18	5.6-7.3	Moderate.
45	35	5	>20.0	.02	7.4-8.4	Low.
100	100	95	0.63-2.0	.20	5.6-6.5	Low.
100	100	100	0.63-2.0	.18	5.6-7.3	Moderate.
80	70	55	0.63-2.0	.10	7.4-8.4	Low.

TABLE 7.--ESTIMATED ENGINEERING PROPERTIES

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	In.			
Kewaunee: KnB, KnC2------	5+	0-10	Silt loam----------	ML	A-4
		10-16	Clay----------	CH	A-7
		16-62	Silty clay----------	CH	A-7
Knowles: KwA, KwB--------	5+	0-7	Silt loam----------	ML	A-4
		7-27	Clay loam----------	CL	A-6
		27-60	Dolomite----------	----------	----------
Lamartine: LmB----------	1-3	0-12	Silt loam----------	ML	A-4
		12-25	Silty clay loam--------	CL	A-7
		25-36	Clay loam----------	CL	A-7 or A-6
		36-60	Loam----------	ML	A-4
Lawson: Lo---------------	1-3	0-60	Silt loam----------	ML	A-4
Lorenzo: LyB2, LyC2, LyD2.	5+	0-8	Loam----------	ML	A-4
		8-19	Clay loam----------	CL	A-6
		19-60	Sand and gravel--------	GP	A-2
Manawa: MaA-------------	1-3	0-9	Silt loam----------	ML	A-4
		9-60	Silty clay----------	CH	A-7
Markham: MeB------------	5+	0-11	Silt loam----------	ML	A-4
		11-26	Silty clay----------	CH	A-7
		26-60	Silty clay loam--------	CL	A-6
Martinton: MgA----------	1-3	0-16	Silt loam----------	ML	A-4
		16-35	Silty clay----------	CH	A-7
		35-62	Silty clay loam--------	CL	A-6
Matherton: MhA, MmA------	1-3	0-14	Silt loam----------	ML	A-4
		14-35	Clay loam----------	CL	A-6
		35-62	Sand and gravel--------	GP-GM	A-1
Mayville: MoA, MoB-------	3-5	0-12	Silt loam----------	ML	A-4
		12-24	Silty clay loam--------	CL	A-7
		24-60	Loam----------	ML	A-4
Mequon: MtA-------------	1-3	0-8	Silt loam----------	ML	A-4
		8-26	Silty clay----------	CL	A-7
		26-60	Silty clay loam--------	CL	A-6 or A-7
Miami: MvB, MvC2, MxB, MxC2, MxD2, MxE.	5+	0-11	Loam----------	ML	A-4
		11-34	Clay loam----------	CL	A-6
		34-62	Sandy loam----------	SM	A-2
Montgomery: Mzb----------	0-1	0-11	Silty clay loam--------	MH or OH	A-7
		11-60	Silty clay----------	CH	A-7
Morley: MzdB, MzdB2, MzdC2, MzdD2.	5+	0-8	Silt loam----------	ML	A-4
		8-23	Silty clay----------	CH	A-7
		23-62	Silty clay loam--------	CL	A-7

See footnotes at end of table.

OF THE SOILS--Continued

Percentage passing sieve 1/			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.07 mm.)				
			In. per hr.	In. per in. of soil depth	pH value	
100	100	95	0.63-2.0	0.20	6.6-7.3	Moderate.
100	100	90	0.20-0.63	.18	6.1-7.3	High.
100	90	90	0.06-0.20	.16	7.4-8.4	High.
100	100	95	0.63-2.0	.20	6.1-7.3	Low.
100	96	90	0.63-2.0	.18	6.1-7.8	Moderate.
----	----	----	---------	----	(2/)	
100	100	95	0.63-2.0	.20	5.6-7.3	Low.
100	100	91	0.63-2.0	.18	5.6-7.3	Moderate.
100	100	95	0.63-2.0	.18	6.6-7.8	Moderate.
85	80	60	0.63-2.0	.16	7.4-8.4	Low.
100	100	100	0.63-2.0	.24	6.6-7.3	Low.
95	85	60	0.63-2.0	.20	5.6-7.3	Low.
95	86	65	0.63-2.0	.18	5.6-7.3	Moderate.
50	45	4	>20.0	.02	7.4-8.4	Low.
100	95	90	0.63-2.0	.20	6.6-7.3	Low.
95	95	80	0.06-0.20	.14	6.6-7.3	High.
100	100	85	0.63-2.0	.20	5.6-7.3	Low.
100	100	90	0.20-0.63	.14	5.6-7.8	High.
100	100	90	0.20-0.63	.16	7.4-8.4	Moderate.
100	100	95	0.63-2.0	.22	6.1-7.3	Low.
100	100	95	0.20-0.63	.18	6.6-7.3	High.
100	100	95	0.06-0.20	.18	7.4-8.4	Moderate.
100	100	100	0.63-2.0	.22	6.1-7.3	Low.
100	100	65	0.63-2.0	.18	5.6-7.3	Moderate.
50	45	5	>20.0	.02	7.4-8.4	Low.
100	95	90	0.63-2.0	.20	5.6-7.3	Low.
100	100	90	0.63-2.0	.18	5.6-7.3	Moderate.
85	80	55	0.63-2.0	.12	7.4-8.4	Low.
100	100	85	0.63-2.0	.20	6.6-7.3	Low.
100	100	95	0.20-0.63	.18	6.6-7.3	High.
100	100	90	0.20-0.63	.16	7.4-8.4	Moderate.
95	90	60	0.63-2.0	.20	5.6-7.3	Low.
95	95	65	0.63-2.0	.18	5.6-7.3	Moderate.
80	75	30	2.0-6.3	.10	7.4-8.4	Low.
100	100	100	0.20-0.63	.20	6.6-7.3	Moderate.
100	95	95	0.06-0.20	.18	6.6-8.4	High.
100	100	85	0.63-2.0	.20	5.6-7.3	Low.
100	100	95	0.20-0.63	.18	5.6-7.3	High.
100	100	90	0.20-0.63	.18	7.4-8.4	Moderate.

TABLE 7.--ESTIMATED ENGINEERING PROPERTIES

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	In.			
Mundelein: MzfA----------	1-3	0-9	Silt loam----------	ML	A-4
		9-20	Silty clay loam-------	CL	A-7
		20-60	Silt loam----------	ML	A-4
Muskego: Mzg----------	0-1	0-32	Muck----------	Pt	----------
		32-65	Sedimentary peat------	Pt	----------
Mussey: Mzk----------	1-3	0-18	Loam----------	ML	A-6
		18-60	Sand and gravel-------	GP-GM	A-2
Navan: Na----------	0-1	0-11	Silt loam----------	ML	A-4
		11-20	Sandy clay loam-------	SC	A-6
		20-60	Silty clay----------	CL	A-6
Ogden: Oc----------	0-1	0-24	Muck and peat---------	Pt	----------
		24-60	Clay----------	CH	A-7
Oshtemo: OmB, OnB--------	5+	0-20	Loamy sand----------	SM	A-2
		20-35	Sandy clay loam-------	SC	A-2
		35-46	Loamy sand----------	SM	A-2
		46-65	Sand----------	SP	A-3
Ozaukee: OuB, OuB2, OuC2, OuD2.	5+	0-11	Silt loam----------	ML	A-4
		11-20	Silty clay----------	CH	A-7
		20-60	Silty clay loam-------	CL	A-7
Palms: Pa----------	0-1	0-30	Muck and peat---------	Pt	----------
		30-60	Loam----------	ML	A-6 or A-7
Pella: Ph----------	0-1	0-11	Silt loam----------	ML or OL	A-4
		11-38	Silty clay loam-------	CH	A-7
		38-62	Silt loam----------	CL	A-6
Pella, moderately shallow variant: Pm.	0-1	0-7	Silt loam----------	ML or OL	A-4
		7-30	Silty clay loam-------	CL	A-7
		30	Dolomite----------	---------	----------
Pistakee: PrA----------	1-3	0-36	Silt loam----------	ML	A-4
		36-60	Silty clay loam-------	CH	A-7
Ritchey: RkB, RkC2, RkE--	5+	0-9	Silt loam----------	ML	A-4
		9-18	Clay loam----------	CL	A-6
		18	Dolomite----------	---------	----------
Ritchey, mottled subsoil variant: R1A.	1-3	0-12	Silt loam----------	ML	A-7
		12-29	Silty clay loam-------	CL	A-7
		29	Dolomite----------	---------	----------
Rodman---------- (Mapped only in complexes with Casco soils.)	5+	0-8	Gravelly loam---------	SM	A-4
		8-72	Sand and gravel-------	GP-GM	A-1

See footnotes at end of table.

Percentage passing sieve 1/			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.07 mm.)				
			In. per hr.	In. per in. of soil depth	pH value	
100	100	95	0.63-2.0	0.22	6.6-7.3	Low.
98	93	85	0.63-2.0	.20	6.6-7.3	Moderate.
100	100	85	0.63-2.0	.16	7.4-8.4	Low.
----	----	----	2.0-6.3	>.20	6.1-7.3	
----	----	----	0.20-0.63	----	7.4-8.4	
95	85	60	0.63-2.0	.20	6.6-7.3	Low.
50	45	5	>20.0	.02	7.4-8.4	Low.
100	95	70	0.63-2.0	.20	6.1-7.3	Low.
90	90	40	0.63-2.0	.16	6.6-7.3	Moderate.
100	100	90	0.06-0.20	.18	7.4-8.4	Moderate.
----	----	----	2.0-6.3	>.20	5.6-7.3	
100	100	95	0.06-0.20	.16	7.4-8.4	High.
100	60	15	6.3-20.0	.08	5.6-7.3	Low.
90	89	33	6.3-20.0	.16	5.6-7.3	Low.
100	60	15	6.3-20.0	.10	6.0-7.8	Low.
100	100	2	>20.0	.04	7.4-8.4	Low.
100	100	85	0.63-2.0	.20	6.1-7.3	Low.
100	100	95	0.20-0.63	.12	5.6-7.3	High.
100	100	90	0.20-0.63	.16	7.4-8.4	Moderate.
----	----	----	2.0-6.3	>.20	5.6-7.3	
90	85	55	0.20-0.63	.16	7.4-8.4	Low.
100	100	100	0.63-2.0	.24	6.6-7.3	Low.
100	100	95	0.20-0.63	.20	6.6-7.3	Moderate.
100	100	95	0.20-0.63	.18	7.4-8.4	Low.
100	100	95	0.63-2.0	.24	6.6-7.3	Low.
100	100	95	0.20-0.63	.20	6.6-7.3	Moderate.
----	----	----	(3/)	----	(2/)	
100	100	95	0.63-2.0	.22	6.1-7.3	Low.
100	100	95	0.63-2.0	.18	5.6-7.3	Moderate.
100	100	95	0.63-2.0	.20	6.1-7.3	Low.
100	95	85	0.63-2.0	.18	6.1-7.3	Moderate.
----	----	----	---------	----	(2/)	
100	100	100	0.63-2.0	.24	6.1-7.3	Low.
100	96	90	0.63-2.0	.20	6.1-7.3	Moderate.
----	----	----	---------	----	(2/)	
80	75	45	6.3-20.0	.04	6.1-7.3	Low.
50	45	5	>20.0	.02	7.4-8.4	Low.

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TABLE 7.--ESTIMATED ENGINEERING PROPERTIES

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Ft.	In.			
Rollin:					
Ru----------	0-1	0-30	Muck----------	Pt	----------
		30-60	Marl----------	MH	A-5
Rv----------	0-1	0-20	Muck----------	Pt	----------
		20-60	Marl----------	MH	A-5
St. Charles: SaA, ScA, ScB, SeA, SeB.	5+	0-15	Silt loam----------	ML	A-4
		15-58	Silty clay loam-------	CL	A-7
		58-68	Sand and gravel-------	SP-SM	A-2
Sawmill, calcareous variant: Sg.	0-1	0-9	Silt loam----------	ML or OL	A-4
		9-60	Silty clay loam-------	CL	A-7
Saylesville: ShA, ShB, ShB2, ShC2.	5+	0-8	Silt loam----------	ML	A-4
		8-14	Silty clay loam-------	CL	A-6 or A-7
		14-31	Silty clay----------	CH	A-7
Sebewa: Sm----------	0-1	0-14	Silt loam----------	ML or OL	A-4
		14-26	Clay loam----------	CL	A-7 or A-6
		26-60	Sand and gravel-------	GP-GM	A-1
Theresa: ThA, ThB, ThB2, ThC2.	5+	0-14	Silt loam----------	ML	A-4
		14-28	Clay loam----------	CL	A-6
		28-60	Loam----------	ML	A-4
Virgil: VsA----------	1-3	0-13	Silt loam----------	ML	A-4
		13-44	Silty clay loam-------	CL	A-7
		44-72	Sand and gravel-------	SP-SM	A-3
Wallkill: Wa----------	0-1	0-30	Silt loam----------	ML	A-4
		30-60	Muck and peat---------	Pt	----------
Warsaw: WdB, WeA, WeB, WeC2, WhA.	5+	0-17	Loam----------	ML	A-4
		17-29	Sandy clay loam-------	SC	A-6
		29-96	Sand and gravel-------	GP-GM	A-1
Wasepi: WmA----------	1-3	0-9	Sandy loam----------	SC	A-2
		9-29	Loamy sand----------	SM	A-2
		29-62	Fine sand----------	SP	A-3

1/ The range in values for the percentage passing the various sieves is plus or minus 5 percent of the values given.

OF THE SOILS--Continued

Percentage passing sieve 1/			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.07 mm.)				
			In. per hr.	In. per in. of soil depth	pH value	
----	----	----	2.0-6.3	0.20	6.6-8.4	
100	100	85	0.20-0.63	.16	(2/)	Low.
----	----	----	2.0-6.3	.20	6.6-8.4	
100	90	85	0.20-0.63	.16	(2/)	Low.
100	100	95	0.63-2.0	.20	5.6-7.3	Low.
100	100	95	0.63-2.0	.18	5.1-7.3	Moderate.
80	75	10	>20.0	.02	7.4-8.4	Low.
100	100	95	0.63-2.0	.22	6.6-8.4	Low.
100	100	95	0.20-0.63	.18	(2/)	Moderate.
100	100	95	0.63-2.0	.20	6.6-7.3	Moderate.
100	100	90	0.20-0.63	.18	6.0-6.5	Moderate.
100	100	99	0.06-0.20	.18	5.6-7.3	High.
100	100	95	0.63-2.0	.22	6.6-7.3	Low.
95	95	65	0.63-2.0	.18	6.6-7.3	Moderate.
40	20	9	>20.0	.02	7.4-8.4	Low.
100	100	95	0.63-2.0	.20	6.1-7.3	Low.
100	100	80	0.63-2.0	.18	6.1-7.3	Moderate.
85	80	55	0.63-2.0	.16	7.4-8.4	Low.
100	100	95	0.63-2.0	.22	6.6-7.3	Low.
100	100	95	0.63-2.0	.20	5.6-7.3	Moderate.
90	85	5	>20.0	.02	7.4-8.4	Low.
100	100	90	0.63-2.0	.22	6.1-7.3	Low.
----	----	----	2.0-6.3	.20	6.1-7.8	
100	90	55	0.63-2.0	.20	5.6-6.5	Low.
100	80	40	0.63-2.0	.16	5.6-7.3	Moderate.
50	45	5	>20.0	.02	7.4-8.4	Low.
90	90	30	0.63-2.0	.10	5.6-6.5	Low.
100	60	15	2.0-6.3	.10	5.6-6.0	Low.
100	100	2	>20.0	.04	7.4-8.4	Low.

2/ Calcareous.

3/ Variable.

TABLE 8.--ENGINEERING

[Clayey land (Cv), Loamy land (Lu), and Sandy and gravelly land (Sf) are omitted from this

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Adrian: Ac	Poor; soil is erodible and oxidizes rapidly.	Fair; underlying sand is variable; high water table hinders excavation.	Very severe; organic material is unsuitable for subgrade.	Very severe; organic material is unsuitable for foundations.
Alluvial land: Am	Fair; variable	Unsuitable; soil material is variable.	Severe; soil material is variable; stability and bearing capacity are variable; occasional flooding.	Moderate to severe; occasional flooding; soil material is variable and is unstable in places.
Ashkum: AsA	Surface layer good; subsoil poor, clayey; water table within 1 foot of surface most of the time.	Unsuitable	Very severe in subsoil; high shrink-swell potential; severe in substratum, low bearing capacity, elastic.	Severe; fair shear strength; high compressibility; high shrink-swell potential; low bearing capacity; high water table.
Aztalan: AzA, AzB	Surface layer good; subsoil poor, lower part is silty clay loam and is unstable in sloping areas.	Unsuitable	Moderate in subsoil, low bearing capacity when wet, low stability in lower part of subsoil; severe in substratum, unstable when wet.	Severe; moderate shrink-swell potential; high compressibility, poor shear strength; seepage, a high water table at times, or both.
Blount: BlA	Surface layer good, thin in some places; subsoil and substratum poor, clayey.	Unsuitable	Very severe in subsoil, high to moderate shrink-swell potential; severe in substratum, moderate shrink-swell potential; low bearing capacity; elastic.	Severe; fair shear strength; high compressibility; high to moderate shrink-swell potential; low bearing capacity; high water table, seepage, or both.

See footnote at end of table.

table because their properties are too variable for rating. Onsite investigation is required]

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Severe; high water table.	Very severe; high water table.	Very severe; high water table; high compressibility and instability; erodible.	Very severe; high water table; high compressibility; erodible.	High; medium in underlying sand.	Low.
Very severe on flood plains and subject to overflow.	Very severe on flood plains and subject to overflow.	Severe; soil material liquefies when saturated; subject to frost heave; low bearing strength when wet; subject to flooding.	Severe; material below the surface layer has low stability and low bearing capacity when wet; subject to flooding.	Medium----	Low.
Severe; low bearing capacity when wet; high shrink-swell potential; fluctuating water table; water management needed.	Very severe; fluctuating high water table.	Severe; low bearing capacity when wet; high shrink-swell potential; fluctuating water table.	Severe; high shrink-swell potential; low bearing capacity when wet; high water table.	High------	Low.
Moderate; moderate shrink-swell potential; seasonal high water table.	Very severe; seasonal high water table; slow permeability.	Severe; moderate shrink-swell potential; high compressibility; low shear strength; seasonal high water table.	Severe; subsoil has low stability and low bearing capacity when wet; subject to slippage and frost heave; seasonal high water table.	High------	Low.
Moderate; low bearing capacity when wet; high to moderate shrink-swell potential; seasonal high water table.	Very severe; seasonal high water table; moderately slow permeability.	Severe; seasonal high water table; high to moderate shrink-swell potential; low bearing capacity when wet; subject to frost heave.	Severe; seasonal high water table; high to moderate shrink-swell potential; low bearing capacity when wet; subject to frost heave.	High------	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Boyer: BmB, BmC2	Surface layer unsuitable; subsoil unsuitable, erodible and thin; underlain by sand and gravel.	Fair to good; poorly graded sand; some pockets of gravel.	Slight in subsoil where properly compacted, low shrink-swell potential; slight in substratum, lacks stability under wheel load, very low shrink-swell potential.	Very slight; very low compressibility; low shrink-swell potential.
BnB	Surface layer poor; subsoil poor, thin.	Fair to good; poorly graded sand, some pockets of gravel.	Slight in subsoil where properly compacted, low shrink-swell potential; slight in substratum, lacks stability under wheel load unless moist; very low shrink-swell potential.	Slight; very low compressibility.
Brookston: BsA	Surface layer good, dark and thick; subsoil poor, loam and silty clay loam in most places; high water table most of the time.	Poor; low content of sand and gravel.	Severe in subsoil, low shrink-swell potential, low bearing capacity when wet, elastic; slight in substratum, low shrink-swell potential, fair stability when wet.	Slight; high bearing capacity; high water table.
Casco: CcB, CcC2, CcD2, CeB, CeC2, CeD2.	Surface layer good but thin in CeB, CeC2, CeD2, and it is fair but thin in CcB, CcC2, CcD2; subsoil poor, clay loam and thin, underlain by sand and gravel.	Good; substratum is poorly graded, stratified sand and gravel.	Moderate in subsoil, moderate shrink-swell potential; slight in substratum.	Slight; very low compressibility; good shear strength.
CfC3, CrC2, CrD, CrE, CrF. (For interpretations of Rodman soil in units CrC2, CrD, CrE, and CrF, refer to the Rodman series.)	Poor; soil is gravelly and low in available water capacity.	Good; substratum is poorly graded, stratified sand and gravel.	Slight; little or no subsoil above substratum.	Slight; very low compressibility; good shear strength.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Moderate; droughty; erodible; vegetation difficult to establish.	Moderate; possible contamination of ground water.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; vegetation difficult to establish on cuts and fills.	Slight; cuts and fills difficult to stabilize.	Low------	Low.
Slight; somewhat droughty.	Slight; possible contamination of ground water.	Slight; somewhat droughty; vegetation difficult to establish on cuts and fills.	Slight; cuts and fills difficult to stabilize.	Low------	Low.
Severe; high water table, basements are wet; ponding is a hazard.	Very severe; high water table.	Severe; high water table; occasional ponding; subject to frost heave.	Severe; subsoil has low bearing capacity when wet; subject to frost heave; high water table.	High-----	Low.
Slight on slopes of 0 to 12 percent; moderate on slopes of 12 to 20 percent; severe on slopes stronger than 20 percent; slightly droughty; erodible in sloping areas.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent; vegetation difficult to establish on cuts.	Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; cuts and fills difficult to stabilize.	Low------	Low.
Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; very droughty; vegetation difficult to establish and maintain.	Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent.	Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent; vegetation difficult to establish.	Moderate; vegetation difficult to establish.	Low------	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Chelsea: CtB, CtD------	Unsuitable; soil is droughty and subject to soil blowing.	Good; poorly graded sand and little gravel.	Slight; low stability under wheel load; suitable for all types of pavement where confined.	Slight; very low compressibility; good shear strength; good bearing capacity.
Colwood: Cw----------	Surface layer good; subsoil fair, unstable in sloping areas; high water table most of the time; underlain by stratified silt and sand.	Poor; in places substratum contains layers of poorly graded fine sand and lenses of silt and clay.	Severe in subsoil, low bearing capacity, unstable in sloping areas; severe in substratum, even where properly compacted, low bearing capacity.	Severe, even where drained; fairly low compressibility; moderately high susceptibility to frost heave; loses bearing capacity on thawing; high water table most of the time.
Dodge: DdA, DdB--------	Surface layer good; subsoil poor, silty clay loam.	Poor; substratum contains pockets of well-graded sand and gravel. 1/	Severe in subsoil, moderate shrink-swell potential, low bearing capacity when wet; slight in substratum, good stability, low shrink-swell potential.	Slight; low compressibility; fair shear strength; moderately high bearing capacity.
Drummer: Dt----------	Surface layer good; subsoil poor, silty clay loam, lower part gravelly.	Good; substratum contains poorly graded, stratified sand and gravel; high water table hinders excavation.	Moderate in subsoil, moderate shrink-swell potential; slight in substratum, very stable.	Slight; very low compressibility; moderate shrink-swell potential; good shear strength; high water table.
Elliott: EsA----------	Surface layer good, thick, dark; subsoil poor, clayey.	Unsuitable-------	Very severe in subsoil, high shrink-swell potential; severe in substratum, moderate shrink-swell potential, low bearing capacity.	Severe; fair shear strength; high shrink-swell potential; low bearing capacity; high water table, seepage, or both.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent; very droughty; vegetation difficult to establish.	Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent; droughty; vegetation difficult to establish on cuts and fills.	Slight on slopes of 0 to 12 percent; moderate on slopes of 12 to 20 percent; droughty; cuts and fills difficult to stabilize.	Low-------	Low.
Severe; high water table; basements are wet; soil liquefies easily; utilities difficult to install.	Very severe; high water table.	Severe; high water table; subject to frost heave, liquefaction, and piping.	Severe; high water table; subject to liquefaction, frost heave, and piping.	High------	Low.
Slight; erodible in sloping areas.	Slight----------	Slight; erodible in sloping areas.	Slight; subject to frost heave; subsoil has moderate shrink-swell potential and low bearing capacity when wet.	Medium----	Low.
Severe; high water table; basements are wet.	Very severe; high water table.	Severe; high water table; subject to frost heave.	Severe; high water table; subject to frost heave; subsoil has low bearing capacity.	High------	Low.
Moderate; low bearing capacity when wet; seasonal high water table; basements are likely to be wet.	Very severe; seasonal high water table; moderately slow permeability.	Severe; seasonal high water table; low bearing capacity when wet; high shrink-swell potential; subject to frost heave.	Severe; seasonal high water table; low bearing capacity when wet; subject to frost heave.	High------	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Fabius: FaA----------	Surface layer good, dark, thin; subsoil poor, loam, thin, and underlain by sand and gravel; seasonal high water table.	Good; substratum is poorly stratified sand and gravel; seasonal high water table.	Moderate in subsoil, low shrink-swell potential; slight in substratum, very stable.	Slight; very low compressibility; low shrink-swell potential; good shear strength; high water table, seepage, or both.
Fox: FmA, FmB, FmC2, FoA, FoB, FoC2.	Surface layer good but thin in places; subsoil poor, clay loam, gravelly in lower part in many places.	Good; substratum is poorly graded, stratified sand and gravel.	Moderate in subsoil, good bearing capacity where properly compacted; very slight in substratum, stable.	Slight; very low compressibility; good shear strength; moderate to low shrink shrink-swell potential.
FnB----------	Surface layer fair; subsoil poor, lower part gravelly in many places.	Poor; substratum contains pockets of well-graded sand and gravel.	Moderate in subsoil, good bearing capacity where properly compacted; slight in substratum, fair to good stability, low shrink-swell potential.	Slight; easy to compact; fair shear strength; low compressibility.
FsA, FsB, FsC2---------	Surface layer good; subsoil poor, lower part gravelly in many places.	Good; substratum contains poorly graded, stratified sand and gravel.	Moderate in subsoil, good bearing capacity where properly compacted; very slight in substratum, very stable.	Slight; very low compressibility; low shrink-swell potential; good shear strength.
FtB----------	Surface layer good; subsoil poor, lower part gravelly in many places.	Poor; substratum has pockets of well-graded sand and gravel.	Moderate in subsoil, good bearing capacity where properly compacted; slight in substratum, fair to good stability; low shrink-swell potential.	Slight; easy to compact; fair shear strength; low compressibility.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Moderate; seasonal high water table.	Very severe; seasonal high water table.	Moderate; seasonal high water table.	Moderate; seasonal high water table.	Medium---	Low.
Slight on slopes of 0 to 12 percent, except in FoA, FoB, FoC2, where limitation is very slight on slopes of 0 to 6 percent; moderate on slopes stronger than 12 percent; slightly droughty; erodible in sloping areas.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent; erodible in sloping areas.	Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; subsoil has moderate shrink-swell potential; erodible in sloping areas.	Low------	High.
Slight; somewhat droughty.	Slight----------	Slight; somewhat droughty.	Slight; subsoil has moderate shrink-swell potential.	Low------	Low.
Very slight on slopes of 0 to 6 percent; slight on slopes of 6 to 12 percent; moderate on slopes stronger than 12 percent; erodible in sloping areas.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent; erodible in sloping areas.	Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; erodible in sloping areas; vegetation difficult to establish on cuts and fills; subsoil has low bearing capacity when wet.	Low------	Low.
Very slight on slopes of 0 to 6 percent; slight on slopes of 6 to 12 percent; moderate on slopes stronger than 12 percent; erodible in sloping areas.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent; erodible in sloping areas.	Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; erodible in sloping areas; vegetation difficult to establish on cuts and fills; subsoil has low bearing capacity when wet.	Medium---	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Gilford: Gd----------	Surface layer good; subsoil poor, thin, droughty; high water table; springs in some places.	Fair to good; substratum is poorly graded sand; high water table hinders excavation.	Slight in subsoil when soil material is properly compacted and drained; slight in substratum, low shrink-swell potential, suitable for all types of pavement where confined.	Slight; very low compressibility; good shear strength; low shrink-swell potential.
Granby: Gf----------	Surface layer fair, dark, thin; subsoil is unsuitable, droughty; high water table.	Good; substratum is poorly graded sand; high water table hinders excavation.	Slight in subsoil, good stability, low shrink-swell potential; slight in substratum, stable under wheel loads, very low shrink-swell potential, in places needs to be confined if used under pavement.	Slight; very low compressibility; good shear strength; low shrink-swell potential.
Grays: GrA, GrB--------	Surface layer good, dark, thick; subsoil poor, unstable in sloping areas; high water table.	Poor; poorly graded fine sand and layers of silt; high water table.	Severe in subsoil, low bearing capacity; severe in substratum, relatively unstable, low bearing capacity, subject to frost heave.	Severe; moderate shrink-swell potential; fairly low compressibility; subject to frost heave; high water table, seepage, or both; liquefies easily.
Griswold: GtB, GtC2----	Surface layer good, thin; subsoil poor, clay loam, many pebbles in lower part.	Poor; substratum contains pockets of well-graded sand and gravel. 1/	Severe in subsoil, moderate shrink-swell potential, low bearing capacity when wet; slight in substratum, good stability, low shrink-swell potential.	Slight; low compressibility; good to fair shear strength.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Severe; high water table; basements likely to be wet.	Very severe; high water table.	Severe; high water table; subject to frost heave.	Severe; high water table; subject to frost heave.	High-----	Low.
Severe; high water table; basements likely to be wet; flotation of pipes.	Very severe; high water table most of the time.	Severe; high water table most of the time; subject to liquefaction and piping.	Severe; high water table most of the time; subject to liquefaction and piping.	Medium---	Low.
Slight; subject to frost heave; liquefies easily; low bearing capacity when wet.	Slight; siltation of filter beds probable.	Moderate; low bearing capacity when wet; subject to frost heave, liquefaction, and piping.	Moderate; low bearing capacity when wet; subject to frost heave, liquefaction, piping, and slippage.	Medium---	Low.
Very slight; erodible in sloping areas.	Slight----------	Slight; erodible in sloping areas.	Slight; subsoil has moderate shrink-swell potential and low bearing capacity when wet.	Medium---	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Griswold, mottled subsoil variant: GwB.	Surface layer good, dark, thick; subsoil poor, clay loam, many pebbles in lower part in some places; seasonal high water table.	Poor; substratum contains pockets of well-graded sand and gravel; seasonal high water table.	Severe in subsoil, moderate shrink-swell potential, loss of bearing capacity when wet; slight in substratum, low shrink-swell potential, good stability.	Slight; low compressibility; fair shear strength; moderate to good bearing capacity.
Hebron: HeA, HeB, HeC2--	Surface layer good; subsoil poor, lower part unstable.	Unsuitable; thin layers of sand and gravel occur only in a few places.	Moderate in subsoil, low stability, low bearing capacity; severe in substratum, unstable when wet.	Severe; moderate shrink-swell potential; high compressibility; poor shear strength.
Hochheim: HmB, HmB2, HmC2, HmD2, HmE2.	Surface layer good but thin; subsoil poor, clay loam, many pebbles in places.	Poor; substratum contains pockets of well-graded sand and gravel in places. 1/	Very severe in subsoil, moderate shrink-swell potential, low bearing capacity; slight in substratum, low shrink-swell potential, fair stability.	Slight; low compressibility; easy to compact; fair shear strength.
HoC3, HoD3, HoE3-------	Poor; gravelly, severely eroded, little or no subsoil.	Poor; substratum contains pockets of well-graded sand and gravel in places. 1/	Slight; low shrink-swell potential; fair stability; little or no subsoil above substratum.	Slight; low compressibility; easy to compact; fair shear strength.
Houghton: HtA, HtB------	Poor; oxidizes easily; erodible.	Unsuitable--------	Very severe; organic soil material.	Very severe; organic soil material.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Moderate; seasonal high water table; basements likely to be wet.	Very severe; seasonal high water table.	Moderate; seasonal high water table; subject to frost heave.	Moderate; seasonal high water table; subject to frost heave; low bearing capacity when wet.	High----	Low.
Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; substratum has moderate shrink-swell potential and low bearing capacity.	Severe; slow permeability.	Moderate; moderate shrink-swell potential; low shear strength; high compressibility.	Moderate; substratum has low bearing capacity when wet; moderate shrink-swell potential.	Medium--	Low.
Very slight on slopes of 0 to 6 percent; slight on slopes of 6 to 12 percent; moderate on slopes of 12 to 20 percent; severe on slopes stronger than 20 percent; erodible in sloping areas.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent; erodible in sloping areas.	Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; subsoil has moderate shrink-swell potential; erodible in sloping areas.	Medium--	Low.
Slight on slopes of 0 to 12 percent; moderate on slopes of 12 to 20 percent; severe on slopes stronger than 20 percent; droughty; gravelly; vegetation difficult to maintain.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent.	Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent; vegetation difficult to establish.	Moderate; vegetation difficult to establish.	Medium--	Low.
Very severe; subject to shrinkage; low bearing capacity; high water table.	Very severe; subject to shrinkage; high water table.	Very severe; high compressibility; unstable; high water table.	Very severe; high water table; high compressibility; unstable; very low bearing capacity.	High----	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Juneau: JuA----------	Surface layer good, thick; subsoil fair to poor, silty clay loam in some places.	Poor; substratum contains pockets of sand and gravel in places.	Severe; subsoil loses bearing capacity when wet; substratum has variable stability and shrink-swell potential but has fair stability when wet.	Slight to moderate; low compressibility; easy to compact; fair shear strength; somewhat variable.
Kane: KeA----------	Surface layer good, thick, and dark; subsoil poor, clay loam; seasonal high water table.	Good; substratum is poorly graded, stratified sand and gravel; high water table.	Moderate in subsoil, good bearing capacity when properly compacted; slight in substratum, high stability.	Slight; very low compressibility and low shrink-swell potential; high water table, seepage, or both.
Kendall: KlA----------	Surface layer good; subsoil poor, clayey, moderately thick; seasonal high water table.	Poor; pockets of well-graded sand and gravel in places; high water table.	Severe in subsoil, moderate shrink-swell potential; slight in substratum, low shrink-swell potential, fair stability when wet; seasonal high water table.	Slight; low compressibility; good to fair shear strength.
Kewaunee: KnB, KnC2-----	Surface layer good; subsoil unsuitable, clayey.	Unsuitable---------	Very severe in subsoil, high shrink-swell potential; severe in substratum, moderate shrink-swell potential, fair shear strength, moderate compressibility.	Severe; high shrink-swell potential; fair shear strength; moderate compressibility.
Knowles: KwA, KwB-------	Surface layer good; subsoil poor, thin, clay loam, underlain by dolomite bedrock.	Unsuitable---------	Severe in subsoil, moderate shrink-swell potential, low bearing capacity when wet; slight below subsoil, dolomite bedrock.	Slight where footing is on dolomite bedrock.
Lamartine: LmB----------	Surface layer good; subsoil poor, silty clay loam; seasonal high water table.	Poor; substratum contains pockets of well-graded sand and gravel in places.	Severe in subsoil, moderate shrink-swell potential, low bearing capacity when wet; slight in substratum, low shrink-swell potential, fair stability.	Slight; low compressibility; fair shear strength.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Moderate; occasional overflow.	Severe; occasional overflow.	Severe; occasional overflow; low bearing capacity when wet; subject to liquefaction, piping, and frost heave.	Severe; occasional overflow; low bearing capacity when wet; subject to frost heave, liquefaction, and piping.	High-----	Low.
Moderate; seasonal high water table.	Very severe; seasonal high water table.	Moderate; seasonal high water table; subject to frost heave.	Moderate; seasonal high water table; subject to frost heave.	Medium---	Low.
Moderate; seasonal high water table; subject to frost heave.	Very severe; seasonal high water table.	Moderate; seasonal high water table; subject to frost heave.	Slight; seasonal high water table; subject to frost heave; low bearing capacity when wet.	High-----	Low.
Moderate; high to moderate shrink-swell potential; low bearing capacity; erodible in sloping areas.	Severe; slow to moderately slow permeability.	Moderate; high shrink-swell potential; low bearing capacity when wet; erodible in sloping areas.	Moderate; high shrink-swell potential; low bearing capacity when wet.	Medium---	Low.
Slight; bedrock hinders excavation in some places; utilities difficult to install.	Severe; bedrock at depth of 20 to 40 inches.	Moderate; bedrock hinders excavation in some places.	Slight; subject to frost heave; bedrock hinders excavation in some places.	Medium---	Low.
Moderate; subject to frost heave; seasonal high water table.	Very severe; seasonal high water table.	Moderate; seasonal high water table; subject to frost heave.	Moderate; seasonal high water table; subsoil subject to frost heave and has low bearing capacity when wet.	High----	Low.

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TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Lawson: Lo----------	Surface layer good, thick, dark; subsoil good to fair; seasonal high water table.	Poor; high water table; layers of sand and gravel in places.	Severe; relatively unstable; very low bearing capacity.	Severe; high susceptibility to frost heave; loss of bearing capacity on thawing; fair shear strength; moderate compressibility.
Lorenzo: LyB2, LyC2, LyD2.	Surface layer good, dark, thin; subsoil poor, clay loam, thin; underlain by sand and gravel.	Good; substratum is poorly graded; stratified sand and gravel.	Moderate in subsoil, moderate shrink-swell potential; slight in substratum, very stable.	Slight; very low compressibility; moderate shrink-swell potential; good shear strength.
Manawa: MaA----------	Surface layer good, thin; subsoil unsuitable, clayey; seasonal high water table.	Unsuitable--------	Very severe in subsoil, high shrink-swell potential; severe in substratum, high to moderate shrink-swell potential, low bearing capacity when wet, elastic.	Severe; fair shear strength; high shrink-swell potential; moderate compressibility.
Markham: MeB----------	Surface layer good, dark; subsoil poor, clayey.	Unsuitable--------	Very severe in subsoil, high shrink-swell potential; severe in substratum, moderate shrink-swell potential, low bearing capacity.	Severe; fair shear strength; moderate compressibility; moderate shrink-swell potential; low bearing capacity.
Marsh: Mf----------	Unsuitable; low mineral content; flooded most of the time.	Unsuitable--------	Very severe; high water table; low stability and bearing capacity.	Very severe; low stability and bearing capacity.
Martinton: MgA----------	Surface layer good; subsoil poor, clayey, unstable in sloping areas; seasonal high water table.	Unsuitable--------	Very severe in subsoil, high plasticity and shrink-swell potential, low bearing capacity; severe in substratum, moderate shrink-swell potential.	Severe; high shrink-swell potential; moderate compressibility; fair to poor shear strength; seasonal high water table, seepage, or both.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Very severe; subject to frost heave; seasonal high water table and frequent overflow.	Very severe; frequent overflow.	Very severe; subject to liquefaction and piping; frequent overflow; seasonal high water table; low bearing capacity when wet.	Very severe; seasonal high water table and frequent overflow; subject to liquefaction, piping, and frost heave; low bearing capacity when wet.	Medium---	Low.
Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; erodible in sloping areas.	Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent; vegetation difficult to establish on cuts and fills.	Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; vegetation difficult to establish on cuts and fills.	Low------	Low.
Moderate; seasonal high water table; high to moderate shrink-swell potential.	Very severe; seasonal high water table; slow permeability in substratum.	Severe; seasonal high water table; low bearing capacity when wet; substratum has high to moderate shrink-swell potential.	Severe; seasonal high water table; low bearing capacity when wet; subject to frost heave.	High-----	Low.
Moderate; moderate to high shrink-swell potential; low bearing capacity when wet.	Severe; moderately slow permeability.	Moderate; low bearing capacity when wet; moderate shrink-swell potential.	Moderate; low bearing capacity when wet; moderate to high shrink-swell potential.	Medium---	Low.
Very severe; flooded most of the time.	Very severe; flooded most of the time.	Very severe; flooded most of the time.	Very severe; flooded most of the time.	High-----	Low.
Moderate; moderate to high shrink-swell potential; low bearing capacity when wet; seasonal high water table.	Very severe; seasonal high water table; slow permeability.	Severe; high shrink-swell potential; low bearing capacity when wet; seasonal high water table.	Severe; moderate to high shrink-swell potential; low bearing capacity when wet; seasonal high water table; subject to seepage and slippage.	High-----	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Matherton:				
MhA	Surface layer fair, thin, slightly droughty; subsoil poor, lower part gravelly in places; seasonal high water table.	Good; substratum is poorly graded, stratified sand and gravel; seasonal high water table.	Moderate in subsoil, good bearing capacity where properly compacted; slight in substratum, very stable.	Slight; very low compressibility; moderate shrink-swell potential; good shear strength.
MmA	Surface layer good; subsoil poor, lower part gravelly, clay loam; seasonal high water table.	Good; substratum is poorly graded, stratified sand and gravel; seasonal high water table.	Moderate in subsoil, good bearing capacity where properly compacted; slight in substratum, very stable.	Slight; very low compressibility and moderate shrink-swell potential; seasonal high water table, seepage, or both.
Mayville: MoA, MoB	Surface layer good; subsoil poor, silty clay loam, gravelly in places.	Poor; substratum contains pockets of well-graded sand and gravel.	Severe in subsoil, moderate shrink-swell potential, low bearing capacity; slight in substratum, good stability, moderate shrink-swell potential.	Slight; low compressibility; fair shear strength; good bearing capacity.
Mequon: MtA	Surface layer good, thin in places; subsoil poor, clayey.	Unsuitable	Very severe in subsoil, high shrink-swell potential; severe in substratum, moderate shrink-swell potential, low bearing capacity, elastic.	Severe; fair shear strength; moderate compressibility; low bearing capacity; high water table, seepage, or both.
Miami:				
MvB, MvC2	Surface layer fair, thin; subsoil poor, lower part droughty and gravelly.	Fair to poor; substratum contains pockets of well-graded sand and gravel in places.	Moderate in subsoil, good stability; slight in substratum, good stability, low shrink-swell potential.	Slight; low compressibility; good to fair shear strength.
MxB, MxC2, MxD2, MxE	Surface layer good, thin; subsoil poor, lower part droughty and gravelly.	Fair to poor; substratum contains pockets of well-graded sand and gravel in places.	Severe in subsoil, good stability; moderate shrink-swell potential; slight in substratum, moderate stability and bearing capacity when compacted.	Slight; low compressibility; good to fair shear strength.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Moderate; seasonal high water table.	Very severe; seasonal high water table.	Moderate; seasonal high water table.	Moderate; seasonal high water table.	Medium--	Low.
Moderate; seasonal high water table.	Very severe; seasonal high water table.	Moderate; seasonal high water table.	Moderate; seasonal high water table.	Medium--	Low.
Slight; erodible in sloping areas; subject to frost heave.	Moderate; seasonal high water table.	Slight; subject to frost heave.	Slight; subject to frost heave; subsoil has low bearing capacity.	Medium--	Low.
Moderate; low bearing capacity when wet; seasonal high water table.	Very severe; seasonal high water table; moderately slow permeability.	Severe; seasonal high water table; low bearing capacity; moderate to high shrink-swell potential; subject to frost heave.	Severe; seasonal high water table; low bearing capacity when wet; subject to frost heave.	High----	Low.
Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; erodible in sloping areas.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent; erodible in sloping areas.	Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; erodible in sloping areas.	Medium--	Low.
Very slight on slopes of 0 to 6 percent; slight on slopes of 6 to 12 percent; moderate on slopes of 12 to 20 percent; erodible in sloping areas.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent; erodible in sloping areas.	Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; erodible in sloping areas.	Medium--	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Montgomery: Mzb--------	Surface layer good, dark; subsoil poor, clayey; high water table.	Unsuitable---------	Very severe in subsoil, high shrink-swell potential, low bearing capacity, not suitable for flexible pavement; severe in substratum, low bearing capacity; moderate shrink-swell potential.	Severe; high shrink-swell potential; high to very high compressibility; high water table.
Morley: MzdB, MzdB2, MzdC2, MzdD2.	Surface layer good; subsoil poor, clayey.	Unsuitable---------	Very severe in subsoil, high shrink-swell potential; severe in substratum, moderate shrink-swell potential, low bearing capacity when wet.	Severe; fair shear strength; moderate compressibility; poor bearing capacity.
Mundelein: MzfA--------	Surface layer good; subsoil poor, unstable in sloping areas; seasonal high water table.	Poor; poorly graded; fine sand and silt in places; seasonal high water table.	Severe in subsoil, low bearing capacity; severe in substratum, relatively unstable.	Severe; fairly low compressibility; high susceptibility to frost heave; seasonal high water table, seepage, or both.
Muskego: Mzg-----------	Poor; soil is erodible and oxidizes rapidly.	Unsuitable---------	Very severe; organic material; not suitable for subgrade.	Very severe; organic material; not suitable for foundations.
Mussey: Mzk------------	Surface layer good, dark; subsoil poor; high water table.	Good; substratum poorly graded sand and gravel; high water table.	Moderate in subsoil, low shrink-swell potential, low stability; very slight in substratum where properly drained, very stable.	Slight; very low compressibility; low shrink-swell potential; good shear strength; high water table.
Navan: Na---------------	Surface layer good, thick, dark; subsoil poor, clayey in lower part; high water table.	Unsuitable---------	Moderate in subsoil, low stability and bearing capacity in lower part; severe in substratum, unstable.	Severe; moderate shrink-swell potential; high compressibility; poor shear strength; high water table.
Ogden: Oc--------------	Poor; erodible; oxidizes rapidly.	Unsuitable---------	Very severe; organic material.	Very severe; organic material.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Severe; high water table; basements likely to be wet; high shrink-swell potential.	Very severe; high water table; slow permeability.	Severe; high water table; high shrink-swell potential; low bearing capacity when wet.	Very severe; high water table; high shrink-swell potential; low bearing capacity when wet; low shear strength.	High----	Low.
Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent; low bearing capacity when wet.	Severe; moderately slow permeability.	Moderate on slopes of 0 to 6 percent; severe on slopes stronger than 6 percent; low bearing capacity when wet; moderate to high shrink-swell potential.	Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent; low bearing capacity when wet; subject to frost heave.	Medium--	Low.
Moderate; liquefies easily; seasonal high water table.	Very severe; seasonal high water table.	Severe; seasonal high water table; low bearing capacity when wet; subject to liquefaction, piping, and frost heave.	Severe; seasonal high water table; low bearing capacity when wet; subject to liquefaction, piping, and frost heave.	High----	Low.
Very severe; high water table; shrinks and settles where drained; compressible.	Very severe; high water table.	Very severe; high water table; subject to shrinkage; unstable.	Very severe; high water table; subject to shrinkage; very low bearing capacity.	High----	Low.
Severe; high water table; basements likely to be wet; flotation of pipes.	Very severe; high water table.	Severe; high water table.	Severe; high water table.	High----	Low.
Severe; substratum has low bearing capacity; high water table; basements likely to be wet.	Very severe; high water table; slow permeability.	Severe; high water table; low bearing capacity when wet; moderate shrink-swell potential.	Severe; high water table; low bearing capacity when wet; subject to liquefaction, piping, and frost heave.	High----	Low.
Severe; subject to shrinkage; high water table.	Very severe; high water table.	Very severe; high water table; clay substratum has high shrink-swell potential.	Very severe; high water table; high compressibility and very low bearing capacity.	High----	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Oshtemo: OmB	Surface layer unsuitable; subsoil unsuitable, erodible in sloping areas, thin over sand and gravel.	Fair to good; poorly graded sand and some pockets of gravel.	Slight in subsoil where properly compacted, low shrink-swell potential; slight in substratum, lacks stability under wheel load, low shrink-swell potential.	Slight; low compressibility and shrink-swell potential; good shear strength and bearing capacity.
OnB	Surface layer poor, droughty; subsoil unsuitable, erodible, thin over sand and gravel.	Fair to good; substratum is poorly graded sand; some gravel in places.	Slight in subsoil where properly compacted; slight in substratum, low stability under load, low shrink-swell potential.	Slight; low compressibility and shrink-swell potential; good shear strength and bearing capacity.
Ozaukee: OuB, OuB2, OuC2, OuD2.	Surface layer good; subsoil poor, clayey.	Unsuitable	Severe in subsoil, high shrink-swell potential; severe in substratum, moderate shrink-swell potential, low bearing capacity when wet.	Severe; fair shear strength; moderate compressibility and shrink-swell potential; low bearing capacity.
Palms: Pa	Poor; erodible; oxidizes rapidly.	Unsuitable	Very severe; organic soil material.	Very severe; organic soil material.
Pella: Ph	Good in surface layer, thick, dark; poor in subsoil, clayey; high water table.	Unsuitable	Very severe in subsoil and substratum; highly plastic; moderate shrink-swell potential.	Moderate to severe; fair shear strength; moderate compressibility; high water table; moderate shrink-swell potential.
Pella, moderately shallow variant: Pm.	Surface layer good, thick, dark; substratum poor, silty clay loam; high water table.	Unsuitable	Very severe in subsoil, highly plastic, moderate shrink-swell potential, elastic; very severe in substratum, dolomite bedrock at depth of 2 to 5 feet; high water table.	Moderate; dolomite bedrock; high water table.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Moderate; erodible; droughty.	Slight----------	Slight; erodible; droughty.	Slight; erodible; droughty; vegetation difficult to establish on cuts and fills.	Low-----	Low.
Moderate; erodible; droughty.	Slight; erodible----	Slight; erodible; droughty.	Slight; erodible; droughty; vegetation difficult to establish on cuts and fills.	Low-----	Low.
Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent; low bearing capacity when wet; subsoil has high shrink-swell potential.	Severe; moderately slow permeability.	Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent; low bearing capacity when wet; subsoil has high shrink-swell potential.	Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent; low bearing capacity when wet; subsoil has high shrink-swell potential; subject to frost heave.	Medium--	Low.
Severe; subject to shrinkage; high water table.	Very severe; high water table.	Very severe; high water table; high compressibility and instability.	Very severe; high water table; high compressibility; low bearing strength.	High----	Low.
Severe; liquefies easily; low bearing capacity when wet; subject to frost heave; high water table; basements likely to be wet.	Very severe; high water table.	Severe; high water table; moderate shrink-swell potential; subject to liquefaction and piping.	Severe; high water table; moderate shrink-swell potential; low bearing capacity when wet; substratum is subject to liquefaction and piping; subject to frost heave.	High----	Low.
Severe; high water table; bedrock hinders excavation; utilities difficult to install.	Very severe; bedrock; high water table.	Moderate; high water table; bedrock hinders excavation.	Slight; bedrock hinders excavation; high water table.	High----	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Pistakee: PrA----------	Surface layer good, thick; subsoil poor, thick; seasonal high water table.	Poor; seasonal high water table; substratum contains pockets of sand and gravel.	Moderate to severe in subsoil, moderate shrink-swell potential; severe in substratum, relatively stable.	Severe; moderate shrink-swell potential; fair shear strength; very high susceptibility to frost heave; seasonal high water table.
Ritchey: RkB, RkC2, RkE.	Surface layer good, thin; subsoil poor, thin over dolomite bedrock.	Unsuitable--------	Severe in subsoil, moderate shrink-swell potential, low bearing capacity when wet; very slight in substratum, dolomite bedrock.	Slight where footing is on dolomite bedrock.
Ritchey, mottled subsoil variant: RlA.	Surface layer good; subsoil poor, thin over dolomite bedrock; seasonal high water table.	Unsuitable--------	Severe in subsoil, moderate shrink-swell potential, low bearing capacity; slight in substratum, dolomite bedrock.	Slight where footing is on dolomite bedrock.
Rodman---------- (Mapped only in complexes with Casco soils.)	Unsuitable; very thin, cobbly, and droughty.	Good; substratum is poorly graded and stratified; very cobbly in places.	Slight in subsoil and substratum; good stability.	Slight; negligible compressibility; good shear strength.
Rollin: Ru, Rv----------	Poor; erodible; oxidizes rapidly.	Unsuitable--------	Very severe; organic soil material and marl.	Very severe; organic soil material and marl.
Rough broken land: Ry---	Unsuitable----------	Unsuitable--------	Severe; moderate shrink-swell potential; low bearing capacity.	Very severe; very steep; moderate shrink-swell potential.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Severe; low bearing capacity when wet; seasonal high water table; occasional overflow.	Very severe; seasonal high water table; occasional overflow.	Severe; seasonal high water table; low bearing capacity when wet; subject to piping, liquefaction, and occasional overflow.	Severe; seasonal high water table; low bearing capacity when wet; subject to piping, liquefaction, frost heave, and occasional overflow.	High----	Low.
Moderate on slopes of 0 to 6 percent; severe on slopes stronger than 6 percent; bedrock hinders excavation and installation of utilities.	Very severe; bedrock near surface; contamination of ground water.	Moderate; bedrock hinders excavation.	Slight; bedrock hinders excavation.	Low-----	Low.
Severe; bedrock hinders excavation and installation of utilities.	Very severe; bedrock near surface; contamination of ground water.	Severe; bedrock; seasonal high water table.	Moderate; subsoil has moderate shrink-swell potential; low bearing capacity.	Medium--	Low.
Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent; droughty; cobbly.	Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent; contamination of ground water.	Moderate on slopes of 0 to 12 percent; severe on slopes stronger than 12 percent; droughty; cobbly; erodible.	Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; droughty; vegetation difficult to establish on cuts and fills.	Low-----	Low.
Very severe; high water table; subject to shrinkage.	Very severe; high water table.	Very severe; high water table; high compressibility; unstable.	Very severe; high water table; high compressibility; unstable; very low bearing capacity.	High----	Low.
Severe; unstable; steep.	Very severe; steep--	Severe; unstable; steep; high to moderate shrink-swell potential.	Severe; unstable; steep; subject to slippage and frost heave.	Medium--	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
St. Charles: SaA, SeA, SeB----------	Surface layer fair; subsoil poor, silty clay loam.	Good; substratum is poorly graded sand and gravel at depth of more than 40 inches.	Severe in subsoil, moderate shrink-swell potential, low bearing capacity when wet; slight in substratum, very stable.	Slight; very low compressibility; good shear strength.
ScA, ScB----------	Surface layer good but thin in places; substratum poor, silty clay loam.	Poor; pockets of well-graded sand and gravel in places.	Severe in subsoil, moderate shrink-swell potential, loss of bearing capacity when wet; slight in substratum, fair stability, low shrink-swell potential.	Slight; fair shear strength; low compressibility; fluctuating water table that can fill excavations in places.
Sandy lake beaches: Sfb.	Unsuitable; sandy material that contains but little organic matter; very low available water capacity.	Fair; poorly graded sand with some gravel.	Very slight; stable under wheel load when damp; low shrink-swell potential; suitable for all types of pavement where confined; ground water level is affected by lake and is high at times.	Slight; low compressibility and shrink-swell potential.
Sawmill, calcareous variant: Sg.	Surface layer good, dark, thick; subsoil good to fair, thick, slightly clayey in places; high water table.	Unsuitable; high water table; thin layers of sand and gravel in places.	Severe in subsoil and substratum; relatively unstable; low bearing capacity.	Severe; subject to frost heave; low bearing capacity on thawing.
Saylesville: ShA, ShB, ShB2, ShC2.	Surface layer good, thin; subsoil poor, clayey, unstable in sloping areas.	Unsuitable--------	Very severe in subsoil, high shrink-swell potential, very plastic, elastic; severe in substratum, moderate shrink-swell potential.	Severe; high to moderate shrink-swell potential; moderate compressibility; fair to poor shear strength.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Very slight for SaA; slight for SeA and SeB; subject to frost heave.	Slight----------	Slight; subsoil has low bearing capacity when wet; subject to frost heave.	Slight; low bearing capacity when wet; subject to frost heave, liquefaction, piping, and slippage.	Medium--	Low.
Slight; erodible in sloping areas.	Moderate; fluctuating water table.	Slight; fluctuating water table in places; subject to frost heave.	Moderate; subsoil has low bearing capacity when wet; subject to frost heave.	Medium--	Low.
Severe; utilities difficult to install and maintain; high water table.	Very severe; high water table.	Moderate; low compressibility; good shear strength; liquefies and flows when saturated; high water table.	Moderate; negligible volume change; stable under wheel load when moist.	Low-----	Low.
Very severe; frequent overflow.	Very severe; frequent overflow.	Very severe; frequent overflow; low bearing capacity when wet; subject to liquefaction, piping, and frost heave.	Very severe; frequent overflow; low bearing capacity when wet; subject to liquefaction, piping, and frost heave.	High----	Low.
Moderate; slow permeability; high to moderate shrink-swell potential.	Severe; slow permeability.	Moderate on slopes of 0 to 6 percent; severe on slopes stronger than 6 percent; high to moderate shrink-swell potential; subject to frost heave.	Moderate; high to moderate shrink-swell potential; low bearing capacity when wet; subject to frost heave, slippage, and seepage.	Medium--	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Sebewa: Sm----------	Surface layer good, dark, thick; substratum poor; high water table.	Good; substratum is poorly graded, stratified sand and gravel; high water table hinders excavation.	Moderate in subsoil, moderate shrink-swell potential, low stability; slight in substratum, very stable under wheel load; high water table.	Slight; very low compressibility; good shear strength; high water table.
Theresa: ThA, ThB, ThB2, ThC2.	Surface layer good; subsoil poor, clay loam, many pebbles in places.	Poor; substratum contains pockets of well-graded sand and gravel in places. 1/	Very severe in subsoil, moderate shrink-swell potential; slight in substratum, good stability, low shrink-swell potential.	Slight; low compressibility; easy to compact; fair shear strength.
Virgil: VsA----------	Surface layer good; subsoil poor, silty clay loam; seasonal high water table.	Good; substratum contains poorly graded sand and gravel; seasonal high water table.	Severe in subsoil, moderate shrink-swell potential, loss of bearing capacity when wet; slight in substratum, very stable.	Slight; very low compressibility; good shear strength; high water table.
Wallkill: Wa----------	Surface layer good, dark, thick; subsoil poor, erodible organic material that oxidizes rapidly; seasonal high water table.	Unsuitable-------	Very severe; organic material.	Very severe; seasonal high water table; very low bearing capacity; special footings required.
Warsaw: WdB----------	Surface layer good, dark; subsoil poor, sandy clay loam, lower part gravelly in places.	Good; substratum contains poorly graded, stratified sand and gravel.	Moderate in subsoil, moderate shrink-swell potential, loss of bearing capacity when wet; slight in substratum, very stable.	Slight; very low compressibility; good shear strength.
WeA, WeB, WeC2, WhA--	Surface layer good, dark, thick; subsoil poor, sandy clay loam, gravelly in places.	Good; substratum contains poorly graded, stratified sand and gravel.	Moderate in subsoil, moderate shrink-swell potential, loss of bearing capacity when wet; slight in substratum, very stable.	Slight; very low compressibility; good shear strength.

See footnote at end of table.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential development with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Severe; high water table; basements likely to be wet.	Very severe; high water table.	Severe; high water table.	Severe; high water table; subsoil has low bearing capacity when wet; subject to frost heave.	High----	Low.
Very slight on slopes of 0 to 6 percent; slight on slopes of 6 to 12 percent; moderate on slopes of 12 to 20 percent; severe on slopes stronger than 20 percent; erodible in sloping areas.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes stronger than 12 percent; subject to frost heave; subsoil has moderate shrink-swell potential.	Slight on slopes of 0 to 12 percent; moderate on slopes stronger than 12 percent; subject to frost heave; subsoil has moderate shrink-swell potential and low bearing capacity when wet.	Medium--	Low.
Moderate; seasonal high water table; basements likely to be wet.	Very severe; seasonal high water table.	Moderate; seasonal high water table; subject to frost heave.	Moderate; seasonal high water table; subsoil has low bearing capacity when wet.	Medium--	Low.
Very severe; high water table; subject to shrinkage on drying; frequent overflow; basements likely to be wet.	Very severe; high water table; frequent overflow.	Very severe; high water table; unstable; frequent overflow.	Very severe; high water table; high compressibility; frequent overflow; low bearing capacity when wet.	High----	Low.
Slight; somewhat droughty.	Slight----------	Slight; erodible in sloping areas.	Slight; erodible in sloping areas.	Low-----	Low.
Very slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; subject to frost heave.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; subject to frost heave.	Slight; subsoil has low bearing capacity when wet.	Low-----	Low.

TABLE 8.--ENGINEERING INTERPRETATIONS

Soil series and map symbols	Suitability as a source of--		Degree and kinds of limitations affecting--	
	Topsoil	Sand and gravel	Road subgrade	Foundations for low buildings
Wasepi: WmA----------	Surface layer fair, somewhat droughty and erodible; subsoil poor, thin over sand and gravel; fluctuating water table.	Fair to good; substratum contains poorly graded sand and some pockets of gravel; fluctuating water table.	Slight in subsoil where properly compacted, low shrink-swell potential; slight in substratum, lacks stability under wheel load unless moist.	Slight; very low compressibility; good shear strength; fluctuating water table, seepage, or both.
Wet alluvial land: Ww--	Fair; variable--------	Unsuitable---------	Severe; unstable; high water table; frequent overflow.	Severe; unstable; high water table; frequent overflow.

1/ In some areas these soils are underlain at a depth of 6 to 15 feet by thick deposits of sand and gravel that are suitable for commercial use.

FOR SPECIFIED USES--Continued

Degree and kinds of limitations affecting--Continued				Corrosion potential for conduits	
Residential developments with public sewer	Onsite sewage disposal systems	Commercial and light industrial developments	Roads and airports	Metal	Concrete
Moderate; fluctuating water table.	Very severe; fluctuating water table.	Moderate; fluctuating water table.	Moderate; fluctuating water table.	Medium---	Low.
Very severe; high water table; frequent overflow.	Very severe; high water table; frequent overflow.	Very severe; high water table; frequent overflow.	Very severe; high water table; frequent overflow.	High-----	Low.

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TABLE 9.--ENGINEERING

[Interpretations are not given in this table for Alluvial land (Am), not suitable for engineering uses or have

Soil series, land types, and map symbols	Soil features affecting--	
	Agricultural drainage	Irrigation
Adrian: Ac	Moderately rapid permeability; substratum generally unstable.	High available water capacity; rapid intake rate; poor drainage; moderate depth over sand; nearly level.
Ashkum: AsA	Moderately slow permeability; high water table.	Poor drainage; high available water capacity; slow intake rate; nearly level.
Aztalan: AzA, AzB	Moderately slow permeability; seasonal high water table.	High available water capacity; moderate intake rate; somewhat poor drainage; nearly level and gently sloping.
Blount: BlA	Moderately slow permeability; seasonal high water table.	High available water capacity; deep soil; moderate intake rate; somewhat poor drainage; gently sloping.
Boyer: BmB, BmC2, BnB	Adequate natural drainage	Medium available water capacity; gently sloping and sloping.
Brookston: BsA	High water table; moderate permeability; feasible to drain.	Poor drainage; high available water capacity; moderate intake rate; nearly level.
Casco: CcB, CcC2, CcD2, CeB, CeC2, CeD2, CfC3, CrC2, CrD, CrE, CrF. (For interpretations of Rodman soils in mapping units CrC2, CrD, CrE, and CrF, refer to the Rodman series.)	Adequate natural drainage	Low available water capacity; moderately deep soil; moderate intake rate; gently sloping to moderately steep.
Chelsea: CtB, CtD	Natural drainage adequate or excessive.	Low available water capacity; rapid intake rate; gently sloping to moderately steep.
Clayey land: Cv	Slow or moderately slow permeability; good to poor drainage.	Medium to high available water capacity; moderately slow to slow intake rate; wide range in slope.
Colwood: Cw	High water table; moderate permeability; substratum generally unstable.	Poor drainage; high available water capacity; moderate intake rate; nearly level.
Dodge: DdA, DdB	Natural drainage adequate	High available water capacity; moderate intake rate; deep; nearly level and gently sloping.

Marsh (Mf), and Wet alluvial land (Ww), because these land types are characteristics too variable for rating]

Soil features affecting--Continued		
Terraces and diversions	Farm ponds	
	Reservoir area	Embankments
Not applicable; little or no runoff.	Moderately rapid permeability; high water table.	Organic soil; not suitable for embankments.
Not applicable; little or no runoff.	High water table; moderately slow permeability.	Fair stability; fair compaction.
Not applicable; little or no runoff.	Moderately slow permeability; seasonal high water table.	Semipervious; fair stability; fair compaction; medium compressibility.
Not applicable; little or no runoff.	Moderately slow permeability; seasonal high water table.	Semipervious; fair stability; fair compaction.
Low stability; droughty; subject to soil blowing.	Moderately rapid permeability in subsoil; rapid permeability in substratum.	Pervious; fair stability; fair compaction; subject to piping.
Not applicable; little or no runoff.	High water table; moderate permeability.	Good stability; good compaction; semipervious.
Moderately deep over sand and gravel; fair stability.	Moderate permeability in subsoil; rapid permeability in substratum.	Semipervious subsoil that has fair stability and compaction; very pervious substratum.
Sandy material; unstable; subject to soil blowing.	Rapid permeability----------	Very pervious; poor stability and compaction.
Wide range in slope and runoff.	Moderately slow or slow permeability-	Generally semipervious.
Not applicable; little or no runoff.	High water table; moderate permeability.	Pervious subsoil, fair stability and compaction; pervious substratum.
Good stability----------	Moderate permeability----------	Semipervious; good stability and compaction.

TABLE 9.--ENGINEERING INTERPRETATIONS

Soil series, land types, and map symbols	Soil features affecting--	
	Agricultural drainage	Irrigation
Drummer: Dt	Moderate permeability; high stability.	Poor drainage; high available water capacity; moderate intake rate; nearly level.
Elliott: EsA	Moderately slow permeability; seasonal high water table.	Somewhat poor drainage; high available water capacity; moderate intake rate; deep; gently sloping.
Fabius: FaA	Moderate permeability	Somewhat poor drainage; medium available water capacity; moderate intake rate; gently sloping.
Fox: FmA, FmB, FmC2, FnB, FoA, FoB, FoC2, FsA, FsB, FsC2, FtB.	Natural drainage adequate or excessive.	Medium available water capacity and intake rate; nearly level to sloping.
Gilford: Gd	High water table; moderate permeability.	Poor drainage; low available water capacity; moderate intake rate; nearly level.
Granby: Gf	High water table; moderately rapid permeability; unstable substratum.	Poor drainage; low available water capacity; rapid intake rate; nearly level.
Grays: GrA, GrB	Natural drainage adequate	High available water capacity; moderate permeability; nearly level and gently sloping.
Griswold: GtB, GtC2	Natural drainage adequate	High available water capacity; moderate intake rate; deep; gently sloping and sloping.
Griswold, mottled subsoil variant: GwB.	Moderate permeability; seasonal high water table.	Somewhat poor drainage; high available water capacity; moderate intake rate.
Hebron: HeA, HeB, HeC2	Natural drainage adequate	Medium available water capacity; moderate intake rate; deep; nearly level to sloping.
Hochheim: HmB, HmB2, HmC2, HmD2, HmE2, HoC3, HoD3, HoE3.	Natural drainage adequate	High available water capacity; moderate intake rate; deep; gently sloping to moderately steep.
Houghton: HtA, HtB	Moderately rapid permeability; high water table.	Poor drainage; high available water capacity; deep; nearly level; subject to soil blowing.
Juneau: JuA	Moderate permeability	Moderately good drainage; very high available water capacity; moderate intake rate; gently sloping.
Kane: KeA	Seasonal high water table; moderate permeability.	Somewhat poor drainage; medium available water capacity; moderate intake rate; deep; nearly level.

FOR FARM USES--Continued

Soil features affecting--Continued		
Terraces and diversions	Farm ponds	
	Reservoir area	Embankments
Not applicable; little or no runoff.	Poor drainage; moderate permeability.	Semipervious subsoil; very pervious substratum.
Not applicable; little or no runoff.	Moderately slow permeability; seasonal high water table.	Semipervious; fair stability and compaction.
Not applicable; little or no runoff.	Moderate permeability; seasonal high water table.	Semipervious subsoil, fair stability and compaction; very pervious substratum.
Moderately deep over sand and gravel.	Moderate permeability in subsoil; rapid permeability in substratum.	Semipervious subsoil, good stability and compaction; very pervious substratum.
Not applicable; little or no runoff.	High water table; moderate permeability.	Semipervious; fair stability and compaction.
Not applicable; little or no runoff.	Moderately rapid permeability; high water table.	Very pervious; poor stability; fair compaction.
Fair stability	Moderate permeability	Semipervious; fair stability and compaction.
Substratum has low stability	Permeability is moderate in subsoil and rapid in substratum.	Semipervious; fair stability and compaction.
Generally not applicable; little or no runoff.	Moderate permeability; seasonal high water table.	Semipervious; fair stability and compaction.
High stability	Slow permeability	Semipervious; good stability and compaction.
Shallow to loamy calcareous material.	Moderate permeability	Semipervious; good stability and compaction.
Not applicable; little or no runoff.	Moderately rapid permeability; high water table.	Organic soils; not suitable for embankments.
Occasional flooding; diversions on adjacent soils beneficial.	Moderate permeability	Semipervious; good stability and compaction.
Not applicable; little or no runoff.	Permeability moderate in subsoil and rapid in substratum; seasonal high water table.	Semipervious subsoil, good stability and compaction; very pervious substratum.

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TABLE 9.--ENGINEERING INTERPRETATIONS

Soil series, land types, and map symbols	Soil features affecting--	
	Agricultural drainage	Irrigation
Kendall: KlA	Seasonal high water table; moderate permeability.	Somewhat poor drainage; high available water capacity; moderate intake rate; gently sloping.
Kewaunee: KnB, KnC2	Natural drainage adequate	Slow intake rate; high available water capacity; deep; gently sloping and sloping.
Knowles: KwA, KwB	Natural drainage adequate	Medium available water capacity; moderate intake rate; moderately deep and gently sloping.
Lamartine: LmB	Seasonal high water table; moderate permeability.	Somewhat poor drainage; high available water capacity; moderate intake rate; deep and gently sloping.
Lawson: Lo	Seasonal high water table; moderate permeability.	Somewhat poor drainage; moderate intake rate; very high available water capacity; nearly level.
Loamy land: Lu	Good to poor drainage; moderate permeability.	Moderate permeability; high available water capacity; wide range in slope.
Lorenzo: LyB2, LyC2, LyD2	Natural drainage adequate	Low available water capacity; rapid intake rate; shallow and gently sloping.
Manawa: MaA	Seasonal high water table; slow permeability.	Somewhat poor drainage; high available water capacity; slow intake rate; gently sloping.
Markham: MeB	Natural drainage adequate	High available water capacity; moderately slow permeability; gently sloping and sloping.
Martinton: MgA	Seasonal high water table; slow permeability.	High available water capacity; slow permeability; gently sloping.
Matherton: MhA, MmA	Moderate permeability; seasonal high water table.	Somewhat poor drainage; moderate intake rate; nearly level and gently sloping.
Mayville: MoA, MoB	Natural drainage adequate	High available water capacity; moderate intake rate; deep; nearly level and gently sloping.
Mequon: MtA	Seasonal high water table; moderately slow permeability.	Somewhat poor drainage; high available water capacity; slow intake rate; deep; nearly level.
Miami: MvB, MvC2, MxB, MxC2, MxD2, MxE.	Natural drainage adequate	Moderate intake rate; high available water capacity; deep; gently sloping to moderately steep.
Montgomery: MzB	High water table; slow permeability.	Poor drainage; high available water capacity; slow intake rate; deep and nearly level.

FOR FARM USES--Continued

Soil features affecting--Continued		
Terraces and diversions	Farm ponds	
	Reservoir area	Embankments
Somewhat poor drainage; good stability.	Moderate permeability; seasonal high water table.	Semipervious subsoil, good stability and compaction; pervious substratum.
Clayey subsoil----------	Slow permeability----------	Semipervious; fair stability and compaction.
Moderately deep over bedrock--	Moderate permeability; fractured dolomite at depth of 20 to 40 inches.	Semipervious; good stability and compaction.
Somewhat poor drainage; substratum strongly calcareous.	Moderate permeability----------	Semipervious; good stability and compaction.
Frequently flooded; low stability.	Seasonal high water table; moderate permeability; subject to flooding.	Pervious; poor stability and compaction.
Wide range in slope and runoff.	Moderate permeability----------	Semipervious.
Sand and gravel near surface--	Rapid permeability in shallow substratum.	Very pervious.
Diversions on adjacent soils beneficial.	Slow permeability----------	Semipervious; fair stability and compaction.
Highly stable----------	Moderately slow permeability---------	Semipervious; highly stable.
Not applicable; little or no runoff.	Slow permeability; seasonal high water table.	Semipervious; fair stability and compaction.
Not applicable; little or no runoff.	Permeability moderate in subsoil and rapid in substratum; seasonal high water table.	Semipervious subsoil, fair stability and compaction; very pervious substratum.
Substratum strongly calcareous.	Moderate permeability----------	Semipervious subsoil, good stability and compaction; pervious substratum.
Diversions on adjacent soils beneficial.	Moderately slow permeability---------	Semipervious; good stability and compaction.
Substratum is calcareous loam.	Moderate permeability----------	Semipervious; good stability and compaction.
Not applicable; little or no runoff.	High water table; slow permeability--	Impervious; good stability and compaction.

TABLE 9.--ENGINEERING INTERPRETATIONS

Soil series, land types, and map symbols	Soil features affecting--	
	Agricultural drainage	Irrigation
Morley: MzdB, MzdB2, MzdC2, MzdD2.	Natural drainage adequate	High available water capacity; slow intake rate; deep; gently sloping to steep.
Mundelein: MzfA	Seasonal high water table; moderate permeability.	Somewhat poor drainage; high available water capacity; moderate permeability; nearly level.
Muskego: Mzg	Moderately slow permeability	Poor drainage; very high available water capacity; rapid intake rate; nearly level.
Mussey: Mzk	Moderate permeability; high water table.	Poor drainage; moderate available water capacity; moderate intake rate; nearly level.
Navan: Na	High water table; slow permeability.	Poor drainage; high available water capacity; moderate intake rate; nearly level.
Ogden: Oc	High water table; permeability slow in substratum.	Poor drainage; rapid intake rate; very high available water capacity; nearly level.
Oshtemo: OmB, OnB	Natural drainage adequate	Low available water capacity; rapid intake rate; deep and gently sloping.
Ozaukee: OuB, OuB2, OuC2, OuD2.	Natural drainage adequate	High available water capacity; slow intake rate; deep; gently sloping to moderately steep.
Palms: Pa	High water table; permeability moderately rapid in substratum.	Poor drainage; rapid intake rate; very high available water capacity; nearly level.
Pella: Ph	High water table; moderately slow permeability.	Poor drainage; high available water capacity; moderate intake rate; nearly level.
Pella, moderately shallow variant: Pm.	High water table; moderately slow permeability; bedrock generally within 40 inches of surface.	Poor drainage; bedrock within 40 inches of surface; moderately slow permeability; high available water capacity; nearly level.
Pistakee: PrA	Seasonal high water table; moderate permeability.	Somewhat poor drainage; moderate intake rate; high available water capacity; gently sloping.
Ritchey: RkB, RkC2, RkE	Natural drainage adequate	Shallow to bedrock; medium available water capacity; moderate intake rate; gently sloping to steep.
Ritchey variant: RlA	Seasonal high water table; shallow over bedrock.	Somewhat poor drainage; shallow over bedrock; medium available water capacity; moderate intake rate; gently sloping.

FOR FARM USES--Continued

Soil features affecting--Continued		
Terraces and diversions	Farm ponds	
	Reservoir area	Embankments
Clayey subsoil	Moderately slow permeability	Semipervious; fair stability and compaction.
Not applicable; little or no runoff.	Moderate permeability; seasonal high water table.	Semipervious subsoil, good stability and compaction; pervious substratum; piping is a hazard.
Not applicable; little or no runoff.	Moderately slow permeability; high water table.	Organic material; not suitable for embankments.
Not applicable; little or no runoff.	Permeability moderate in subsoil and rapid in substratum.	Semipervious subsoil, fair stability and compaction; very pervious substratum.
Not applicable; little or no runoff.	Slow permeability; high water table	Semipervious; fair stability and compaction.
Not applicable; little or no runoff.	Permeability slow in substratum; poor drainage.	Organic material; not suitable for embankments.
Fair stability; droughty; subject to soil blowing.	Moderately rapid permeability	Pervious subsoil, good stability and compaction; very pervious substratum.
Fair stability; moderately slow permeability.	Moderately slow permeability	Semipervious; fair stability and compaction.
Not applicable; little or no runoff.	Permeability moderately rapid in substratum; poor drainage.	Organic material; not suitable for embankments.
Not applicable; little or no runoff.	Moderate permeability; poor drainage.	Semipervious; fair stability and compaction.
Not applicable; little or no runoff.	Moderately slow permeability; bedrock within 40 inches of surface.	Semipervious; fair stability and compaction.
Somewhat poor drainage; diversions on adjacent soils beneficial.	Moderate permeability; seasonal high water table.	Semipervious; good stability and compaction.
Shallow over bedrock	Moderate permeability; shallow to bedrock.	Shallow over bedrock; semipervious; good stability and compaction.
Shallow over bedrock; diversions on adjacent soils beneficial.	Shallow over bedrock; moderate permeability; seasonal high water table.	Shallow over semipervious material; fair stability and compaction.

TABLE 9.--ENGINEERING INTERPRETATIONS

Soil series, land types, and map symbols	Soil features affecting--	
	Agricultural drainage	Irrigation
Rodman---------- (Mapped only in complexes with Casco soils.)	Natural drainage excessive----------	Low available water capacity----------
Rollin: Ru, Rv----------	High water table; permeability moderately slow in substratum.	Poor drainage; very high available water capacity; rapid intake rate; nearly level.
Rough broken land: Ry----------	Natural drainage adequate----------	Very steep----------
St. Charles: SaA, ScA, ScB, SeA, SeB.	Natural drainage adequate----------	High available water capacity; moderate intake rate; deep; nearly level and gently sloping.
Sandy and gravelly land: Sf----	Natural drainage adequate----------	Low available water capacity; variable intake rate; little or no soil material.
Sandy lake beaches: Sfb--------	Subject to flooding----------	Low available water capacity; low fertility; subject to flooding.
Sawmill, calcareous variant: Sg-	High water table; moderately slow permeability.	Poor drainage; very high available water capacity; moderate intake rate; nearly level.
Saylesville: ShA, ShB, ShB2, ShC2.	Natural drainage adequate----------	High available water capacity; slow intake rate.
Sebewa: Sm----------	High water table; moderate permeability.	Poor drainage; medium available water capacity; moderate permeability; nearly level.
Theresa: ThA, ThB, ThB2, ThC2--	Natural drainage adequate----------	High available water capacity; moderate intake rate; deep and gently sloping.
Virgil: VsA----------	Seasonal high water table; moderate permeability.	Somewhat poor drainage; high available water capacity; moderate intake rate; nearly level.
Wallkill: Wa----------	High water table; moderate permeability; frequently flooded.	Poor drainage; high available water capacity; moderate intake rate; nearly level.
Warsaw: WdB, WeA, WeB, WeC2, WhA.	Natural drainage adequate----------	Medium available water capacity; moderate intake rate; moderately deep; nearly level and gently sloping.
Wasepi: WmA----------	Seasonal high water table; moderately rapid permeability.	Somewhat poor drainage; low available water capacity; moderately rapid permeability; nearly level.

FOR FARM USES--Continued

Soil features affecting--Continued		
Terraces and diversions	Farm ponds	
	Reservoir area	Embankments
Shallow over sand and gravel--	Very rapid permeability----------	Very pervious.
Not applicable; little or no runoff.	Moderately slow permeability; high water table.	Organic material; not suitable for embankments.
Very steep----------	Very steep; permeability is variable--	Semipervious; fair stability.
Highly stable----------	Moderate permeability in subsoil; rapid permeability in substratum of SaA, SeA, and SeB.	Semipervious subsoil, good stability and compaction; very pervious substratum in SaA, SeA, and SeB.
Little or no soil material----	Rapid permeability----------	Very pervious.
Not applicable; little or no runoff.	Unstable; rapid permeability----------	Very pervious; unstable.
Not applicable; little or no runoff.	Moderately slow permeability----------	Semipervious; fair stability and compaction.
Clayey substratum hinders construction.	Slow permeability----------	Semipervious; fair stability and compaction.
Not applicable; little or no runoff.	Poor drainage; moderate permeability--	Fair stability; good compaction; pervious.
Substratum is strongly calcareous.	Moderate permeability----------	Semipervious subsoil, good stability and compaction; pervious substratum.
Somewhat poor drainage; good stability.	Moderate permeability; seasonal high water table.	Semipervious subsoil, good stability and compaction; pervious substratum.
Not applicable; little or no runoff.	Moderate permeability for mineral soil material; moderately rapid permeability for organic material; high water table.	Semipervious subsoil, fair stability and compaction; substratum is organic material, not suitable for embankments.
Substratum is sand and gravel-	Moderate permeability in subsoil; rapid permeability in substratum.	Semipervious subsoil, fair stability and compaction; very pervious substratum.
Not applicable; little or no runoff.	High water table; moderately rapid permeability in subsoil; rapid permeability in substratum.	Semipervious subsoil, good stability and compaction; very pervious substratum.

a liquid state. The plasticity index is the numerical difference between liquid limit and plastic limit. It indicates the range in moisture content within which a soil material is in a plastic condition.

Estimated Engineering Properties

In table 7 the soil series and map symbols for each series are listed and estimates of properties significant in engineering are given. The estimates are for undisturbed soil. They are based on data shown in table 6, on test data from similar soils in other counties, on comparison with similar soils that have been tested, and on study of the soils in the field. Alluvial land, Clayey land, Loamy land, Marsh, Rough broken land, Sandy and gravelly land, Sandy lake beaches, and Wet alluvial land are not listed in the table. These land types are too variable to be rated or are not suitable for engineering uses.

The dominant USDA texture, and the Unified and AASHO classifications, are shown in table 7 for each of the major soil horizons. Also shown are the estimated percentages of material passing through the various sieves.

Estimated depth to water table refers to the highest level at which the ground water stands for a significant period of time. Ordinarily, free water stands at this level in spring or during a prolonged wet period. The depth to water table is related to the natural drainage of the soils, as follows: 0 to 1 foot, poorly drained or very poorly drained; 1 foot to 3 feet, somewhat poorly drained; more than 3 feet, moderately well drained to excessively drained.

The permeability of a soil horizon is the rate at which water moves through the undisturbed soil material when the soil is saturated. The estimates are in inches per hour. Permeability is determined largely by examining the texture, structure, and consistence of the soil. The permeability rate of the soil profile is generally determined by the least permeable layer in the soil.

Available water capacity refers to the amount of water that can be stored in the soil for the use of plants. It is expressed in table 7 as inches of water per inch of soil.

Reaction refers to the acidity or alkalinity of the soil, expressed in terms of pH. A pH of 7.0 is neutral; values of less than 7.0 indicate acidity, and values of more than 7.0 indicate alkalinity. A knowledge of the pH of soil material in each horizon can be used to indicate the need for lime and to determine the hazard of corrosion for metal conduits and the risk of deterioration for cement tile.

Shrink-swell potential is an indication of the volume changes that can be expected with changes in moisture content. It depends largely on the amount and type of clay and on the organic-matter content of the soil. Soils in which illite clays are predominant do not have so high a shrink-swell potential as soils in which montmorillonite clays are predominant.

Engineering Interpretations

Tables 8 and 9 give engineering interpretations for the soils of Milwaukee and Waukesha Counties. In table 8 the soils are rated according to their suitability as sources of topsoil and of sand and gravel. Also given are soil limitations that affect use of the soils as subgrade for roads, as supports for foundations of low buildings, as sites for residential development with public sewer and for onsite sewage disposal systems, and as sites for commercial and light industrial developments, roads and airports, as well as ratings of the corrosion potential for metal and concrete conduits. Table 9 gives soil features that affect agricultural drainage, irrigation, terraces and diversions, and farm ponds.

In these tables a rating of slight means that the soil has no limitations or has limitations for a given use that are easily overcome. A rating of moderate means that the soil has limitations for a given use that can be overcome by average management and careful design. A rating of severe means that the soil has limitations for a given use that are difficult to overcome. A rating of very severe means that the soil has limitations that generally preclude its use for a given purpose.

The ratings given the soils in table 8 as sources of topsoil and of sand and gravel are good, fair, poor, and unsuitable. Topsoil refers specifically to soil material that is used as topdressing for roadbanks, parks, gardens, and lawns. The ratings are based on the texture of the soil material and on its content of organic matter. A soil that is medium textured and is high in content of organic matter, for example, has a suitability rating of good as a source of topsoil. A soil that is coarse textured or very fine textured and is low in content of organic matter, on the other hand, is given a rating of poor or is regarded as unsuitable.

In the column showing suitability as a source of sand and gravel, the ratings are based on the characteristics of the soil material to a depth of 5 feet. No distinction is made between deposits that are mainly coarse grained and those that contain both coarse-grained material and an appreciable amount of finer material. Onsite testing and laboratory analysis are needed to make these determinations.

Ratings of the limitations that affect use as subgrade material for roads are determined by the characteristics that enable soils to support base courses, including curbs and gutters, in highway construction and in construction of airports. In table 8 both subsoil and substratum are rated as to their limitations for road subgrade. The degree to which subgrade material is influenced by such things as surface drainage and depth of frost penetration should be determined locally for each site. The surface layer is not evaluated as to suitability for use as subgrade material, because it generally has severe limitations for this use.

The major properties that limit use of the soils for residential developments are slope, drainage,

soil texture, and depth to bedrock. Also considered in rating the soils is the ease or difficulty of establishing a cover of plants. Steep soils are more susceptible to erosion and slippage than nearly level or gently sloping ones, and steep slopes make public utilities and access roads more difficult to install. Poor drainage, a high water table, runoff from higher areas, and flooding contribute to flotation of sewage pipes and to the difficulty of installing and maintaining public utilities. They also contribute to the difficulty of installing and maintaining access roads, and they are likely to cause wetness in basements. Soil texture is the main factor that determines droughtiness, shrink-swell behavior, susceptibility to liquefaction, bearing capacity, and other factors important to residential development. Bedrock is a major limitation where it is shallow enough that it interferes with excavation for public utilities or basements. Establishing a cover of plants is difficult on soils that have a texture of sand or clay.

Limitations of the soils for disposing of sewage effluent through onsite disposal systems indicate the capacity of the soil material to absorb and dispose of effluent without contaminating the surrounding areas. The properties that affect this use include soil permeability, the percolation rate, depth to water table, drainage, the hazard of flooding, depth to bedrock, and slope. Soils that have moderate or severe limitations require onsite investigation and appropriate tests before their suitability can be determined. Soils used for an onsite sewage disposal system should have moderate to rapid permeability and have a percolation rate of 60 minutes per inch or faster.

A water table that rises to the level of the subsurface tile lines forces sewage effluent upward to the surface, thus creating an ill-smelling, unsanitary bog in the filter field. In most soils a layer of soil material 4 feet thick between the bottom of the trench or filter bed and a seasonal high water table or indurated rock provides adequate material for filtering and purifying effluent from a septic tank. Filter fields are generally difficult to lay out and construct where slopes are steeper than 10 percent, and seepage beds are impractical in those places. Where slopes are very steep, the effluent is likely to flow laterally and to seep out at the surface.

Estate-type lots more than 1 acre in size generally are large enough that a large filter field can be installed to compensate for slow soil permeability. Increasing the size of the filter field is of little value, however, in somewhat poorly drained and poorly drained soils. A lot of this size is large enough that it may contain better drained soils that can be used as a location for the filter field.

Commercial and light industrial developments ordinarily are areas in which the buildings are no more than three stories high. Only the substratum is rated, for the buildings generally rest on this part of the soil. Among the most important characteristics that affect the ratings are soil bearing capacity, shear strength, and shrink-swell potential, but other characteristics that affect the ratings are compressibility, soil stability, susceptibility to liquefaction and piping, depth to bedrock, and depth to the water table.

The properties that affect the performance of soils used for the location and construction of roads, including railroads and airports, are texture, presence and thickness of organic material, depth to bedrock, presence of stones and boulders, depth to the water table, soil stability, bearing capacity, susceptibility to frost heave, suitability of the soils as a source of embankment material, need for cutting and filling, and hazard of flooding.

The corrosion potential of soils for underground metal pipes and concrete conduits is closely related to soil reaction, drainage, and electrical conductivity of the soil solution. Most conduits, either metal or concrete, are laid in the lower part of the subsoil or in the substratum. Generally, poor aeration, a high pH value, high electrical conductivity, and a high content of moisture are characteristics of soils that are corrosive to metal conduits. Soils that have a low pH value, however, are the most corrosive to metal conduits. Where the pH value is either low or high, corrosion is more rapid when the moisture content of the soil is high than when it is low. The ratings given for corrosion potential for conduits are based on relative corrosiveness of the soils and are low, medium, and high.

Table 9 gives soil features that affect selected farm uses.

Agricultural drainage is affected mainly by depth to the water table and by soil permeability. In some soils the substratum is unstable, and tile drains are difficult to maintain in these soils.

The most important features affecting the use of soils for irrigation are available water capacity, the rate of water intake, natural drainage, and slope. Available water capacity is the total quantity of water that will not drain away but can be taken up by roots to a depth of 5 feet or to bedrock, whichever is less. The ratings are very high, more than 12 inches; high, 9 to 12 inches; medium, 6 to 9 inches; low, 3 to 6 inches; and very low, less than 3 inches. The rate of water intake is an evaluation of the combined effects of the initial infiltration rate and the soil permeability.

Also shown in table 9 are features of the soils that determine suitability for terraces and diversions. The main features are slope, soil depth, and soil stability. Depth must be adequate for the excavation of a shallow channel that will carry flowing water. Stability affects the ease or difficulty of maintaining terraces and diversions.

In addition, the table lists soil features that influence the construction of the reservoir area and the embankment of farm ponds. Among the features that affect reservoir areas are soil permeability, depth to bedrock, depth and permeability of the substratum, and depth to the water table. Affecting embankments are compaction characteristics, soil stability, and perviousness of the material when compacted. Perviousness refers to water permeability

of the soil material and is expressed in feet per day. The features considered for reservoir areas are for undisturbed soils. Those for embankments are for soil material that has been disturbed.

FORMATION AND CLASSIFICATION OF SOILS

In this section the factors that have affected the formation of soils in Milwaukee and Waukesha Counties are discussed. Then, the current system of soil classification is explained and the soils are placed in higher categories. The soil series in the two counties and a profile representative of each series are described in the section "Descriptions of the Soils."

Formation of Soils

Soil is produced by the interaction of soil-forming processes on material deposited by geologic agencies. The characteristics of the soil at any given point are determined by (1) the composition of the parent material; (2) the relief, or lay of the land; (3) the climate under which the soil material has accumulated and existed since accumulation; (4) the plant and animal life on and in the soil; and (5) the length of time the processes of soil development have acted on the soil material. As a result of these soil-forming processes, soil material is transformed in place, is removed through chemical action or by water and wind, or is added by chemical precipitation or by deposition and transfer of soil components from one part of the soil profile to another.

The results of these soil-forming processes can be readily seen in the Theresa soils. The parent material of these soils was calcareous gravelly loam till and windblown silt. The silt probably was deposited over the till after the glacial period. The gently sloping and sloping relief contributed to the characteristics that make these soils well drained. The temperate climate, and rainfall that was adequate for the growth of plants, were conducive to dissolving minerals and moving them in solution downward in the soil profile. In time, moisture and organic acids started the soil-forming processes. Plants and animals contributed to the accumulation of organic matter and organic acids, and they mixed the soil to some extent. These processes were accelerated as more and higher forms of organisms grew in the soil and produced a greater volume of organic residue and acids.

Free lime in the soil material gradually dissolved and was moved downward by percolating waters into the lower part of the soil. As water continued to move downward through the soil, suspended particles of clay were also translocated. As a result, the lower part of the silty layer and the upper part of the glacial till in the Theresa profile contain more clay than other parts of the profile. While clay was being moved downward in the soil, organic matter in various stages of decomposition was accumulating on and near the surface. This decomposed organic matter gave the surface layer a darker color than it originally had.

During the time these changes were occurring in the silty part of the soil, the loamy lower part, composed mainly of ground dolomite, was also being subjected to chemical weathering. The upper part of this layer was gradually changed to a mixture of gravel and brown clay loam. Impurities in the iron of the dolomitic till became oxidized in the presence of soil air, and this gave the clay loam its dark-brown color.

As a result of these soil-forming processes, the Theresa soils now have a silt loam surface layer, a silty clay loam upper subsoil, and a dark-brown clay loam lower subsoil. They are underlain at a depth of about 28 inches by unweathered calcareous glacial till that has changed but little since it was deposited by the glacier. Processes that took place in the formation of Theresa soils were the accumulation of organic matter in the surface layer, removal of clay from the upper part of the soil, addition of clay to the lower part of the profile, and transformation of some material in place. In varying degrees all these processes are occurring in all soils of the survey area. In Milwaukee and Waukesha Counties, the kinds of parent material and the relief, or topography, have, to a great extent, determined the kinds of processes that have been dominant in the formation of all the soils, and they have thus caused differences among the soils. Processes that have contributed to the formation of soils of the survey area are described in more detail in the following paragraphs.

PARENT MATERIAL. Most of the soils in Milwaukee and Waukesha Counties have formed wholly or in part from material laid down by glaciers of Wisconsin age. Each time the glacial ice advanced, it changed surface features that had been left by earlier glacial ice. In the last major advance, known as the Late Wisconsin stage, ice covered all of the area now in Milwaukee and Waukesha Counties, and it obliterated most traces of earlier stages. As a result, little is known of the earlier glacial stages.

The glacial material left in this area after the ice melted was derived mainly from the underlying bedrock (1). Part of this material, however, originated north of the survey area. It was moved here by glaciers and was mixed with material derived from local bedrock. The resulting soil material ranges from a few inches to several hundred feet in thickness. Where this material is less than 40 inches thick over limestone bedrock, Knowles and Ritchey soils have formed. These and other soils of the survey area have derived many of their characteristics from the glacial material and the landscape on which they occur.

Shale and dolomite are the main kinds of bedrock underlying the glacial material. Shale is the underlying bedrock in the northeastern corner of Milwaukee County. Dolomite underlies the glacial debris in the rest of Milwaukee County and in most parts of Waukesha County east of the Kettle Moraine. Dolomitic shale occurs in a narrow band that is roughly parallel to the western edge of the Kettle Moraine. Dolomitic bedrock lies west of the dolomitic shale.

After the glacial ice melted, deposits of till, outwash, and lacustrine material remained. Of these deposits, glacial till, consisting of poorly sorted, crushed, and mixed material, is most common in the survey area. The till ranges from sandy loam that contains many pebbles and cobblestones to silty clay loam that contains fragments of shale and only a few pebbles. The sandy loam till west of the Kettle Moraine contains more igneous material than the till east of that moraine, and it is the parent material of the Miami soils. Hochheim and Theresa soils have formed in loam till east of the Kettle Moraine. Kewaunee soils have formed in silty clay till, and Ozaukee and Morley soils have formed in silty clay loam till in areas still farther east, in the eastern part of the survey area.

In some places in the central part of Waukesha County, the till is underlain by glacial outwash (pl. VI). This material is composed of stratified sand and well-rounded pebbles and cobblestones that were deposited by moving water during a previous glacial stage. The flowing water carried away the finer particles and sorted the coarser material. Fox, Casco, and Boyer soils have formed in this glacial outwash. The outwash is a major source of sand and gravel used for construction in the survey area.

Saylesville, Martinton, Grays, and Montgomery soils have formed in lacustrine material deposited by the very slowly moving or ponded waters of temporary glacial lakes. This material consists of clay, silt, and very fine sand, generally deposited in thin layers.

The parent material in the area east of the Kettle Moraine was influenced by several advances and meltings of the Lake Michigan lobe of the ice sheet. The first major melting of the glacial ice of the Lake Michigan lobe left a long, narrow deposit of outwash extending southward from the town of Wales through North Prairie to a point east of Eagle. The Warsaw and Lorenzo soils have formed mainly in this material. Hochheim and Theresa soils have formed in the highly calcareous, loamy glacial till that made up the rest of the material left after the first major melting of the glacial ice of the Lake Michigan lobe.

The second major melting of the ice sheet in the area that is now Milwaukee and Waukesha Counties left a series of moraines consisting mainly of silty clay loam glacial till. Morley and Ozaukee soils have formed in this finer textured till.

During the last major glacial advance, ice covered the area east of the Milwaukee River. The reddish-brown silty clay glacial material left after the melting of the ice is called Valders till. Soils of the Kewaunee and Manawa series have formed in this material.

During the postglacial period, many shallow lakes in the area were favorable places for the growth of aquatic plants. Organic soils of the Houghton, Palms, and Adrian series have formed in the partly decomposed remains of these aquatic plants. In places deposits of these decomposed organic remains are 20 feet or more thick.

RELIEF AND DRAINAGE. The drainage of soils is determined, to a great extent, by relief and by position of the soils on the landscape. As an example, the Dodge, Lamartine, and Pella soils all formed in a mantle of silt over calcareous, loamy glacial till. The Dodge soils generally occur at the higher elevations on the landscape, and they typically are gently sloping and well drained. Lamartine soils, which in many places are on foot slopes, are nearly level or gently sloping, and they receive some runoff from adjacent higher areas. Runoff from the Lamartine soils is slow, and those soils are somewhat poorly drained. They contain grayish mottling, and this indicates that these soils are poorly aerated and are excessively moist. The Pella soils are in depressions or other low areas where the water table is near the surface most of the time. Runoff from the Pella soils is very slow. Pella soils are poorly drained, and they have gray and olive-gray colors in their profile, indicating that the reduction of iron has taken place.

CLIMATE AND PLANTS AND ANIMALS. Differences in climate within the survey area are too small to have caused any obvious differences in the soils. The area is within a climatic zone, however, where prairie vegetation and woodland vegetation are constantly competing for dominance in the soil-plant regime. Undisturbed soils in wooded areas in the southeastern part of Wisconsin, including the survey area, generally have a thin surface layer that is somewhat darker than typical for most soils in wooded areas. This darker color can be the result of many factors. For example, maple, basswood, and some other species of trees remove a large amount of calcium from the highly calcareous, loamy glacial till. Leaf litter and organic matter from these trees have a high content of dark-colored calcium humates, which are neutral to mildly alkaline in reaction. Oak and hickory trees assimilate less calcium, and leaf litter and organic matter from those trees are more acid and are lighter colored than those from maple and basswood. As a result, the soils in a forest consisting mainly of oak and hickory trees have a lighter colored surface layer and are more leached than soils that have formed under a forest consisting mainly of maple and basswood.

During the past 100 years, man has influenced the soils to a marked extent by disturbing and altering the natural soil-forming processes. Man has removed trees so that he could grow crops, and he has added organic matter in an effort to maintain

favorable soil structure, improve tilth, and increase the infiltration of water and the available moisture capacity. Man has also added lime to correct soil acidity and has applied fertilizer to increase the supply of plant nutrients. He has grown alfalfa, which with its long taproot transfers calcium from the calcareous glacial till or outwash to the surface, and he has planted grasses, such as Kentucky bluegrass and bromegrass, which through their fine, fibrous root systems have added organic matter to the upper part of the soil.

The lime that man has added has not only neutralized soil acidity, but it also has created a more favorable environment for soil bacteria. The increased bacterial action, in turn, has hastened the decomposition of organic matter that darkens the cultivated part of many soils. In a relatively short time, man's activities are changing typical forest soils to those that resemble prairie soils. Results of these activities can be seen by comparing an undisturbed soil in a woodlot with a cultivated soil just a few feet distant. In other places planting of trees on cultivated prairie soils, or allowing trees to reproduce naturally on those soils, is changing soils that were formerly prairie soils to ones that now have some characteristics of forest soils. In these soils the characteristics of forest soils are less obvious than where the soils have formed under forest, because nature works much more slowly than man.

TIME. The factor of time has had some effect on differences among the soils of the survey area. Soils of the alluvial plains, for example, do not have distinct horizons, because the soil material has not been in place long enough for the soil-forming processes to have exhibited their full effects. Soils that formed in older glacial till and in water-sorted material, on the other hand, have well-defined horizons as the result of processes that have been active for thousands of years. In some soils, such as the Juneau and Wallkill, new material is added to the surface from time to time, and this material covers an older soil. It has not been in place long enough for distinct horizons to have formed.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics; assemble knowledge about them; see their relationships to one another and to the whole environment; and develop principles that help us understand their behavior and response to manipulation. First through classification, and then through the use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The current system of classification defines classes in terms of observable or measurable properties of soils (4, 6). The properties chosen are primarily those that permit grouping soils that are similar in genesis. Genesis, or mode of soil origin, does not appear in the definitions of the classes; it lies behind the classes. The classification is designed to accommodate all soils. It employs a unique nomenclature that is both connotative and distinctive.

In table 10 the soil series of Milwaukee and Waukesha Counties are placed in some categories of the current system. Placement of some soil series in this system may change as more precise information becomes available.

The classification has six categories. Beginning with the most inclusive, the categories are the order, suborder, great group, subgroup, family, and series. This system of classification was adopted for general use by the National Cooperative Soil Survey, effective January 1, 1965. Classes of the current system are briefly defined in the following paragraphs.

ORDERS. Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, the Entisols and Histosols, occur in many different kinds of climate. The five orders in Milwaukee and Waukesha Counties are Entisols, Inceptisols, Mollisols, Alfisols, and Histosols. These are shown in table 10.

TABLE 10.--CLASSIFICATION OF SOILS

Series	Family	Subgroup	Order
Adrian	Sandy or sandy-skeletal, euic, mesic	Terric Medisaprists	Histosols.
Ashkum	Fine, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Aztalan	Fine-loamy, mixed, mesic	Aquic Argiudolls	Mollisols.
Blount	Fine, illitic, mesic	Aeric Ochraqualfs	Alfisols.
Boyer	Coarse-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Brookston	Fine-loamy, mixed, mesic	Typic Argiaquolls	Mollisols.
Casco	Fine-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Hapludalfs	Alfisols.
Chelsea	Mixed, mesic	Alfic Udipsamments	Entisols.

TABLE 10.--CLASSIFICATION OF SOILS--Continued

Series	Family	Subgroup	Order
Colwood	Fine-loamy, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Dodge	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Drummer	Fine-silty, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Elliott	Fine, illitic, mesic	Aquic Argiudolls	Mollisols.
Fabius	Fine-loamy, over sandy-skeletal, mixed, mesic.	Aquic Argiudolls	Mollisols.
Fox	Fine-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Hapludalfs	Alfisols.
Gilford	Coarse-loamy, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Granby	Sandy, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Grays	Fine-silty, mixed, mesic	Mollic Hapludalfs	Alfisols.
Griswold	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Griswold, mottled subsoil variant.	Fine-loamy, mixed, mesic	Aquic Argiudolls	Mollisols.
Hebron	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Hochheim	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Houghton	Euic, mesic	Typic Medisaprists	Histosols.
Juneau	Coarse-silty, mixed, nonacid, mesic	Typic Udifluvents	Entisols.
Kane	Fine-loamy over sandy or sandy-skeletal, mixed, mesic.	Aquic Argiudolls	Mollisols.
Kendall	Fine-silty, mixed, mesic	Aeric Ochraqualfs	Alfisols.
Kewaunee	Fine, mixed, mesic	Typic Hapludalfs	Alfisols.
Knowles	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Lamartine	Fine-silty, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Lawson	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Lorenzo	Fine-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Argiudolls	Mollisols.
Manawa	Fine, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Markham	Fine, illitic, mesic	Mollic Hapludalfs	Alfisols.
Martinton	Fine, illitic, mesic	Aquic Argiudolls	Mollisols.
Matherton	Fine-loamy over sandy or sandy-skeletal, mixed, mesic.	Udollic Ochraqualfs	Alfisols.
Mayville	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Mequon	Fine, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Miami	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Montgomery	Fine, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Morley	Fine, illitic, mesic	Typic Hapludalfs	Alfisols.
Mundelein	Fine-silty, mixed, mesic	Aquic Argiudolls	Mollisols.
Muskego	Coprogenous, euic, mesic	Limnic Medisaprists	Histosols.
Mussey	Fine-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Argiaquolls	Mollisols.
Navan	Fine-loamy, mixed, mesic	Typic Argiaquolls	Mollisols.
Ogden	Clayey, euic, mesic	Terric Medisaprists	Histosols.
Oshtemo	Coarse-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Ozaukee	Fine, mixed, mesic	Typic Hapludalfs	Alfisols.
Palms	Loamy, euic, mesic	Terric Medisaprists	Histosols.
Pella	Fine-silty, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Pella, moderately shallow variant.	Fine-silty, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Pistakee	Coarse-silty, mixed, nonacid, mesic	Aquic Udifluvents	Entisols.
Ritchey	Loamy, mixed, mesic	Lithic Hapludalfs	Alfisols.
Ritchey, mottled subsoil variant.	Loamy, mixed, mesic	Aquic Hapludalfs	Alfisols.
Rodman	Sandy-skeletal, mixed, mesic	Typic Hapludolls	Mollisols.
Rollin, deep	Marly, euic, mesic	Limnic Medisaprists	Histosols.
Rollin, shallow	Marly, euic, mesic	Limnic Medisaprists	Histosols.
St. Charles	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.

TABLE 10.--CLASSIFICATION OF SOILS--Continued

Series	Family	Subgroup	Order
Sawmill, calcareous variant.	Fine-silty, mixed, noncalcareous, mesic----	Cumulic Haplaquolls-------	Mollisols.
Saylesville---------	Fine, illitic, mesic----------	Typic Hapludalfs----------	Alfisols.
Sebewa----------	Fine-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Argiaquolls---------	Mollisols.
Theresa----------	Fine-loamy, mixed, mesic----------	Typic Hapludalfs----------	Alfisols.
Virgil----------	Fine-silty, mixed, mesic----------	Udollic Ochraqualfs-------	Alfisols.
Wallkill----------	Fine-loamy, mixed, nonacid, mesic----------	Thapto Histic Haplaquepts-	Inceptisols.
Warsaw----------	Fine-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Argiudolls----------	Mollisols.
Wasepi----------	Coarse-loamy, mixed, mesic----------	Aquollic Hapludalfs-------	Alfisols.

Entisols are recent mineral soils that have been only slightly modified from the geologic material in which they have formed. They are without genetic horizons or have only the beginnings of such horizons.

Inceptisols are mineral soils in which horizons have started to develop, but these soils do not contain an accumulation of illuvial clay. They have a light-colored surface layer.

Mollisols are mineral soils that have a dark-colored surface layer, 10 inches or more thick, and a base saturation of more than 50 percent.

Alfisols are mineral soils that have horizons of clay accumulation and a base saturation of more than 35 percent.

Histosols are organic soils that are saturated with water at some season of the year unless they have been artificially drained. The order Histosols has not been completely defined.

SUBORDERS. Each order is divided into groups (suborders) that are based mostly on soil characteristics that seem to produce classes having the greatest similarity from the standpoint of their genesis. Suborders narrow the broad climatic range of soils that are in the order.

Soil characteristics used to separate suborders mainly reflect either the presence or absence of waterlogging or soil differences produced through the effects of climate or vegetation. The names of suborders have two syllables, the last of which indicates the order. An example is Aquoll, Aqu meaning associated with wetness, and oll, from Mollisol.

GREAT GROUPS. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and other features. The horizons used as a basis for distinguishing between great groups are those in which (1) clay, iron, or humus have accumulated; (2) a pan has formed that interferes with growth of roots, movement of water, or both; or (3) a thick, dark-colored surface horizon has formed. The other features commonly used are the self-mulching properties of clay, temperature of the soil, major differences in chemical composition (mainly the bases calcium, magnesium, sodium, and potassium), or the dark-red or dark-brown colors associated with soils formed in material weathered from basic rocks.

Names of the great groups have three or four syllables. They are made by adding a prefix to the name of the suborder. An example is Argiaquoll, Argi meaning argillic horizon; aqu for wet; and oll from Mollisol. The great group is not shown separately in table 10, because it is the last word in the name of the subgroup.

SUBGROUPS. Great soil groups are subdivided into subgroups. One of these represents the central, or typic, segment of the group. Other subgroups have properties of the group but have one or more properties of another great group, suborder, or order, and these are called intergrades. Also, subgroups may be established for soils having properties that intergrade outside the range of any other great group, subgroup, or order. The names of subgroups are formed by placing one or more adjectives before the name of the great group. An example is Typic Argiaquoll (a typical Argiaquoll).

FAMILIES. Families are separated within a subgroup, primarily on the basis of properties that are important to the growth of plants or to the behavior of soils used for engineering. The main properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. The names of families consist of a series of adjectives that precede the name of a subgroup. The adjectives used are the class names for soil texture, mineralogy, and so on (see table 10). An example is the fine-loamy, mixed, mesic family of Typic Argiaquolls.

SERIES. The series consists of a group of soils that formed from a particular kind of parent material and that have genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

ADDITIONAL FACTS ABOUT MILWAUKEE AND WAUKESHA COUNTIES

This section gives facts about the history of Milwaukee and Waukesha Counties. It also briefly describes trends in farming and industrial development, and it discusses the climate of these two counties. Agricultural statistics used are from records of the U.S. Bureau of the Census and from information supplied by the Wisconsin and Livestock Reporting Service (8).

History of Milwaukee and Waukesha Counties

Milwaukee County was established in 1834 when Wisconsin was still a territory. At that time the county was much larger than it is today. Later, its size was greatly reduced when a large acreage was taken to form other counties. Still later, in 1846, its size was again reduced. At that time the present boundaries of Milwaukee County were established through the formation of Waukesha County.

The Public Land Survey of the area was completed in 1830, and most of the choice lands and locations were claimed by 1840. These first claims were made shortly after the Black Hawk War by persons from the northeastern part of the United States.

When the first census was taken in 1850, a total of 31,077 persons resided in Milwaukee County and more than 1,900 persons resided in Waukesha County. Between 1850 and 1860, the population of Milwaukee County more than doubled and the population of Waukesha County increased by 25 percent. The population of Milwaukee County increased slowly between 1860 and 1870, but it increased rapidly after that. The increase in population of Waukesha County was much slower until well into the 1900's. Then, during the period between 1930 and 1960, the population of Waukesha County tripled. In 1965 Waukesha County had a population of 158,249 and Milwaukee County had a population of more than 1 million.

Because of the rapid increase in population and the rapid encroachment of housing and industrial developments in areas formerly used for farms, more than 40,000 acres in 920 farms was converted to urban use in Milwaukee County between the late 1940's and 1959. The change in land use was even more pronounced in Waukesha County, for during the same period a total of more than 76,000 acres in 1,084 farms was converted to urban use. As a result of these rapid changes in land use, all of the land in Milwaukee County and most of the land in the four eastern townships of Waukesha County is now within the corporate limits of a village or city.

In 1964 land in farms in Milwaukee and Waukesha Counties occupied a total of 225,785 acres. Of this total acreage, 132,644 acres was cropland harvested; 15,335 acres was cropland used only for pasture; 35,179 acres was idle cropland and cropland not harvested and not pastured; 11,101 acres was pastured; and 24,006 acres was wooded. The rest of the land in farms was occupied by house lots, roads, and similar uses.

Approximately 38 percent of the total income derived from the sale of farm products in the two counties in 1964 was derived from the sale of dairy products. Another 22 percent was derived from the sale of livestock and livestock products other than dairy products, and about 21 percent was derived from the sale of forest products and horticultural specialties. Income from the sale of vegetables accounted for a small part of the farm income, and income from the sale of field crops accounted for about 19 percent.

Crops are well diversified at the present time, but wheat was the main crop from the time farming first started in this area to about 1880 (8). Much of the wheat was shipped to Milwaukee for processing and shipment to other areas. Some of the locally grown wheat was ground into flour by the numerous mills that had been built along streams in Waukesha County. The one-crop system of farming soon depleted the soils. Then, reduced yields, damage from insects, and declining prices decreased the popularity of wheat as the major crop.

The malting industry began to develop in Milwaukee about 1880, and this new industry stimulated the growing of barley. A total of 32,880 acres of barley was grown in Waukesha County in 1890. After that year, the popularity of this crop declined and farmers began to raise dairy cattle as a major farm enterprise. The growing of oats, corn, and hay increased as more feed was required to feed the dairy cattle. Dairying is still the major farm enterprise in Waukesha County, but its importance has decreased. In 1943 there were 45,200 dairy cattle in Waukesha County, but this number had decreased to 21,698 by 1964.

Trends in farming cannot be separated from the economic, industrial, and urban growth that was taking place in the two counties simultaneously. During the late 1800's, Milwaukee was fast developing as a major city and port. Most of the industrial development of the two counties has always been centered in that city, which has become one of the most important Great Lakes ports. Much of this development can be credited to the many skilled artisans, mechanics, and metalworkers who arrived from Europe late in the 1800's and settled in this area. These people used their skills to establish shops and industrial plants that have since developed into large enterprises. Important industries in Milwaukee at the present time are milling, brewing, meatpacking, the processing of grain, the processing of leather and other animal products, and metalworking.

Climate of Milwaukee and Waukesha Counties[5/]

Milwaukee and Waukesha Counties have a continental climate that is modified somewhat by Lake

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5/ By HANS E. ROSENDAL, State climatologist, Weather Bureau, Environmental Science Services Administration, U.S. Department of Commerce.

Michigan. The effects of the lake are most pronounced in spring and early in summer, when the prevailing northeasterly winds are off the lake. The effects are least in winter, when the prevailing winds are westerly. The modifying influence of Lake Michigan is greatest near the lake, where the temperature is cooler in summer and warmer in winter than it is away from the lake. The length of days varies greatly from season to season, ranging from 15 hours and 21 minutes late in June to only 9 hours and 10 minutes late in December. Four distinct seasons give a wide variety of weather throughout the year.

Winters in these two counties are long, cold, and snowy. Streams and small lakes generally are frozen from late in November to early in April. A change in weather can be expected every 2 or 3 days from late in fall through midspring. Spring is slow in coming, and it consists of alternate warm and cold periods. As spring advances, precipitation changes from snow to rain. The frequency of precipitation is reduced, but the intensity of precipitation is increased. The summers are warm, and they normally include several short periods in which the weather is hot and humid. Cool periods are likely to occur any month of the summer. Dew forms on most summer mornings, and often it is heavy. In nearly every fall, there are one or more periods of Indian summer, when the days are abnormally warm, the sky is cloudless but hazy, and the nights are cool. In fall the temperature at night generally is somewhat warmer near the lake than it is farther inland. The change from fall to winter is often abrupt. Table 11 gives climatic data representative of Milwaukee and Waukesha Counties. The data were compiled from records of the U.S. Weather Bureau in the city of Waukesha.

Also listed in table 11 are the average number of degree days, based on 65°, for each month of the year. Degree days computed on this base are useful in determining fuel needs for homes and other buildings. A degree day is counted for every degree the average daily temperature is below the temperature base of 65°. For example, a day in which the average daily temperature is 55° has a value of 10 degree days. The base of 65° is used because it is generally the lowest average daily temperature at which no heat is required in homes or other buildings.

Temperatures in the two counties vary greatly from season to season and commonly from day to day. In spring and early in summer, a sudden shift of wind from a westerly to an easterly direction can result in a drop in temperature of 10° to 15° in areas near Lake Michigan. Temperatures in winter are affected less by the lake than temperatures in summer because the cold air sweeps across land instead of water. The average number of days in a year when the temperature reaches 90° or higher is 10 near the lake and 15 farther from the lake, but the number ranges from 1 to 30. The average number of days when the temperature is zero or lower is 15, but the number ranges from 5 to more than 30. In 1 year out of 5, the temperature is 100° or higher on 1 or more days, and in 1 year out of 5, it is 20° below zero or lower on 1 or more days.

In Waukesha County the average date of the last temperature of 32° or lower in spring is May 8, and the average date of the first temperature of 32° or lower in fall is October 8. In Milwaukee County, for the first 2 or 3 miles inland from Lake Michigan, the last freezing temperature in spring takes place about 2 weeks earlier than May 8, and the first freezing temperature in fall takes place about 2 weeks later than October 8. The length of the average growing season in the western part of Waukesha County is about 153 days, and the length of the average growing season near Lake Michigan in Milwaukee County is about 180 days. The growing season is the number of days between the last temperature of 32° or lower in spring and the first temperature of 32° or lower in fall.

Annual precipitation normally is adequate for the crops grown. The supply of moisture is low in July and August, but a severe drought that damages all crops is rare. About 55 percent of the annual rainfall comes in the months of May through September, when the main crops are grown. About 1 inch of rain is needed each week in summer for good growth of crops, but the probability of receiving this amount of rain during each week of the growing season is small. The probability of a dry week, when only a trace of precipitation or no precipitation is received is greatest late in August.

The occurrence of dry days, or days having less than 0.1 inch of rain, is important. In making field-cured hay of top quality, for example, 3 or more consecutive dry days are needed. The probability of having 3 such days in a row is about 50 percent in June and is 55 percent in July and August.

The average annual snowfall is about 42 inches, but the amount of snow that falls in a year ranges from less than 15 inches to more than 100 inches. The average date of the first snowfall of 1 inch or more is December 1.

Freezing of the ground usually begins late in November and lasts until early in April. If snowfall of 10 inches or more occurs before the ground has frozen deeply, and if this cover remains throughout the winter, frost penetrates to a depth of only a few inches regardless of how low the temperature drops. In years when the ground freezes before the first snowfall, however, and when temperatures are low and the snow cover is light and does not remain on the ground, the soil is likely to freeze to a depth of 36 inches or more.

Thunderstorms occur on an average of 37 days each year, but the number of days they occur ranges from 20 to 55. These storms occur most frequently in June, July, and August. Most of the severe thunderstorms occur in July between the hours of 2 p.m. and 7 p.m.

Only about two hailstorms generally occur each year, and as a rule, they affect only small areas. Most hailstorms occur late in the afternoon in mid spring, but some occur at other times. Those late

TABLE 11.--TEMPERATURE AND PRECIPITATION IN WAUKESHA COUNTY

[Station is at an elevation of 860 feet. Data based on a 30-year record in the period 1930-59]

Month	Temperature			Average days temperature is--				Average degree days (Base 65° F.)	Precipitation		Average days precipitation is 0.10 inch or more
				Maximum of--		Minimum of--					
	Average daily maximum	Average daily minimum	Average	90° F. and above	32° F. and below	32° F. and below	0° F. and below		Average	Average snowfall or sleet	
	°F.	°F.	°F.	Number	Number	Number	Number	Number	Inches	Inches	Number
January-----	29.0	12.3	20.7	0	18	30	7	1,370	1.70	11.8	4
February----	31.6	14.5	23.1	0	14	27	4	1,170	1.26	6.6	4
March-------	40.8	23.4	32.1	0	7	27	1	1,020	2.16	10.7	5
April-------	56.0	34.7	45.4	0	(1/)	14	(1/)	590	2.52	1.1	6
May---------	68.2	44.8	56.5	(1/)	0	2	0	300	3.46	.4	7
June--------	78.6	55.2	66.9	4	0	(1/)	0	50	3.72	0	7
July--------	84.1	60.1	72.1	7	0	0	0	10	3.31	0	5
August------	82.6	59.0	70.8	6	0	0	0	20	3.06	0	6
September---	74.1	50.6	62.4	2	0	1	0	140	2.93	(2/)	5
October-----	62.3	40.2	51.3	0	0	6	0	430	2.09	(2/)	4
November----	44.8	27.9	36.4	0	5	21	(1/)	860	2.30	3.5	5
December----	32.4	17.4	24.9	0	15	29	4	1,240	1.56	7.7	4
Year-----	57.0	36.7	46.9	19	59	157	16	7,200	30.07	41.8	62

1/ Less than one-half day

2/ Trace, an amount too small to measure.

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in the afternoon in mid-July are likely to be the most damaging.

Winds are northwesterly from November through March, northeasterly from April through June, and southwesterly from July through October. March, April, and November are normally the most windy months. In those months the average velocity of the wind is 14 miles per hour. June and July are the least windy. The average velocity of the wind in those months is about 10 miles per hour.

The average amount of possible sunshine received is about 55 percent. November and February are the cloudiest months. During those months only 40 percent of the total possible sunshine is generally received. In contrast, between 50 and 60 percent of the total possible sunshine is received during March, April, May, and October; more than 60 percent is received during June through September; and more than 70 percent is received in July.

Relative humidity varies from hour to hour, from day to day, and from season to season. Generally, it is highest near daybreak and lowest in early afternoon and midafternoon.

The estimated annual evaporation from the surface of a lake or from other free water surfaces is about 29 inches. Approximately 80 percent of this evaporation takes place during the months of May through October.

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Acidity. See Reaction.

Alluvium. Soil or rock material, such as gravel, sand, silt, or clay, deposited by a stream.

Available moisture capacity. The difference between the amount of water in a soil at field capacity and the amount in the same soil at the permanent wilting point of plants. Commonly expressed as inches of water per inch depth of soil.

Blinding. The practice of placing permeable material, such as sawdust, woodchips, or coarse aggregate, around newly installed drainage tile to filter out sand, silt, and clay but allow water to enter the tile freely.

Bottom land. Nearly level land on the bottom of a valley that has a stream flowing through it. Subject to flooding and often referred to as a flood plain.

Calcareous soil. A soil that contains enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) when treated with cold, dilute hydrochloric acid.

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.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found 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; will 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.

Contour stripcropping. Growing crops in strips that follow the contour or that are parallel to terraces or diversions; strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Diversion. A broad-bottomed ditch that serves to divert runoff water so that it will flow around the slope to a safe outlet.

Dolomite. A calcium-magnesium carbonate mineral. Limestone that contains magnesium carbonate is commonly called dolomitic limestone.

Drainage, natural. Refers to the conditions that existed during the development of the soil, 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 different classes of natural drainage are recognized.

Excessively drained soils commonly are very porous and rapidly permeable, and they have low available moisture capacity. Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and commonly have a texture intermediate between that of coarse-textured soils and fine-textured soils.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time; the water table is within 12 to 24 inches of the surface for part of the year; and in some of these soils mottles are below a depth of 6 to 16 inches in the lower part of the A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally are mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Erosion. The wearing away of the land surface by wind, moving water, or ice and by such processes as landslides and creep.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct

characteristics produced by soil-forming processes. These are the major horizons:

O horizon.--The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residue.

A horizon.--The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active, and it is therefore marked by the accumulation of humus. The horizon may have lost one or more soluble salts, clay, and sesquioxides.

B horizon.--The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused by accumulation of clay, sesquioxides, humus, or some combination of these; prismatic or blocky structure; redder or stronger colors; or some combination of these characteristics. The combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.--The weathered rock material immediately beneath the solum. This layer, commonly called the soil parent material, is presumed to be like that from which the overlying horizons were formed in most soils.

R layer.--Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Roman numerals are prefixed to the master horizon or layer designations (O, A, B, C, R) to indicate lithologic discontinuities either within or below the solum. The first, or uppermost, material is not numbered, for the Roman numeral I is understood; the second, or contrasting, material is numbered II; and others are numbered III, IV, and so on, consecutively downward. Thus for example, a sequence from the surface downward might be A2, B1, IIB2, IIB3, IIC1, IIC2.

Following are the symbols used in this soil survey with those letters that designate the master horizons:

g--strong gleying.
p--plow layer.
t--illuvial clay.

Humus. The well-decomposed, more or less stable, dark-colored part of the organic matter in mineral soils.

Massive. Large uniform masses of cohesive soil, in some places with ill-defined and irregular breakage, as in some of the fine-textured alluvial soils; structureless.

Mottled. Irregularly marked with different colors that vary in number and size. Mottling in soils generally indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance--few, common, or many; size--fine, medium, or coarse; and contrast--faint, distinct, or prominent.

Muck. An organic soil consisting of fairly well decomposed organic material that is relatively high in mineral content, finely divided, and dark colored.

Neutral, soil. See Reaction, soil.

Peat. Unconsolidated soil material, largely undecomposed organic matter, that has accumulated where there has been excess moisture.

Ped. An individual natural soil aggregate, such as a crumb, prism, or a block, in contrast to a clod.

Permeability. The quality of a soil horizon that enables water or air to move through the soil material. Terms used to describe permeability and permeability rates, given in inches of water movement per hour, follow. These reflect hydraulic conductivity commonly used in soil survey testing procedure. Very slow (less than 0.063 inch per hour); slow (0.063 to 0.2 inch per hour); moderately slow (0.2 to 0.63 inch per hour); moderate (0.63 inch to 2.0 inches per hour); moderately rapid (2.0 to 6.3 inches per hour); rapid (6.3 to 20.0 inches per hour); very rapid (greater than 20.0 inches per hour).

Profile, soil. A vertical section of a soil through all its horizons and extending into the parent material. See also Horizon, soil.

Reaction. The degree of acidity or alkalinity of soil expressed in pH values or in words as follows:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations and inequalities of the land surface, considered collectively.

Sand. Individual fragments of rocks and minerals that have diameters ranging from 0.05 millimeter (0.002 inch) to 2.0 millimeters (0.079 inch). Most sand grains consist of quartz, but they may be of any mineral composition. The term "sand" also is applied to a soil that contains 85 percent or more of sand and not more than 10 percent of clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material as conditioned by relief over periods of time.

Solum, soil. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons.

Structure, soil. The arrangement of primary soil particles into lumps, granules, or other aggregates. Structure is described by grade (weak, moderate, or strong), that is, the distinctness and durability of the aggregates; by the size of the aggregates (very fine, fine, medium, coarse, or very coarse); and by their shape (platy, prismatic, columnar, blocky, granular, or crumb). A soil is described as structureless if there are no observable aggregates. Structureless soils may be massive (coherent) or single grain (noncoherent)

- Blocky angular. Aggregates are block shaped; they may have flat or rounded surfaces that join at sharp angles.
- Blocky, subangular. Aggregates have some rounded and some plane surfaces; vertices are rounded.
- Columnar. Aggregates are prismatic and are rounded at the upper ends.
- Crumb. Generally soft, small, porous aggregates, irregular, but tending toward a spherical shape.
- Granular. Roughly spherical, firm, small aggregates that may be either hard or soft but that generally are firmer than crumb and lack the distinct faces of blocky structure.
- Platy. Soil particles are arranged around a plane that is generally horizontal.
- Prismatic. Soil particles are arranged around a vertical line; aggregates have flat, vertical faces.

Subsidence. Depression or lowering of the surface of a soil as the result of oxidation, drying, or compaction.

Subsoil. The B horizon of soils that have a distinct profile. Generally, that part of the profile that is between the plow layer and the unweathered layers below.

Substratum. Any layer beneath the solum, either conforming (C or R) or unconforming.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil.

Terrace, stream. An area that is fairly level and formerly was the flood plain of a stream but now lies above the present flood plain; the area is underlain by stratified stream sediments.

Terracing. Construction of shallow, nearly level ditches that have broad slopes suitable for farming; used for controlling runoff water on sloping land.

Texture, soil. The relative proportions of sand, silt, and clay particles in a soil. The basic textural classes in increasing proportions of fine particles are sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of a soil or seedbed in relation to the growth of plants, especially soil structure.

Upland. Land that lies above the stream terraces and that is underlain by bedrock at a fairly shallow depth; generally, all areas that are not on terraces or bottom land.

Variant, soil. A soil whose properties are believed sufficiently different from those of other known soils to justify a new series name but whose geographic area is so limited that creation of a new series is not believed to be justified.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering, soil. The physical and chemical disintegration and decomposition of rocks and minerals. Soil is the result of weathering and other chemical, physical, and biological alterations that have changed the upper part of the earth's crust through various periods of time.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. In referring to a capability unit, a woodland suitability group or any other group, read the introduction to the section it is in for general information about its management. Other information is given in tables as follows:

Acreage and extent of soils, table 1, p. 8.
Predicted average yields of crops, table 2, p. 81.
Estimated yields from woodland, table 3, p. 86.
Tree planting guide, table 4, p. 92.
Shrub and vine planting guide, table 5. The section in which this table occurs begins on p. 91
Engineering uses of soils, tables 6, 7, 8, and 9, pp. 108 to 163.

Map symbol	Mapping unit	Page	Capability unit Symbol	Page	Woodland group Number	Page	Wildlife group Number	Page	Recreation group Number	Page	Shrub and vine group Number
Ac	Adrian muck	11	IVw-7	79	10	90	6	102	9	106	3
Am	Alluvial land	12	IIIw-12	77	1	88	7	102	6	105	3
AsA	Ashkum silty clay loam, 0 to 3 percent slopes	13	IIw-1	74	7	90	5	101	7	105	3
AzA	Aztalan loam, 0 to 2 percent slopes	13	IIw-2	74	12	91	5	101	6	105	3
AzB	Aztalan loam, 2 to 6 percent slopes	14	IIw-2	74	12	91	5	101	6	105	3
BlA	Blount silt loam, 1 to 3 percent slopes	14	IIw-2	74	7	90	5	101	6	105	3
BmB	Boyer loamy sand, 1 to 6 percent slopes	15	IIIs-4	78	4	89	1	100	4	104	2
BmC2	Boyer loamy sand, 6 to 12 percent slopes, eroded	15	IIIe-7	76	4	89	1	100	4	104	2
BnB	Boyer sandy loam, 1 to 6 percent slopes	15	IIIs-4	78	3	88	1	100	2	103	2
BsA	Brookston silt loam, 0 to 3 percent slopes	16	IIw-1	74	7	90	5	101	7	105	3
CcB	Casco sandy loam, 2 to 6 percent slopes	17	IIIe-4	76	5	89	1	100	2	103	2
CcC2	Casco sandy loam, 6 to 12 percent slopes, eroded	17	IVe-3	78	5	89	1	100	2	103	2
CcD2	Casco sandy loam, 12 to 20 percent slopes, eroded	17	VIe-4	80	5	89	1	100	2	103	2
CeB	Casco loam, 2 to 6 percent slopes	17	IIIe-4	76	5	89	1	100	2	103	2
CeC2	Casco loam, 6 to 12 percent slopes, eroded	17	IVe-4	78	5	89	1	100	2	103	2
CeD2	Casco loam, 12 to 20 percent slopes, eroded	18	VIe-4	80	5	89	1	100	2	103	2
CfC3	Casco soils, 6 to 12 percent slopes, severely eroded	18	VIe-4	80	6	89	1	100	5	104	2
CrC2	Casco-Rodman complex, 6 to 12 percent slopes, eroded	18	IVe-4	78	5	89	3	101	2	103	2
CrD	Casco-Rodman complex, 12 to 20 percent slopes	18	VIe-4	80	5	89	3	101	2	103	2
CrE	Casco-Rodman complex, 20 to 30 percent slopes	18	VIIe-4	80	5	89	3	101	2	103	2
CrF	Casco-Rodman complex, 30 to 45 percent slopes	18	VIIe-4	80	6	89	3	101	5	104	2
CtB	Chelsea fine sand, 1 to 6 percent slopes	19	VIIs-9	80	4	89	3	101	5	104	2
CtD	Chelsea fine sand, 6 to 20 percent slopes	19	VIIs-9	80	4	89	3	101	5	104	2
Cv	Clayey land	19	VIIIs-10	80	11	91	2	101	10	106	4
Cw	Colwood silt loam	20	IIw-1	74	7	90	5	101	7	105	3
DdA	Dodge silt loam, 0 to 2 percent slopes	21	I-1	73	1	88	1	100	1	103	1
DdB	Dodge silt loam, 2 to 6 percent slopes	21	IIe-1	73	1	88	1	100	1	103	1
Dt	Drummer silt loam, gravelly substratum	22	IIw-1	74	7	90	5	101	7	105	3

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Map symbol	Mapping unit	Page	Capability unit Symbol	Page	Woodland group Number	Page	Wildlife group Number	Page	Recreation group Number	Page	Shrub and vine group Number
EsA	Elliott silt loam, 1 to 3 percent slopes	23	IIw-2	74	12	91	5	101	6	105	3
FaA	Fabius loam, 1 to 3 percent slopes	23	IIw-5	75	12	91	5	101	6	105	3
FmA	Fox sandy loam, 0 to 2 percent slopes	24	IIIs-4	78	3	88	1	100	2	103	2
FmB	Fox sandy loam, 2 to 6 percent slopes	24	IIIs-4	78	3	88	1	100	2	103	2
FmC2	Fox sandy loam, 6 to 12 percent slopes, eroded	24	IIIe-2	76	3	88	1	100	2	103	2
FnB	Fox sandy loam, loamy substratum, 2 to 6 percent slopes	24	IIIs-4	78	3	88	1	100	2	103	2
FoA	Fox loam, 0 to 2 percent slopes	25	IIs-1	75	1	88	1	100	2	103	1
FoB	Fox loam, 2 to 6 percent slopes	25	IIe-2	74	1	88	1	100	2	103	1
FoC2	Fox loam, 6 to 12 percent slopes, eroded	25	IIIe-2	76	1	88	1	100	2	103	1
FsA	Fox silt loam, 0 to 2 percent slopes	25	IIs-1	75	1	88	1	100	2	103	1
FsB	Fox silt loam, 2 to 6 percent slopes	25	IIe-2	74	1	88	1	100	2	103	1
FsC2	Fox silt loam, 6 to 12 percent slopes, eroded	25	IIIe-2	76	1	88	1	100	2	103	1
FtB	Fox silt loam, loamy substratum, 2 to 6 percent slopes	25	IIe-2	74	1	88	1	100	2	103	1
Gd	Gilford loam	26	IIIw-5	77	7	90	5	101	7	105	3
Gf	Granby fine sandy loam	27	IIIw-5	77	8	90	5	101	7	105	3
GrA	Grays silt loam, 0 to 2 percent slopes	28	I-1	73	1	88	1	100	1	103	1
GrB	Grays silt loam, 2 to 6 percent slopes	28	IIe-1	73	1	88	1	100	1	103	1
GtB	Griswold silt loam, 2 to 6 percent slopes	28	IIe-1	73	12	91	4	101	2	103	1
GtC2	Griswold silt loam, 6 to 12 percent slopes, eroded	29	IIIe-1	76	12	91	4	101	2	103	1
GwB	Griswold silt loam, mottled subsoil variant, 2 to 6 percent slopes	29	IIw-2	74	12	91	5	101	6	105	3
HeA	Hebron loam, 0 to 2 percent slopes	30	IIs-7	75	1	88	1	100	3	104	1
HeB	Hebron loam, 2 to 6 percent slopes	30	IIe-6	74	1	88	1	100	3	104	1
HeC2	Hebron loam, 6 to 12 percent slopes, eroded	30	IIIe-6	76	1	88	1	100	3	104	1
HmB	Hochheim loam, 2 to 6 percent slopes	31	IIe-1	73	1	88	1	100	2	103	1
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	31	IIe-1	73	1	88	1	100	2	103	1
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	31	IIIe-1	76	1	88	1	100	2	103	1
HmD2	Hochheim loam, 12 to 20 percent slopes, eroded	32	IVe-1	78	1	88	1	100	2	103	1
HmE2	Hochheim loam, 20 to 30 percent slopes, eroded	32	VIe-4	80	1	88	1	100	2	103	1
HoC3	Hochheim soils, 6 to 12 percent slopes, severely eroded	32	IVe-1	78	5	89	1	100	2	103	2
HoD3	Hochheim soils, 12 to 20 percent slopes, severely eroded	32	VIe-4	80	5	89	1	100	2	103	2
HoE3	Hochheim soils, 20 to 30 percent slopes, severely eroded	32	VIIe-4	80	5	89	1	100	2	103	2
HtA	Houghton muck, 0 to 2 percent slopes	33	IIIw-9	77	10	90	6	102	9	106	3
HtB	Houghton muck, 2 to 6 percent slopes	33	IIIw-9	77	10	90	6	102	9	106	3

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Woodland group		Wildlife group		Recreation group		Shrub and vine group
			Symbol	Page	Number	Page	Number	Page	Number	Page	Number
JuA	Juneau silt loam, 1 to 3 percent slopes	34	I-1	73	1	88	7	102	6	105	1
KeA	Kane silt loam, 1 to 3 percent slopes	34	IIw-5	75	12	91	5	101	6	105	3
KlA	Kendall silt loam, 1 to 3 percent slopes	35	IIw-2	74	7	90	5	101	6	105	3
KnB	Kewaunee silt loam, 2 to 6 percent slopes	36	IIe-6	74	2	88	2	101	3	104	1
KnC2	Kewaunee silt loam, 6 to 12 percent slopes, eroded	36	IIIe-6	76	2	88	2	101	3	104	1
KwA	Knowles silt loam, 0 to 2 percent slopes	37	IIs-1	75	1	88	1	100	2	103	1
KwB	Knowles silt loam, 2 to 6 percent slopes	37	IIe-2	74	1	88	1	100	2	103	1
LmB	Lamartine silt loam, 1 to 4 percent slopes	38	IIw-2	74	7	90	5	101	6	105	3
Lo	Lawson silt loam	38	IIw-13	75	12	91	5	101	8	105	3
Lu	Loamy land	39	VIIIs-10	80	11	91	1	100	10	106	4
LyB2	Lorenzo loam, 2 to 6 percent slopes, eroded	39	IIIe-4	76	12	91	4	101	2	103	2
LyC2	Lorenzo loam, 6 to 12 percent slopes, eroded	39	IVe-4	78	12	91	4	101	2	103	2
LyD2	Lorenzo loam, 12 to 20 percent slopes, eroded	40	VIe-4	80	12	91	4	101	2	103	2
MaA	Manawa silt loam, 1 to 3 percent slopes	40	IIw-2	74	7	90	5	101	6	105	3
MeB	Markham silt loam, 2 to 6 percent slopes	41	IIe-6	74	1	88	4	101	3	104	1
Mf	Marsh	41	VIIIw-15	80	11	91	6	102	10	106	4
MgA	Martinton silt loam, 1 to 3 percent slopes	42	IIw-2	74	12	91	5	101	6	105	3
MhA	Matherton sandy loam, 1 to 3 percent slopes	43	IIw-5	75	7	90	5	101	6	105	3
MmA	Matherton silt loam, 1 to 3 percent slopes	43	IIw-5	75	7	90	5	101	6	105	3
MoA	Mayville silt loam, 0 to 2 percent slopes	44	I-1	73	1	88	1	100	1	103	1
MoB	Mayville silt loam, 2 to 6 percent slopes	44	IIe-1	73	1	88	1	100	1	103	1
MtA	Mequon silt loam, 1 to 3 percent slopes	45	IIw-2	74	7	90	5	101	6	105	3
MvB	Miami sandy loam, sandy loam substratum, 2 to 6 percent slopes	46	IIe-1	73	3	88	1	100	2	103	2
MvC2	Miami sandy loam, sandy loam substratum, 6 to 12 percent slopes, eroded	46	IIIe-1	76	3	88	1	100	2	103	2
MxB	Miami loam, sandy loam substratum, 2 to 6 percent slopes	46	IIe-1	73	1	88	1	100	2	103	1
MxC2	Miami loam, sandy loam substratum, 6 to 12 percent slopes, eroded	46	IIIe-1	76	1	88	1	100	2	103	1
MxD2	Miami loam, sandy loam substratum, 12 to 20 percent slopes, eroded	46	IVe-1	78	1	88	1	100	2	103	1
MxE	Miami loam, sandy loam substratum, 20 to 30 percent slopes	46	VIe-1	79	5	89	1	100	2	103	2
Mzb	Montgomery silty clay loam	47	IIw-1	74	7	90	5	101	7	105	3
MzdB	Morley silt loam, 2 to 6 percent slopes	48	IIe-6	74	2	88	2	101	3	104	1
MzdB2	Morley silt loam, 2 to 6 percent slopes, eroded	48	IIe-6	74	2	88	2	101	3	104	1
MzdC2	Morley silt loam, 6 to 12 percent slopes, eroded	48	IIIe-6	76	2	88	2	101	3	104	1

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Map symbol	Mapping unit	Page	Capability unit Symbol	Page	Woodland group Number	Page	Wildlife group Number	Page	Recreation group Number	Page	Shrub and vine group Number
MzdD2	Morley silt loam, 12 to 20 percent slopes, eroded	48	IVe-6	78	2	88	2	101	3	104	1
MzfA	Mundelein silt loam, 1 to 3 percent slopes	49	IIw-2	74	7	90	5	101	6	105	3
Mzg	Muskego muck	50	IVw-7	79	10	90	6	102	9	106	3
Mzk	Mussey loam	51	IIw-5	75	7	90	5	101	7	105	3
Na	Navan silt loam	51	IIw-1	74	7	90	5	101	7	105	3
Oc	Ogden muck	52	IIIw-8	77	10	90	6	102	9	106	3
OmB	Oshtemo loamy sand, 1 to 6 percent slopes	53	IIIs-4	77	4	89	1	100	4	104	2
OnB	Oshtemo sandy loam, 1 to 6 percent slopes	53	IIIs-4	78	3	88	1	100	2	103	2
OuB	Ozaukee silt loam, 2 to 6 percent slopes	54	IIe-6	74	2	88	2	101	3	104	1
OuB2	Ozaukee silt loam, 2 to 6 percent slopes, eroded	54	IIe-6	74	2	88	2	101	3	104	1
OuC2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	54	IIIe-6	76	2	88	2	101	3	104	1
OuD2	Ozaukee silt loam, 12 to 20 percent slopes, eroded	54	IVe-6	78	2	88	2	101	3	104	1
Pa	Palms muck	55	IIw-8	75	10	90	6	102	9	106	3
Ph	Pella silt loam	56	IIw-1	74	7	90	5	101	7	105	3
Pm	Pella silt loam, moderately shallow variant	56	IIIw-3	77	7	90	5	101	7	105	3
PrA	Pistakee silt loam, 1 to 3 percent slopes	57	IIw-2	74	7	90	5	101	8	105	3
RkB	Ritchey silt loam, 1 to 6 percent slopes	58	IIIe-3	76	5	89	3	101	2	103	2
RkC2	Ritchey silt loam, 6 to 12 percent slopes, eroded	58	IVe-3	78	5	89	3	101	2	103	2
RkE	Ritchey silt loam, 12 to 30 percent slopes	58	VIe-3	79	5	89	3	101	2	103	2
RlA	Ritchey silt loam, mottled subsoil variant, 1 to 3 percent slopes	59	IIIw-3	77	7	90	5	101	6	105	3
Ru	Rollin muck, deep	60	IVw-7	79	10	90	6	102	9	106	3
Rv	Rollin muck, shallow	60	Vw-7	79	10	90	6	102	9	106	3
Ry	Rough broken land	60	VIIIs-10	80	11	91	8	102	10	106	4
SaA	St. Charles sandy loam, gravelly substratum, 1 to 3 percent slopes	61	I-1	73	1	88	1	100	2	103	1
ScA	St. Charles silt loam, 0 to 2 percent slopes	61	I-1	73	1	88	1	100	1	103	1
ScB	St. Charles silt loam, 2 to 6 percent slopes	61	IIe-1	73	1	88	1	100	1	103	1
SeA	St. Charles silt loam, gravelly substratum, 0 to 2 percent slopes	61	I-1	73	1	88	1	100	1	103	1
SeB	St. Charles silt loam, gravelly substratum, 2 to 6 percent slopes	61	IIe-1	73	1	88	1	100	1	103	1
Sf	Sandy and gravelly land	62	VIIIs-10	80	11	91	8	102	10	106	4
Sfb	Sandy lake beaches	62	VIIIs-10	80	11	91	8	102	10	106	4
Sg	Sawmill silt loam, calcareous variant	63	Vw-14	79	9	90	5	101	7	105	3
ShA	Saylesville silt loam, 0 to 2 percent slopes	63	IIs-7	75	2	88	2	101	3	104	1
ShB	Saylesville silt loam, 2 to 6 percent slopes	63	IIe-6	74	2	88	2	101	3	104	1
ShB2	Saylesville silt loam, 2 to 6 percent slopes, eroded	64	IIe-6	74	2	88	2	101	3	104	1
ShC2	Saylesville silt loam, 6 to 12 percent slopes, eroded	64	IIIe-6	76	2	88	2	101	3	104	1

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Map symbol	Mapping unit	Page	Capability unit		Woodland group		Wildlife group		Recreation group		Shrub and vine group
			Symbol	Page	Number	Page	Number	Page	Number	Page	Number
Sm	Sebewa silt loam	65	IIw-5	75	7	90	5	101	7	105	3
ThA	Theresa silt loam, 0 to 2 percent slopes	65	I-1	73	1	88	1	100	2	103	1
ThB	Theresa silt loam, 2 to 6 percent slopes	66	IIe-1	73	1	88	1	100	2	103	1
ThB2	Theresa silt loam, 2 to 6 percent slopes, eroded	66	IIe-1	73	1	88	1	100	2	103	1
ThC2	Theresa silt loam, 6 to 12 percent slopes, eroded	66	IIIe-1	76	1	88	1	100	2	103	1
VsA	Virgil silt loam, gravelly substratum, 0 to 3 percent slopes	67	IIw-2	74	7	90	5	101	6	105	3
Wa	Wallkill silt loam	67	IIw-13	75	9	90	5	101	8	105	3
WdB	Warsaw sandy loam, 2 to 6 percent slopes	68	IIIs-4	78	12	91	4	101	2	103	2
WeA	Warsaw loam, 0 to 2 percent slopes	68	IIs-1	75	12	91	4	101	2	103	1
WeB	Warsaw loam, 2 to 6 percent slopes	68	IIe-2	74	12	91	4	101	2	103	1
WeC2	Warsaw loam, 6 to 12 percent slopes, eroded	68	IIIe-2	76	12	91	4	101	2	103	1
WhA	Warsaw silt loam, 0 to 2 percent slopes	69	IIs-1	75	12	91	4	101	2	103	1
WmA	Wasepi sandy loam, 1 to 3 percent slopes	69	IVw-5	79	8	90	5	101	6	105	3
Ww	Wet alluvial land	69	Vw-14	79	9	90	5	101	8	105	3

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