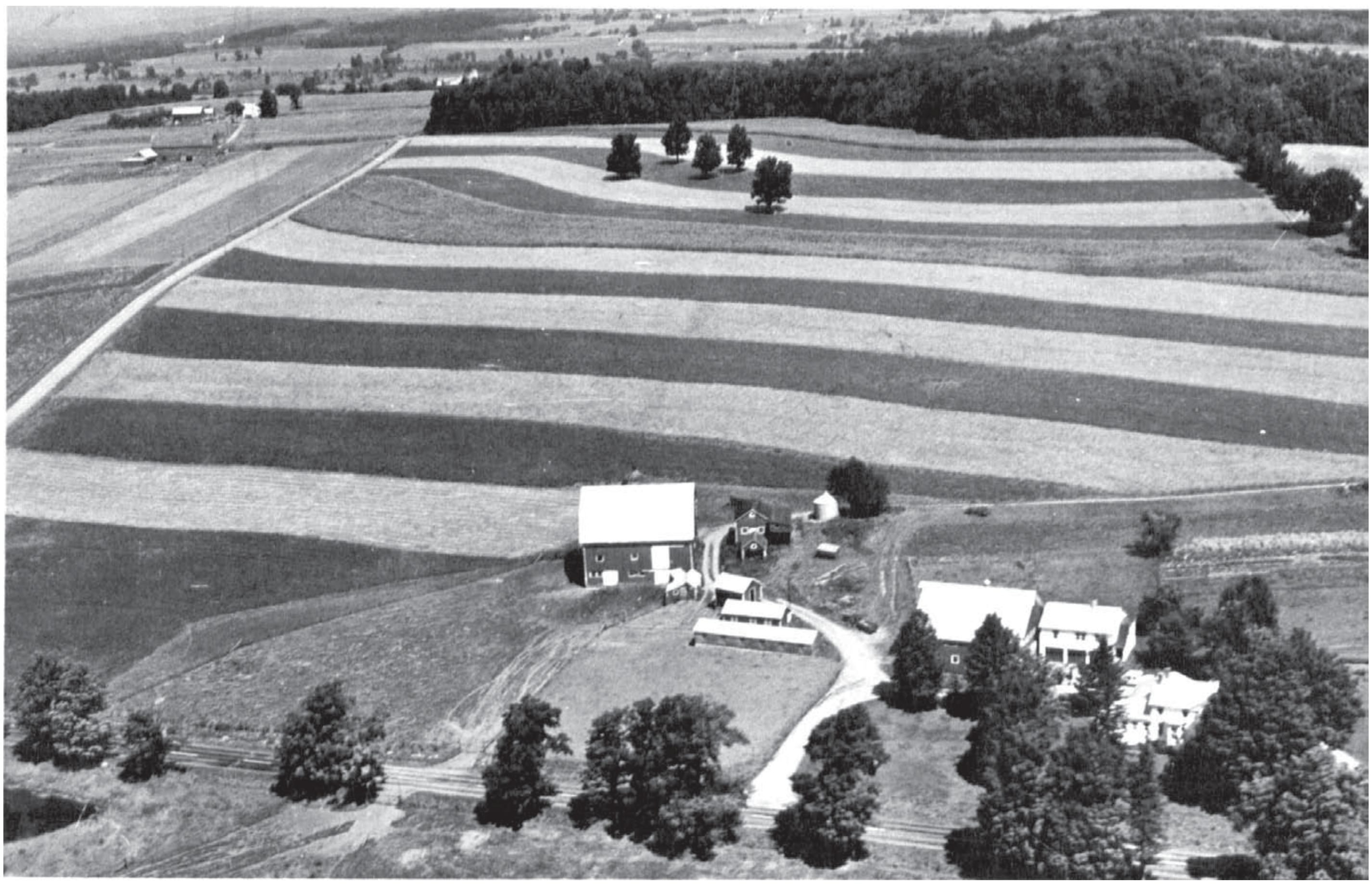
Series 1961, No. 25

Issued July 1965

SOIL SURVEY

Tompkins County, New York



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY will serve several groups of readers. It will help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; serve as a reference for students and teachers; aid foresters in managing woodlands; and add to our knowledge of soil science.

Locating Soils

Use the index to map sheets at the back of this report to locate areas on the detailed soil map. On the detailed map, the boundaries of the soils are outlined, and each kind of soil is identified by a symbol. All areas marked with the same symbol are the same kind of soil, wherever they appear on the map. Suppose, for example, an area located on the map has the symbol ArB. The legend for the detailed map shows that this symbol identifies Arkport fine sandy loam, 2 to 6 percent slopes. This soil and all others mapped in the county are described in the section "Descriptions of the Soils."

Finding Information

The "Guide to Mapping Units" at the back of this report can help readers in using the map and the report. This guide lists each soil mapped in the county and the number of the page on which each is described. It also lists, for each soil, the capability unit and the woodland suitability group in which the soil has been placed, and the numbers of the pages on which each of these groupings is described. Readers will want to refer to different parts of the report, according to their special interests.

Farmers and those who work with farmers can learn about the soils in the section "Descriptions of the Soils" and then turn to the section "Use and Management of the Soils." In this way they first identify the soils on their farm and then learn how these soils can be managed and what yields can be expected. The soils are grouped by capability units, which are groups of soils that need similar management and respond in about the same way. Arkport fine sandy loam, 2 to 6 percent slopes, for example, is in capability unit IIe-3. The capability units are discussed in the section "Use and Management of the Soils."

Foresters and others interested in woodlands can refer to the section "Woodland." In that section the soils of the county are grouped according to their suitability for trees, and factors affecting the management of woodland are explained.

Engineers will want to refer to the section "Engineering Applications." Tables in that section show soil characteristics that affect engineering.

Scientists and others who are interested will find information about how the soils formed and how they were classified in the section "Formation, Morphology, and Classification of the Soils."

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

Newcomers to Tompkins County will be especially interested in the section "General Soil Map," in which broad patterns of soils are described. They may also be interested in the section "General Nature of the County," which gives information about population, climate, topography, and drainage.

* * * * *

Fieldwork for this survey was completed in 1961. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time. This soil survey was made as part of the technical assistance furnished by the Soil Conservation Service to the Tompkins County Soil Conservation District.

Cover picture: Characteristic rolling landscape in the Howard-Valois soil association, which is extensive in the northeastern part of the county. Corn, oats, and hay, grown as part of dairying enterprises, are the principal crops. Stripcropping is an important conservation practice.

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Series 1961, No. 25

Issued July 1965

SOIL SURVEY OF TOMPKINS COUNTY, NEW YORK

BY JOHN A. NEELEY, SOIL CONSERVATION SERVICE

SOILS SURVEYED BY E. B. GIDDINGS AND JOHN A. NEELEY, SOIL CONSERVATION SERVICE, AND CARL S. PEARSON, CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION

TOMPKINS COUNTY is in the Finger Lakes region of central New York (fig. 1). The county is bounded

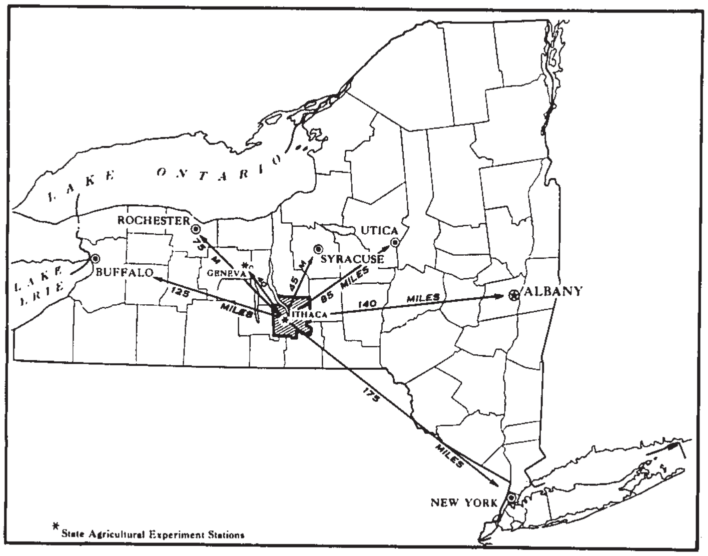

Figure 1.—**Location of Tompkins County in New York.**

by Cayuga and Seneca Counties on the north, by Cortland and Tioga Counties on the east, by Tioga, Chemung, and Schuyler Counties on the south, and by Schuyler County on the west.

The county extends approximately 24 miles from north to south and 22 miles east to west. It has a total area of 314,240 acres, or 491 square miles. Ithaca, the county seat, is about 175 miles northwest of New York City, 140 miles west of Albany, the State capital, and 125 miles southeast of Buffalo.

About half of the county is in farms. Dairying is the predominant kind of agriculture. A large amount of fluid milk is sold. The main crops grown are those used to feed dairy cattle. They include corn grown for silage and grain, oats, and grass-legume hay. Potatoes are grown in a few places on acid soils, and wheat and dry,beans are grown on the limy soils. In the Inlet Valley, vegetables are grown for sale to local inhabitants. A few areas are used for the production of strawberries. Near Cayuga Lake, a few acres are used for the production of grapes, apples, peaches, and pears.

An estimated 30 percent of the county is in forest. Most of the woodland is scattered through the farming area and is used to supplement farm incomes. Included are small sugar-bush operations. Local lumber companies also have some fair-sized woodland holdings. A small part of the woodland is State owned. Some of the State-owned acreage provides public hunting areas. The rest has been developed, along with scenic natural attractions, as State parks, including Buttermilk Falls, Taughannock Falls, and the Robert H. Treman Park at Enfield Glen.

How Soils Are Mapped and Classified

Soil scientists made this survey to learn what kinds of soils are in Tompkins County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; kinds of native plants or crops; kinds of rock; and many facts about the soils. They studied soils along tile trenches, pipelines, and roadbanks, and dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material that has not been changed much by leaching or by roots.

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 report 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, the major horizons of all the soils of one series 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. Howard and Palmyra, 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. Ovid silt loam and Ovid silty clay loam are two soil types in the Ovid 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, Bath channery silt loam, 2 to 5 percent slopes, is one of several phases of Bath channery silt loam, a soil type that ranges from nearly level to steep.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

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 one recognized soil type or soil phase. The inclusions are mentioned in the descriptions of the soil types or phases.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed or occur in individual tracts of such small 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, Hudson-Cayuga silt loams. The soils that make up a complex may be similar in properties or sharply contrasting. In either case, they tend to have a characteristic landform and are present in about the same relative proportions wherever the complex is mapped. Generally, the first name is that of the dominant soil; for instance, the Hudson soil is generally dominant in the complex called Hudson-Cayuga silt loams.

Some delineations shown on the maps are undifferentiated units. These consist of two or more soil types or soil phases that have been grouped together as a unit because of similarities of properties and management needs. Howard and Palmyra soils, 35 to 60 percent slopes, is an undifferentiated unit consisting of steep phases of Howard and Palmyra soils. Both are gravelly soils on glacial outwash deposits, but the depth to calcareous material is greater in Howard soils than in Palmyra soils. Where the soils are steep and eroded, however, the difference in depth to calcareous material is slight, and no useful purpose is served by differentiating between the two soils. Areas shown on the map as Howard and Palmyra may consist entirely of the Howard soil, entirely of the Palmyra soil, or partly of one and partly of the other.

In the name of an undifferentiated unit, the soil names are joined by "and"; in the name of a soil complex the soil names are joined by hyphens.

Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind or water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Alluvial land or Rock outcrop, and are called miscellaneous land types rather than soils.

The process of assigning uniform names to soils of various areas is called soil correlation. This is part of the nationwide system of mapping and classifying soils. Its purpose is to show similarities and differences between the soils of each surveyed area and those of the rest of the United States. To do this, the same combination of soil characteristics is given the same name, wherever found. Unlike soils are never correlated under the same name.

Soils do not change abruptly at political or other man-made boundaries. Many of the soils of Tompkins County are found also in other eastern States. Valuable information about the use and management of these soils, especially about some of the newer practices and uses, may be developed in other counties or States. Assigning the same name to the same soil, wherever mapped, makes comparisons of soils and exchanges of experiences easier.

General Soil Map [1]

The soils of Tompkins County vary considerably in physical properties and in suitability for crops and other uses. On the general soil map at the back of this report are delineated ten general soil areas, or soil associations, each of which has a characteristic landscape and pattern of soils. Each association is made up of soils of two or more series. The soils in any one association may be somewhat similar, but they commonly differ drastically in important characteristics.

Each association is named for the one or two most important series in it, but generally an association includes soils of other series, too. Thus, an area of the Lima-Honeoye association is dominated by soils of these two series but may include extensive areas of Kendaia and Lyons soils. The Howard-Valois association, which occupies all of the major valleys and their adjacent slopes, is dominated by soils of these two series, but it also includes alluvial soils and moderately well drained, somewhat poorly drained, and poorly drained soils on benches and terraces.

The general soil map represents a rather broad generalization and is not useful for farm planning or other detailed planning. It can be used for community planning, for making predictions for groups of farms, for development of forest resources, for liming programs, and for other broad planning.

In this soil survey report of Tompkins County, the soil associations are grouped, according to the lime content of the soils, as high lime, medium lime, low lime, and very

[1] This section prepared by CARL S. PEARSON, soil technologist, Cornell University.

low lime. Figure 7, p. 14, shows the general location in the county of soils in each of the four lime-level groups. To establish a relationship between the different lime-level groups and the soil associations, compare figure 7 with the general soil map, which is in the back of this report.

Research indicates that soil acidity, or a low pH value, limits crop production more frequently than any other one factor (*13*).[2] The grouping of the soil associations into four levels of lime content indicates, in a general way, the need for lime when crops are grown. The soils in the associations designated as high lime, for example, require lime for high yields of legumes, but they do not need such heavy or such frequent applications as do the soils in the other three lime-level groups.

Associations Dominated by High-Lime Soils

These associations occur in the northwestern part of the county (see general soil map). They are in the southernmost part of the extensive high-lime area that extends from this section north through Cayuga County to the outcrop of limestone bedrock in the vicinity of Auburn. Soils in the high-lime group have a neutral or slightly acid surface layer but generally have free lime at a depth of 16 to 42 inches (see fig. 7, p. 14). They may occasionally need an application of lime if alfalfa or other legumes are grown, but the applications can be smaller and less frequent than on the medium-lime and low-lime soils.

Lima-Honeoye association (LH)

Gently rolling to moderately steep, moderately well drained, medium-textured soils dominate in this association, which is in the northwestern corner of the county, along the Cayuga County line. The topography is generally smooth and gently rolling on the ridge between Cayuga Lake and Salmon Creek but is moderately steep on the slopes adjacent to the lake and creeks. About 3 percent of the county is in this association.

The moderately well drained Lima silt loam is the dominant soil and accounts for 60 percent of the association. The well-drained Honeoye soils, which occupy the more sloping parts of the area, make up 20 percent of the association, and the somewhat poorly drained Kendaia and the poorly drained and very poorly drained Lyons soils make up 20 percent. Lima silt loam is the principal soil on the level and gently sloping parts of the association. Kendaia and Lyons soils are level or slightly depressed and have slow surface drainage.

All of these soils formed on calcareous, medium-textured glacial till in which limestone is the dominant rock material. Also in the glacial till are lesser amounts of shale and sandstone derived from the local underlying bedrock (fig. 2). The subsoil is higher in clay content than is the surface soil or the underlying glacial till. The subsoil has subangular blocky structure. The moderate drainage of the Lima soil is indicated by the mottled subsoil. The Honeoye soil is free of mottling and is brown down to the gray, compact, limy glacial till, which is at a depth of 16 to 30 inches. The Kendaia and Lyons soils have a dark-gray surface soil and a strongly mottled subsoil, both of which are characteristic of somewhat poorly drained and poorly drained soils.

The Lima-Honeoye association is in the most productive part of the county. The moderate drainage of the dominant Lima soils is not a serious limiting factor for

[2] Italic numbers in parentheses refer to Literature Cited, p. 232.

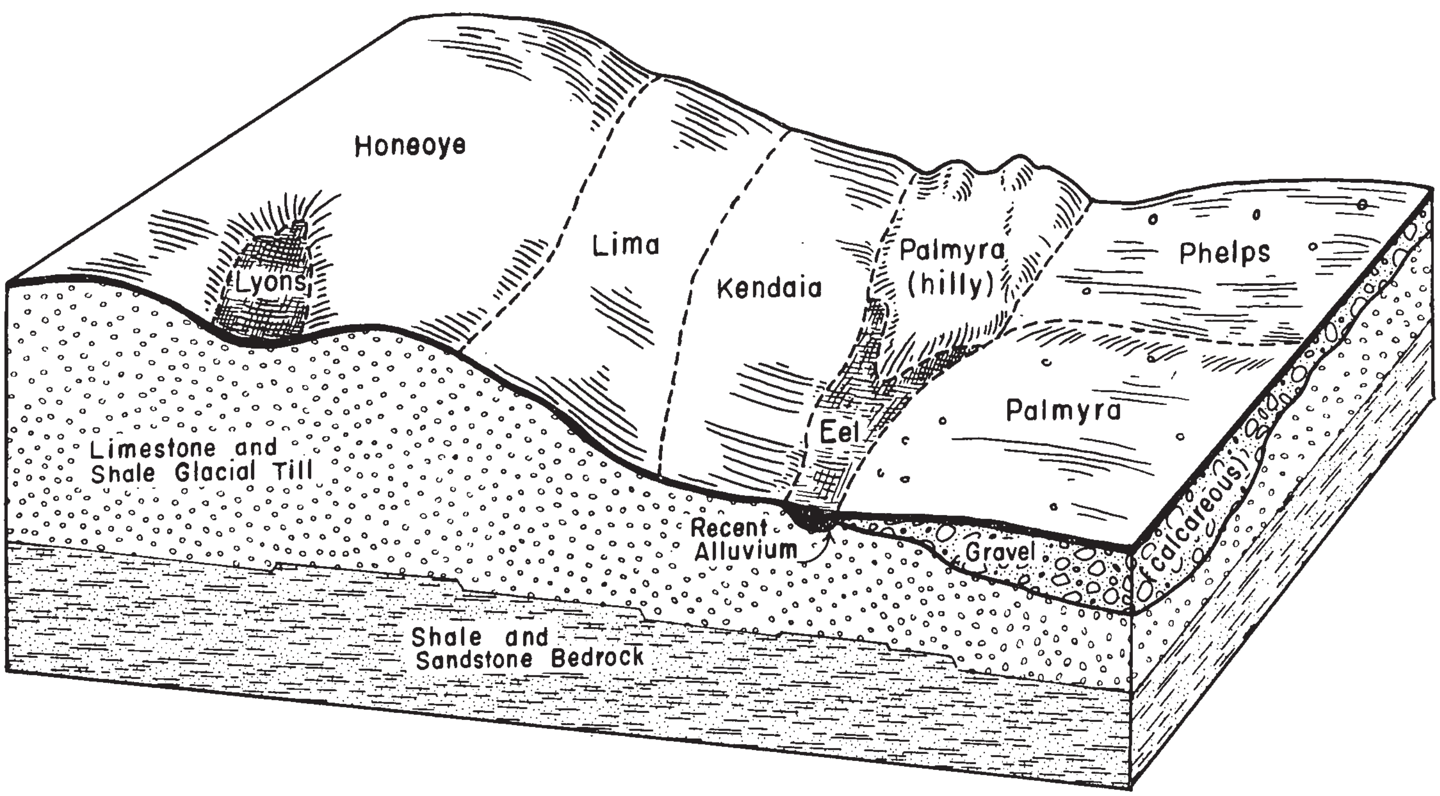

Figure 2.—Typical cross section of Lima-Honeoye association and Palmyra association in northwestern Tompkins County.

the crops commonly grown. Because of the subangular blocky structure in the subsoil and the absence of a fragipan (often called hardpan), these soils respond to artificial drainage with tile if adequate outlets can be obtained. These soils are high in available potassium; usually they supply enough potassium each year for yields of about 2 tons per acre of legume-grass hay. For higher yields, additional potassium is needed in the form of commercial fertilizer, farm manure, or crop residues. Crops on these soils show a high response to phosphorus, also.

Dairying and the production of winter wheat and field beans as cash crops are the principal agricultural pursuits. The soils are also well suited to sugar beets. Farms are medium sized. The management level is generally high. Crop yields are high because these soils respond to management.

These soils make good building sites, but the underlying compact glacial till absorbs septic tank effluent very slowly and may cause trouble during wet periods or when the soils are frozen. The more nearly level areas are the most likely to cause difficulty. Table 14, in the section "Engineering Applications," contains additional information on these soils and their engineering properties. The villages of Lake Ridge, Lansingville, and North Lansing are within the Lima-Honeoye association.

Hudson-Cayuga association (HC)

This association consists of soils that are predominantly moderately steep and steep, moderately well drained and well drained, and moderately fine textured. It occurs along Cayuga Lake and Salmon Creek below the 1,000-foot contour, which represents the level of glacial Lake Ithaca when its outlet was to the south. Soils that formed at or below this elevation in the vicinity of Cayuga Lake are generally strongly influenced by lake-laid material. The shallow Lordstown soils account for approximately 15 percent of the area and ordinarily occur where the gradient is more than 15 percent, and the somewhat poorly drained Ovid soils occur in the less sloping areas around South Lansing and make up approximately 15 percent of the association. No more than 4 percent of the county is in this association.

For the most part these soils are moderately fine textured. Hudson soils are most commonly silty clay loam in texture. They developed entirely in lake-laid clayey material and are ordinarily free of stones and gravel. They make up about 35 percent of the area. Cayuga soils developed in a thin deposit of lake-laid clayey material over limy glacial till similar to the till underlying Lansing and Honeoye soils. They make up about 30 percent of the area. The subsoil of both Hudson and Cayuga soils has a blocky structure and is higher in clay than is the surface soil. These soils are fairly well drained where they occur on slopes as steep as those bordering Cayuga Lake. They have a faintly to distinctly mottled pinkish color below the grayish-brown surface soil. The somewhat poorly drained Ovid soils are fine textured and strongly mottled. They formed in the same kind of material as Cayuga soils and have a blocky subsoil high in clay, but their drainage is slower.

Steep slopes and high erodibility limit the agricultural use of the soils in the Hudson-Cayuga association. Intensive conservation practices are required to control water movement and to prevent excessive soil loss. Dairying is the main type of farming, but a considerable acreage on the west side of Cayuga Lake is used for grapes and tree fruits. Much of the steeper portion either is in forest or is idle. Where the topography is favorable, the soils are well suited to the field crops, such as corn, oats, wheat, and legume-grass hay, commonly grown on dairy farms. They are especially well suited to alfalfa because of their high-lime status and very high potassium-supplying power. They release enough potassium annually for yields of 2 to 3 tons per acre of legume-grass hay. Crops grown on these soils are especially responsive to phosphorus fertilizer. The soils on gentle slopes are also well suited to sugar beets.

Many summer cottages and houses and some trailers are located in this association along the shores of Cayuga Lake. The soils, however, are not well suited to large buildings or structures unless the foundations can be placed in the underlying till or on bedrock. Some difficulty may be encountered in establishing vegetation around houses, because of the fine texture of the excavated material. Sewage disposal is a problem because of the slowly permeable clay in the subsoil. The West Hill section of Ithaca is in this association. Additional information on the engineering properties of these soils may be found in the section "Engineering Applications."

Hudson-Rhinebeck association (HR)

Moderately well drained and somewhat poorly drained, moderately fine textured, high-lime soils in stone-free, clayey, lake-laid deposits are dominant in this association. The largest areas are found in the vicinity of Ithaca, on nearly level and gently rolling slopes bordering Cayuga Lake and on rough to steep topography through the Cayuga Inlet Valley. They occur at elevations below 1,000 feet, the level of the glacial lake in which the parent materials of these soils were deposited. The association also includes areas of the sandy Arkport and Williamson soils, which are low in potassium-supplying capacity, and a few areas of alluvial soils. About 8 percent of the county is in this association.

Hudson and Rhinebeck soils are deep and have silt loam and silty clay loam textures. The moderately well drained or well drained Hudson soils formed in pinkish, clayey, lake-laid sediments. Locally, the upper part of the subsoil is mottled. Rhinebeck soils, which formed in the same kind of material, are ordinarily grayer in color and are strongly mottled from below the plowed layer down through the subsoil. The subsoil of both Hudson and Rhinebeck soils generally is higher in clay content than is the surface soil and has moderate to strong blocky structure. The sandy Arkport and Williamson soils are yellowish brown in color and are generally free of stones. The subsoil of Arkport soils is strongly acid to neutral, and that of Williamson soils is strongly acid to medium acid. Bedrock is close to the surface in the steeper areas.

Hudson soils account for about 40 percent of the association; Rhinebeck soils, about 20 percent; Arkport soils, about 10 percent; Williamson soils, 5 percent; and the soils of the Howard, Lordstown, Ovid, and Ilion series, about 25 percent.

The soils in this association are fertile and are generally limy in the subsoil, but they are somewhat difficult to work. They are highly erodible, even on gentle slopes, and favorable tilth is difficult to maintain. The dominant Hudson and Rhinebeck soils are very high in available potassium. Usually they supply enough potassium annually for yields of about 2 to 3 tons per acre of deep-rooted legumes and grasses. Phosphorus fertilizers are particularly needed for high yields. The soils are well suited to grass-legume mixtures for hay or pasture and to corn, wheat, and oats, which are grown extensively. The soils in this association are also suited to sugar beets. Dairy farming is the principal pursuit.

Much of the urban and suburban development in the vicinity of Ithaca is on these soils. Because of the slowly permeable clay subsoil, disposal of sewage effluent is a problem if houses are built beyond the existing municipal sewerage system.

Palmyra association (P)

Well-drained, medium-textured soils in stratified, calcareous sand and gravel deposits make up this association. The dominant high-lime Palmyra soils account for 75 percent of the acreage. The asosociation occurs as long, narrow areas on either side of Salmon Creek in the northern part of the county. Small areas of Howard soils make up about 10 percent of the association. Howard soils are medium lime but in other characteristics are similar to Palmyra soils. Smaller areas of alluvial soils of the Genesee and Eel series together occupy about 15 percent of the association. The gravelly Palmyra and Howard soils occur on nearly level terraces, on the tops of deltas, and on the steep fronts of old deltas of glacial Lake Ithaca. Eel soils and some areas of Genesee soils are on first bottoms along the creek, where annual flooding may occur. About 2 percent of the county is in this association.

Palmyra soils have a friable gravelly loam surface soil and a gravelly brown subsoil in which some clay has accumulated. The substratum is stratified sand and gravel in which limestone is dominant (see figure 2). The depth to free lime is generally 18 to 24 inches but ranges from 15 to 30 inches. These soils are shallower over the slightly clayey subsoil and over free lime than the medium-lime Howard soils, which have a somewhat clayey subsoil at a depth of 18 to 20 inches and free lime at 36 to 60 inches. Eel and Genesee soils are moderately well drained and well drained, neutral to alkaline soils on recent alluvial sediments along Salmon Creek. The deep substratum of these alluvial soils consists of stratified sand and gravel and is a good source of gravel if exposed along the creekbed.

Where relief is favorable, these highly productive soils have few limitations for the crops commonly grown. They are mostly medium in potassium-supplying capacity and can supply enough potassium annually for yields of about 1½ tons per acre of grass-legume hay. The phosphorus supply is low. A considerable part of the total acreage is too steep for cropping. The nearly level alluvial soils are productive but are not extensive.

The villages of Ludlowville and Myers are in this association. Palmyra and Howard soils are permeable and absorb effluent from septic tanks readily. Consequently, there is a serious risk of septic tank effluent contaminating ground water supplies. Sewage systems located on the low-lying alluvial soils may have backup problems during wet weather.

Associations Dominated by Medium-Lime Soils

These associations are more extensive than those dominated by high-lime soils but less extensive than those dominated by low-lime soils. They occupy a transitional zone between the high-lime and low-lime soils. Where relief is favorable, these are good soils for the crops commonly grown. They generally require some lime for high yields of legumes, but for equivalent yields they do not need so much of this amendment as the low-lime and very low-lime soils need.

Conesus-Lansing association (CL)

This association consists predominantly of moderately well drained and well drained, medium-textured soils and occupies gently rolling to moderately sloping landscapes in true ground moraine. Mild, favorable relief characterizes this association. The largest areas are in the northern part of the county west of Cayuga Lake. North of Ithaca, smaller areas occur east of the lake. The well-drained Lansing soils occupy the ridgetops and other high portions of the association. The moderately well drained Conesus soils occupy the more nearly level parts. The somewhat poorly drained Kendaia soils and the poorly drained and very poorly drained Lyons soils occupy flat areas and depressions. Approximately 12 percent of the county is in this association.

The Conesus and Lansing soils are deep gravelly silt loams. They formed in glacial till that is predominantly from local shale and sandstone but contains a significant amount of limestone. Ordinarily, the surface and subsurface layers are slightly to moderately acid, but free lime is present at a depth of 30 to 42 inches. The subsoil begins 14 to 22 inches below the surface, has subangular blocky structure, and contains more clay than either the overlying or underlying horizons. The moderately well drained Conesus soils are mottled in the subsoil. Lansing soils are free of mottling throughout the profile. Kendaia and Lyons soils, both minor in the association, have a dark-colored surface soil and a highly mottled subsoil.

Lansing soils make up about 35 percent of the association; Conesus soils, about 40 percent; Kendaia soils, 15 percent; and Lyons soils, 5 percent. The remaining 5 percent is made up of other soils of minor extent, such as the Valois, Langford, Howard, and Lima.

This association is fertile and productive and is well suited to the crops commonly grown. Dairying is the main type of farming. Hay, oats, and corn are the common crops. Under good management, the soils in this association are well suited to sugar beets. Winter wheat and field beans are important cash crops. Conesus and Lansing soils are easy to work, have good moisture-holding capacity, and are responsive to management practices. They are high in available potassium but require potassium fertilizer for yields of more than 2 tons of deep-rooted legumes and grasses. Soil tests indicate that about 60 percent of the acreage is low in available phosphorus. The associated Kendaia and Lyons soils have been tile drained in most places and consequently do not limit the use of the better drained soils.

The clayey subsoil and the compact substratum of limy glacial till interfere with sewage disposal. Nevertheless, many areas west of Salmon Creek and north of Myers have been selected as building sites. The villages of Jacksonville and parts of South Lansing and Trumansburg are in this association. Vegetation is more easily established around building sites than on the Hudson and Cayuga soils, because the material excavated is loamy till. The material is stony, however, and boulders may be encountered during excavation for basements or for septic tanks and drainage fields. Additional information on the engineering properties of the soils of the Conesus-Lansing association can be found in the section "Engineering Applications."

Howard-Valois association (HV)

This association consists of well-drained, moderately coarse textured and medium-textured, gravelly soils on level, rolling, or steep topography. It is one of the most extensive associations and occupies all the major valleys and a large section in the uplands in the northeastern corner of the county. It includes flat alluvial bottom lands, nearly level terraces, alluvial fans, steep fronts of glacial lake deltas, smooth valley walls, and rolling uplands. Besides the dominant Howard and Valois soils, this association includes all of the bottom-land soils of the Genesee and Tioga catena. It also includes the acid Chenango gravelly loam on terraces and fans, Bath channery silt loam on valley walls, a considerable acreage of Rhinebeck silty clay loam, and Arkport fine sandy loam in the valleys. The same relative topographic relationship between the various soils is apparent in these areas in all parts of the county. About 20 percent of the county is in this association.

Howard soils account for about 25 percent of the association; Valois soils, 25 percent; Chenango soils, 15 percent; Bath soils, 5 percent; soils of the Genesee, Eel, and Wayland series, about 15 percent; and soils developed in lacustrine sediments, mainly of the Arkport, Rhinebeck, and Hudson series, about 15 percent.

The medium-lime Howard and the very low-lime Chenango gravelly loams, which are medium in potassium-supplying power, developed in deposits of stratified sand and gravel. Thus, Howard soils resemble Palmyra soils to some extent; they have less limestone in the underlying deposit, however, and are more strongly acid in the surface soil and upper subsoil. Their surface soil is gravelly. The lower subsoil shows some accumulation of clay. Chenango soils are similar to Howard soils but lack an accumulation of clay in the subsoil. The associated low-lime Valois gravelly loams and silt loams, which also are medium in potassium-supplying power, formed in deposits of weakly calcareous glacial till and have some evidence of water sorting in the substratum. They ordinarily occur at a higher elevation on slopes than do Howard soils. On valley walls, Howard and Valois soils are mapped as a complex.

The low-lime Valois soils are less gravelly than Howard soils. They have little or no accumulation of clay in the subsoil, but they have a weak fragipan (hardpan) deep in the subsoil. They are about like Howard soils in natural acidity of the surface and subsurface layers but are somewhat deeper over free lime, which is generally at a depth of 3½ to 5 feet.

Alluvial soils are not extensive in Tompkins County. The largest areas occur at the south end of Cayuga Lake and along Cayuga Inlet. Small areas occur along Cascadilla, Fall, Trumansburg, Taughannock, and other smaller creeks. The moderately well drained Eel soils are more widespread than the well drained Genesee soils. The poorly drained and very poorly drained alluvial soils are mapped as an undifferentiated unit of Wayland and Sloan soils. The acid alluvial soils of the Tioga, Middlebury, Holly, and Papakating series are less extensive than the alluvial soils previously mentioned.

Some of the best farms of the county are located in the Howard-Valois association. The proportion of good soils is relatively high, and these valleys have the longest growing season of any part of the county. One disadvantage, however, is the variability of the soils; if there are extensive areas of the soils other than the Howard or Valois, lack of adequate drainage may be a problem. A second disadvantage is the significant percentage of strong slopes. Dairying is the main type of farming, and most of the land is used to grow crops to feed dairy cattle. Corn, oats, and hay are the principal crops. Valois and Howard soils are good for growing alfalfa, as are most of the other well-drained associated soils if adequately limed and fertilized.

Most of the villages, roads, and railroads of the county are in this association. The soils are generally well suited to use as building sites. Occasionally, the lowest lying areas of alluvial soils are flooded. Also, houses built on gravelly outwash soils adjacent to upland areas are likely to have flooded basements and septic tanks in spring because of runoff.

There are deep deposits of limy gravel, from which several companies supply gravel and concrete mix to builders in the county. Much of the gravel is suitable for road subbase.

All of the scenic gorges and waterfalls of the State parks in Tompkins County are within this association. Taughannock Falls State Park is on the west side of Cayuga Lake near the northern boundary of the county; the Robert H. Treman State Park is near Enfield, west of Cayuga Inlet; Buttermilk Falls State Park is on the east side of the Inlet Valley at the southern city limits of Ithaca; and Stewart Park is located at the south end of Cayuga Lake. These parks provide swimming, picnicking, camping, and hiking for local residents and for tourists, who add considerably to the summer population of Ithaca. The Fall Creek and Cascadilla gorges through the campus of Cornell University are good places for studying the kinds of bedrock that underlie much of the county. Ithaca Falls, located below the campus on Fall Creek, is a tourist attraction also; fishing is permitted in the creek below the Falls. The streams in this soil association are generally stocked with trout and afford good fishing in summer. Information on the engineering properties of the soils in this association is given in the section "Engineering Applications."

Associations Dominated by Low-Lime Soils With a Strong Fragipan

These associations are in the central and north-central parts of the county (see general soil map), generally between the associations of medium-lime and very low-lime soils; the amount of natural lime in Tompkins County soils decreases from north to south. In unlimed areas, the surface soil is strongly acid and the lower subsoil is neutral or slightly alkaline. The soils in this association require heavy liming for high yields of legumes and other crops.

Langford-Erie association (LE)

This association consists of moderately well drained and somewhat poorly drained, medium-textured soils on rolling to moderately steep topography. These low-lime soils, which are medium in potassium-supplying power, are dominant in two areas in the north-central and northeast parts of the county along the Cayuga County line. They developed in glacial till that was deposited as ground moraines. The topography is generally mild. The moderately well drained Langford soils, which occupy 40 percent of the association, are the most extensive. They are on the rounded ridgetops and steep slopes. The somewhat poorly drained Erie soils account for 30 percent of the association and are generally smoother and more nearly level. The poorly drained and very poorly drained Ellery and Alden soils occupy flat areas, swales, and depressions and make up about 25 percent of the association. The well-drained Valois soils and other soils of minor extent make up about 5 percent of the association. About 5 percent of the county is in this association.

All of these soils, except possibly Alden soils, have a strongly expressed fragipan (hardpan). The pan in Langford soils is 15 to 24 inches below the surface, that in Erie soils is 12 to 18 inches below the surface, and that in Ellery soils, 12 to 15 inches. These pans are dense enough to seriously restrict root penetration and air and water movement.

Langford and Erie soils are not stony soils but contain numerous fragments of local shale and sandstone and are classed as channery. Typically, these soils are silt loams and are deep over bedrock (fig. 3), but in a few areas the depth to bedrock is less than 30 inches. Langford soils have a grayish-brown surface soil, a yellowish-brown upper subsoil, and a mottled, dense, compact fragipan as the lower part of the subsoil. Erie soils are grayish brown in color. They are mottled from the plowed layer down, and the dense pan is close to the surface.

Langford soils generally are good for crops when well managed. Erie soils are fair, considering the present choice of crops, lime, fertilizer, and management practices. Slow internal drainage limits the use of Erie and Ellery soils. Drainage can be improved by means of drainage-type diversion terraces and in some places by means of open ditches. Diversion ditches on Erie soils make it possible to plant oats 7 to 10 days earlier in spring. Contour stripcropping and diversion terraces also are well suited to Langford soils.

Vigorous new crop varieties, adequate liming and fertilizing, and improved management practices have in recent years tended to minimize the disadvantages of the wetness, acidity, and low natural fertility of these soils. Moderate to high yields of many crops can be obtained if crops are wisely selected and properly managed (see current issue of "Cornell Recommends for Field Crops"). Hay mixtures of adapted varieties of alfalfa, tall birdsfoot trefoil, and timothy are suited to fields that consist of both Langford and Erie soils. Adapted varieties of alfalfa are well suited to Langford soils; birdsfoot trefoil grows very well

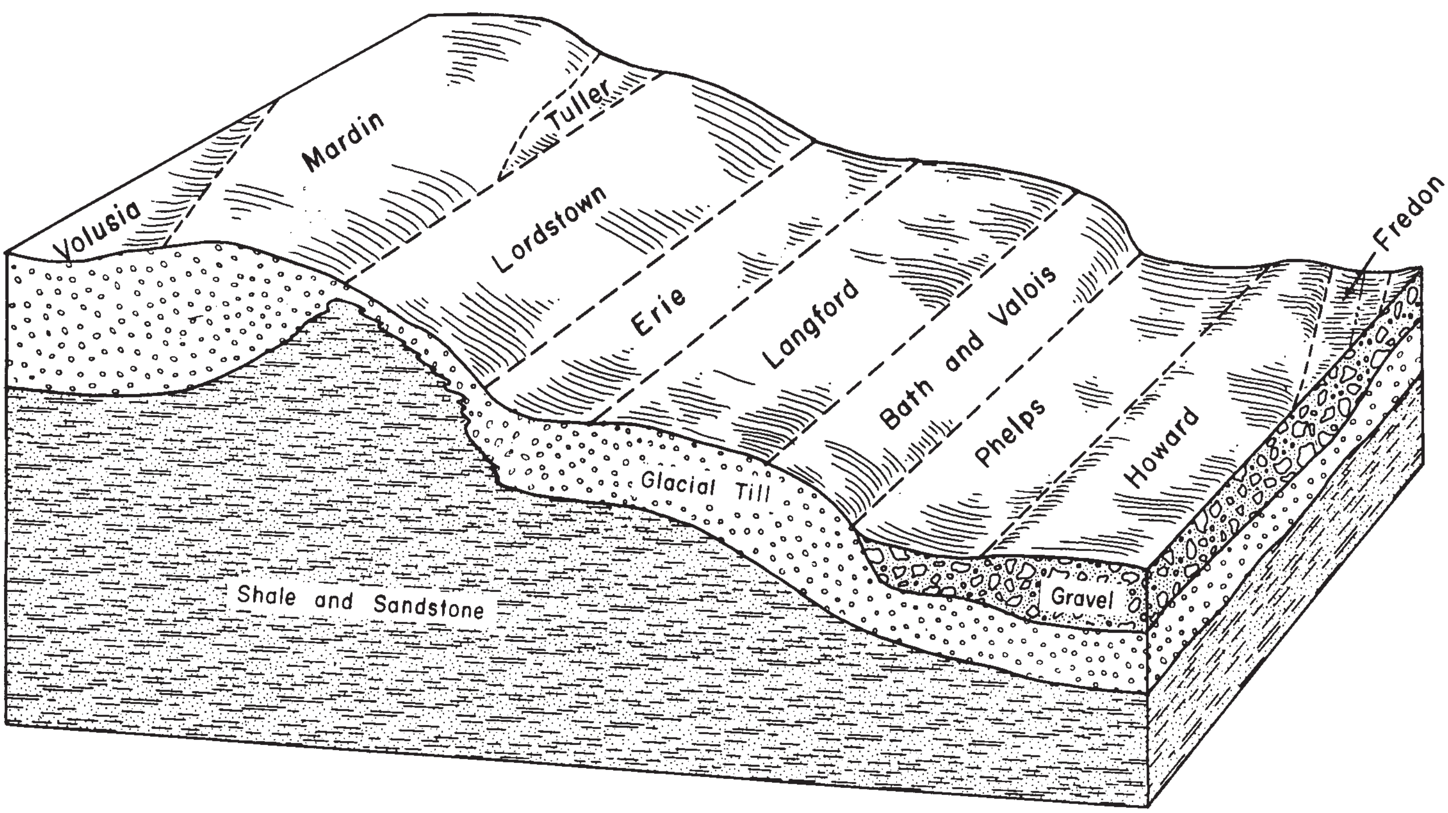

Figure 3.—**Typical cross section of southern Tompkins County soils, consisting mainly of low-lime and very low-lime soils with a fragipan.**

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on well-managed Erie soils. Dairying is the main type of farming, and most of the acreage in crops is in oats, corn for silage, and grass-legume hay. Field beans, winter wheat, and cabbage are grown to some extent on Langford and Valois soils along the northern border of this association. Erie soils are moderately responsive to good management practices, and Langford soils are highly responsive. The potassium-supplying power is medium, and the supply of available phosphorus is low in both soils.

The village of West Groton is mostly on the Erie soils of this soil association. Sewage disposal is a problem on the fragipan soils because of slow permeability. The dense fragipan makes good building foundations, but it also holds water unless adequate toe drains and outlets are provided. North of West Groton the bedrock is close to the surface and would cause difficulty in excavations more than 2 feet deep. Part of this area is used for recreation and hunting and for hobby farms. For information on the engineering properties of the soils in this association, see the section "Engineering Applications."

Erie-Langford association (EL)

Somewhat poorly drained, silty soils on mild topography are dominant in this association, which occurs on ground moraines throughout the central part of the county, between areas of medium-lime and very low-lime soils. Erie soils and the associated poorly drained Ellery soils occupy the nearly level part of the landscape, and Langford soils occupy the steeper slopes and rounded ridgetops. Erie soils are the most extensive. They make up about 40 percent of the association. Langford soils account for about 25 percent; Ellery soils, 20 percent; Alden soils, 10 percent; and the associated well-drained Valois soils, about 5 percent. About 21 percent of the county is in this association.

The soils of this association are not stony, but they contain numerous channery fragments of shale and sandstone. They all have a strongly expressed fragipan (hardpan) that is sufficiently dense to interfere with root penetration and air and water movement.

These soils are deep. Their surface soil is channery silt loam. The fragipan is 15 to 24 inches below the surface in the moderately well drained Langford soils. The upper 15 to 24 inches of these soils is friable, is generally free of mottling, and can be utilized by plant roots. Erie and Ellery soils are mottled from the plowed layer down, and the compaction of the fragipan is evident about 12 to 18 inches below the surface.

The somewhat poor drainage of Erie soils and the poor drainage of the extensive Erie-Ellery complex are the principal limitations in the use of these soils. These soils warm up slowly in spring, and tillage operations may have to be delayed because of wetness. Dairying is the main type of farming. Hay, oats, and short-season silage corn are the principal crops. If properly managed and in places artificially drained, these soils can be farmed with moderate success. Birdsfoot trefoil and timothy are particularly well suited to Erie soils.

The village of West Dryden, which is dominantly on Erie and Ellery soils, is in the largest area of this association, northeast of Ithaca. The village of Danby is on the edge of another Erie-Langford area, south of Ithaca. Slow surface runoff, slow permeability, and slow internal drainage result in wetness and problems of sewage disposal. Many building sites require fill to make the lots high and dry enough for good lawns. Scarcity of outlets adds to the cost of construction. Bedrock is 20 inches or less below the surface in many places in the area south of the Ithaca College campus; consequently, it interferes with excavation. Bedrock also outcrops in numerous areas. Information on the engineering properties of these soils is given in the section "Engineering Applications."

Associations Dominated by Very Low-Lime Soils With a Strong Fragipan

These associations occur as scattered areas throughout the southern part of the county where the elevation is higher and the terrain is more rugged. The soils are very strongly acid in the surface soil and subsoil and medium acid to strongly acid in the fragipan and substratum. Farming has been abandoned in many areas in this part of the county.

Volusia-Lordstown association (VL)

This association consists of somewhat poorly drained, deep soils and well-drained, moderately deep soils on rolling to steep topography. It is in the southern part of the county. Volusia soils occupy the gently rolling hilltops and moderately steep slopes. The well-drained, moderately deep Lordstown soils are on the very steep slopes. Large areas that were once farmed have been abandoned and are now idle or have been reforested. The proportion of native forest is considerably higher here than in other parts of the county because most of the land is too steep and rough for agriculture. Besides Volusia and Lordstown soils, this association includes a sizable acreage of the moderately well drained, deep, strongly acid Mardin soils and small areas of the poorly drained Chippewa and Tuller soils. About 21 percent of the county is in this association.

Volusia soils occupy about 40 percent of the association; Lordstown soils, 35 percent; Mardin soils, 20 percent; and Chippewa and Tuller soils, about 5 percent.

The somewhat poorly drained Volusia soils have a gray, silty, strongly acid surface soil. They are mottled under the plowed layer and have a strongly expressed fragipan, locally called a hardpan. The pan becomes apparent at a depth of 10 to 15 inches, and it is dense enough to interfere with root penetration and movement of water. The strongly acid Lordstown soils are well drained but have bedrock 20 to 40 inches below the surface. On some of the higher hilltops these soils may be shallow, but in most places the Lordstown soils are moderately deep. All of the very steep valley walls throughout the southern part of the county are mapped as either Lordstown soils or Rock outcrop.

This association is less favorable for farming than are other parts of the county. The growing season is somewhat shorter, the region is less accessible, and the soils generally are somewhat less productive than equivalent low-lime soils. Slow drainage, a compact fragipan, and strongly acid reaction limit the use of Volusia soils. Moderate depth, strong acidity, and steepness of slope limit the use of Lordstown soils. Strong acidity and moderate depth to the fragipan are limiting factors in the included Mardin soils. Dairying is the main type of farming; oats and hay are the most important crops. Potatoes and silage corn are ordinarily planted on the included Mardin soils.

These soils have medium potassium-supplying and low phosphorus-supplying capacity. They respond less to management than soils of other associations, but if heavily limed and fertilized they produce good yields of suitable crops.

This association still includes a few farms, but it is used mainly for forest and for recreational purposes. The State owns a sizable holding, which has been reforested and provides excellent food and cover for the large deer population. This area is open to the public for hunting. Engineering properties of these soils are described in the section "Engineering Applications."

Lordstown-Mardin association (LM)

This association consists of well drained and moderately well drained, shallow and deep, strongly acid soils on rolling to steep topography. It occurs in four small areas east and south of Ithaca. The steep Lordstown soils make up 45 percent of the area; Mardin soils, 40 percent; the somewhat poorly drained Volusia soils, 10 percent; and the well-drained Valois soils, about 5 percent. Only 4 percent of the county is in this association.

The well-drained Lordstown soils are shallow to moderately deep over bedrock and in most places are too steep to be used for farming. The moderately well drained Mardin soils, which occur on hilltops, have a friable surface soil and subsoil and a strongly developed fragipan at a depth of more than 15 to 20 inches. The fragipan is dense enough to hinder root development and downward movement of water. Both soils are strongly acid, and both are low in available phosphorus and medium in potassium-supplying power. Where relief and depth are favorable, they can be used for farming. They respond moderately well to good management practices.

The soils in this association are generally too steep for anything except woodland, wildlife, and recreational uses. Their engineering properties are described in the section "Engineering Applications."

Use and Management of the Soils

This section has six main parts. The first part discusses general management practices applicable to the county, such as methods of tillage, liming, fertilizing, and controlling the loss of soil and water. The second part groups the soils into capability units to show their relative suitability for agriculture and discusses the management of the soils of each capability unit. The third part presents estimates of the yields that are obtained from each of the soils at different levels of management. The fourth part groups the soils according to their suitability for use as woodland and gives information that is useful in the management of woodland. A table showing the suitability of the soils for different species is a part of this section. In the fifth part, present patterns of wildlife in the county are described in relation to areas shown on the general soil map of the county, and the soils are rated according to their ability to support specific kinds of birds and animals. The sixth part presents information about soil properties that are important to engineers, builders, and town or city planners.

General Management for Agriculture [3]

This section is designed to help farmers, those who advise farmers, and students to choose combinations of soil- and crop-management practices suitable for the wise and economic utilization of the soils on a farm and appropriate for conditions prevailing at the time the choices are made. The user of this report should modify his choices to take advantage of rapid advances in knowledge of soil and crop management resulting from agricultural research during the 1950–60 period, as well as advances anticipated in the future. New research findings are reported currently in annually revised editions of "Cornell Recommends for Field Crops" and "Cornell Recommends for Vegetable Crops." Cornell Miscellaneous Bulletin Number 47 and current editions of other applicable publications on soil and crop management should also be consulted. A great body of constantly revised but unpublished information is available upon request from Tompkins County agricultural agents and from the Soil Conservation Service soil conservationists assisting the Tompkins County Soil Conservation District. Currently applicable information concerning soil and crop management is also available to the user of this report from industry representatives who serve the farmers of Tompkins County.

Factors of management

In contrast to formerly held concepts of managing soils and crops, wherein one or, at the most, two or three combinations of practices were applied to all the soils of a county and differences in yields were attributed to differences in productivity, the modern view is the direct opposite. Current thinking during these early sixties is that the individual farmer custom fits a combination of management practices to each soil on his farm to meet the objectives of his enterprise. Within reasonable limits then, the farmer gets the same yield of a given variety of crop from many kinds of soils; the amounts, kinds, and combinations of practices he utilizes to achieve this end result usually differ from one soil to another.

The rapidly accelerating rate at which soil- and crop-management technology and crop varieties were developed between 1940 and 1962 has opened new yield horizons for arable Tompkins County soils. And it is likely that the process has only begun. By the 1970's many of the crop-yield predictions for the "B" level of management contained in this report may be as outdated as the 1½-ton hay yields predicted in the 1920 Soil Survey of Tompkins County (*20*). For example, since the early 1950's, the introduction of new germ plasm in the French DuPuits variety of alfalfa raised the yield potentials on deep, well-drained soils for skillful Tompkins County farmers from 3 or 4 tons to 5 or 6 tons of alfalfa hay per year. A second example is the introduction, in the early 1960's, of new germ plasm in a Cornell-developed hybrid field corn, M–3, that opens possibilities of silage and grain yields 15 to 20 percent greater than were obtainable from previously

[3] This section prepared by REESHON FEUER, associate professor of agronomy, Cornell University. Unless otherwise noted, the material is based on the results of research studies performed on the Aurora and Mount Pleasant Research Farms by staff members and associates of the New York State College of Agriculture at Cornell University.

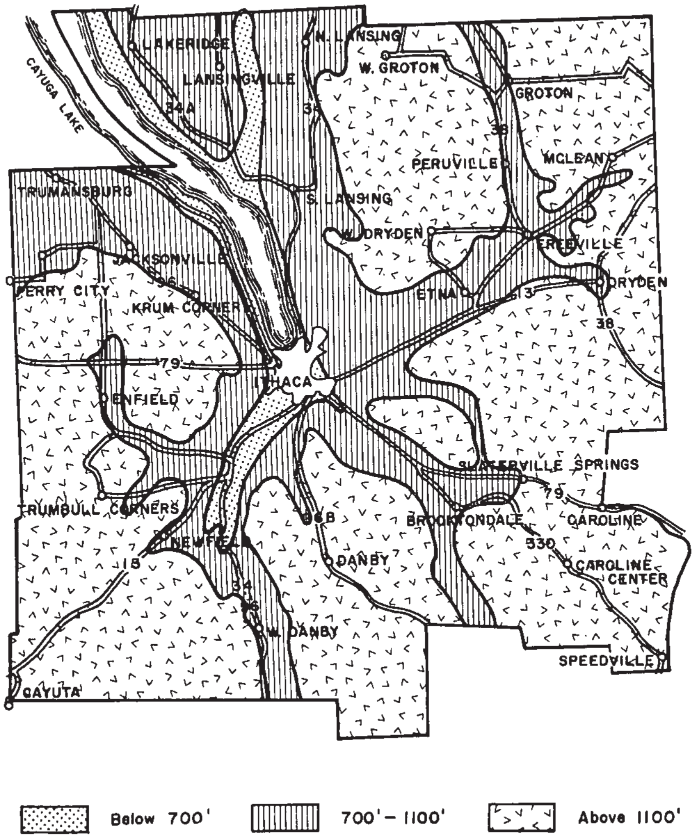

Figure 4.—**Elevation zones of Tompkins County.**

available hybrids. Such greater yields will be obtained only by farmers who adjust their soil-, water-, and crop-management practices to utilize the yield capability of such new crop germ plasm.

The factors of soil, water, and crop management that affect yields can be placed in broad groups as follows: climate; soil properties; crop characteristics; soil-management and water-management practices; crop-management practices; management skill; weather this year. Yield is the result of the combination of and interactions among these factors. Because of their interdependence, it is impossible to discuss one of these factors without reference to the effects of the others.

Climate.—The many aspects of climate from place to place within Tompkins County, such as length of growing season, amount and distribution of rainfall, radiant energy received per unit area, percentage of possible sunshine, wind movement, temperature, and humidity, all affect the results of specified management practices. For example, it is easier to get a high yield of a cool-season crop, such as oats, in the higher elevations of the southern half of the county than in the lower northern half of the county where the temperatures of the air and soil are warmer (fig. 4). For field corn, the reverse is true. Consequently, the skillful farmer at higher elevations in the southern part of the county chooses a shorter season hybrid corn better adapted to the cooler temperatures and shorter growing season in his area.

During the 4-year period 1958–61, the directors of the Tompkins County Soil Conservation District carried out a survey of growing-season rainfall at stations throughout the county. The number of stations reporting varied between 27 and 47 from month to month. A map showing the location of the rain gauges is on file at the Soil Conservation District office in Ithaca. Daily, monthly, and seasonal measurements varied greatly from station to station, and no definite pattern showed up. The wide variations in single-storm measurements between neighboring stations reflected the fact that most of the growing-season rain fell during localized thunderstorms. Table 1 summarizes the results of this study. In this table, *high* indicates the highest amount of rainfall reported by a station; *low* indicates the lowest amount of rainfall reported by a station; and *average* refers to the average amount of rainfall of all the stations reporting for a specified period.

More details of local climate are discussed under the heading "Climate" in the section "General Nature of the County."

Soil Properties.—The current viewpoint that the skillful farmer chooses the appropriate combination of practices to get the yields he wishes from a specific soil puts a high premium on knowing all of the properties of a soil and understanding how these properties and qualities affect yields. The properties of individual soils in

Table 1.—*Highest, lowest, and average rainfall, in inches, reported during a specified 4-year period, by stations in Tompkins County*

[Table prepared by Howard H. Wilson, soil conservationist, Soil Conservation Service, Ithaca, N.Y.]

Year	Rainfall reported—																	
	During May			During June			During July			During August			During September			From May through September		
	High	Low	Average	High	Low	Average	High	Low	Average	High	Low	Average	High	Low	Average	High	Low	Average
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
1958	6.3	2.3	3.6	8.6	3.0	6.2	7.2	3.2	5.5	6.0	1.8	3.7	7.0	3.9	5.1	28.8	19.9	24.7
1959	3.5	1.2	2.3	5.5	2.0	3.3	6.3	2.1	3.6	7.8	3.1	4.9	3.1	.7	1.5	20.7	12.0	15.9
1960	7.9	4.8	6.1	6.7	2.0	4.2	3.7	1.3	2.2	4.6	2.2	3.1	6.7	2.9	4.2	23.0	15.8	20.0
1961	6.9	3.2	4.9	12.7	3.7	7.1	7.5	2.7	4.8	7.2	2.1	4.8	4.3	.6	1.5	29.8	17.5	23.5

Tompkins County are described in other sections of this report. Most of this section of the report gives explanations, interpretations, and, in the discussion of capability units, specific suggestions for wise use and management of the soils.

CROP CHARACTERISTICS.—The scientific accomplishments of modern plant breeders are making available many improved crop varieties of high genetic potential, tailormade for specific conditions. The results of agronomic research in testing and evaluating these modern crop varieties and designing suitable production practices means that farmers and those who serve and advise them, can no longer say, for example, "Grow 'hay' on this field." Rather, it is now essential to specify the variety or varieties and the management most likely to give optimum results for a given soil.

The estimated crop yields for the "B" level of management, as shown in table 8 of this report, reflect the influence on yields of characteristics of perennial forage varieties grown in the early 1960's.

SOIL-MANAGEMENT AND WATER-MANAGEMENT PRACTICES.—Abundant and conclusive evidence exists to show that only the most skilled farmers are utilizing a majority of the ever-increasing fund of technical knowledge concerning soil and water management. The average crop yields from Tompkins County soils in the early 1960's are estimated to be about one-half to two-thirds of those physically and economically feasible. Individual farmers in the county, however, are successfully applying much of the agronomic technology available to them. The efforts of the county agricultural agents and the soil conservationists in encouraging and assisting Tompkins County farmers to utilize better soil-management practices are evident on many farms throughout the county.

Current recommendations for such major practices as liming, fertilizing, and soil testing, and for establishing measures for soil and water conservation, are available from both the Tompkins County Agricultural Extension Service and the Tompkins County Soil Conservation District. The basic principles and practices are in this section of the report.

CROP-MANAGEMENT PRACTICES.—To get the most from the new high-yielding varieties of crops, adequate timing is important, and if appropriate a number of harvests should be made. For example, to get the most from the DuPuits variety of alfalfa on soils to which it is adapted, three cuttings per growing season should be made. A four-cutting schedule reduces the overall yield, even though other management practices remain the same. Corn silage of highest feeding value (grain content) results when the corn grown is a hybrid that can come close to physiological maturity by harvesttime.

Current recommendations for crop management are available from the same sources as recommendations for soil and water management.

MANAGEMENT SKILL.—As in all endeavors, it is the management skill of the operator and advisor that determines results. An ever-increasing amount of management-research data is being made available to Tompkins County farmers. Dissemination of information concerning the results obtained by Tompkins County farmers who are enrolled in the Farm Business Management Program is one example of utilizing skills in the management of soils (see "Estimated Crop Yields").

WEATHER THIS YEAR.—The weather in any given year modifies the results of the interaction of the other six factors. The variation is likely to be 20 to 25 percent, and local variations may be more or less than that in a given year. As increasingly better choices are made in relation to the other factors, there will be less deviation in results that can be attributed to the weather in the current year.

Crop rotations and supporting practices

Ever since the benefits of growing a sequence of crops (crop rotation) rather than the same crop year after year were first demonstrated at the Rothamstead Agricultural Experimental Station in England about 200 years ago, the interest in and the use of crop rotations have been widespread. The results of research with various kinds of crop rotations on different kinds of soils, at different levels of fertility, using crop varieties of specified germ plasm and different management practices, are voluminous. These results can be summarized for Tompkins County in just one sentence: The crop rotation(s) that will return the most dollars, in relation to costs and objectives, provided soil erosion is adequately controlled, is the one to choose.

The majority of Tompkins County farmers are dairy farmers. They follow crop rotations that consist of 1 year of row crops, usually corn for silage; 1 year of small grain, usually spring oats; and 4 or 5 years of legume-grass hay. Sometimes winter wheat is grown on a few acres, after the spring oats crop is harvested. In some fields the hay stand remains only 3 years, especially if the DuPuits variety of alfalfa is the major sod-forming legume. In most fields the sod-forming crop remains for 5 or 6 years and in the later years is predominantly grass.

There are a few cash-grain farmers in the northern parts of the county, where the soils are high and medium lime, are of blocky structure, and have clayey accumulations in the subsoil. These farmers utilize diversion terraces, tile underdrainage, contour stripcropping, winter cover crops, and crop-residue management as soil- and water-conservation measures.

SELECTION OF A CROP ROTATION.[4]—Modern understanding of soils and soil management; larger and faster farm machinery; better soil- and crop-management "know-how," and the new high-yielding field crop varieties all add up to the need for a new look at crop rotations.

Recent research points to soil protection, soil structure, water conservation, and nutrient status as the important factors in getting high yields from a crop rotation. Modern rotations can be both shorter and higher yielding than those of yesterday.

The old idea that a good crop rotation would continually improve the soil and increase yields is not supported by long-time research. Recently published results of the famous Ohio rotation experiments on the Wooster soil, which is similar to many New York soils, show that after the first round in any reasonable cropping sequence, if erosion is not a problem, the yield levels tend to remain essentially the same (*10*). These results were obtained over a 50-year period. The same results were secured on

[4] Adapted from material prepared by REESHON FEUER (1959) for use by farmers throughout New York State in a Soils and Crops Workshop presented jointly by Extension Service and Soil Conservation Service personnel.

the Jordan rotation plots in Pennsylvania (the second oldest rotation experiment in the United States). Only if the inputs—fertility, varieties, management, or rotation—are changed will the yields change on a specific kind of soil. This is a finding of considerable significance in choosing a rotation for a particular farm.

Five points in the selection of a suitable modern crop rotation are described in the following paragraphs.

1.—Select crops suited to the soil, slope, and climate.
- a.—Selecting crops suited to the soil and the climate is easy. Keep up to date with new varieties.
- b.—Selecting crops suited to the slope has received too little attention; soil erosion is proof of this. As the slope increases, decrease the number of cultivated crops, or add supporting practices, or both. The following crop sequences represent the approximate maximum intensity of use of well drained and moderately well drained, medium-textured, deep soils.
  - (1)—Nearly level slopes: Row crop (winter cover), row crop (winter cover).
  - (2)—Gentle slopes: Row crop, small grain, hay. Row crop (winter cover), row crop, small grain, hay, hay.
  - (3)—Moderate slopes: Row crop, small grain, hay, hay.
  - (4)—Strong slopes: Small grain, hay, hay, hay.
- c.—Combinations of crop rotations (cropping sequences) and supporting practices to protect the soil, conserve water, maintain the organic-matter content, and preserve soil tilth are suggested for each of the 54 capability units in which Tompkins County soils have been grouped (see section "Capability Groups of Soils").

2.—Use enough legumes and grasses to increase at least slightly the nitrogen content and organic-matter content of the soils.
- a.—Generally, at least one-fourth to one-third of the rotation should consist of sod crops.
- b.—Improvements in soil structure and accumulation of nitrogen from legume-grass sod crops take place principally during the first 2 years of the stand. If hay or pasture is retained for more than 2 years, it is for any one, two, or all of the following other reasons.
  - (1)—Soil protection is needed.
  - (2)—Hay, pasture, or both are needed.
  - (3)—The soils are heavy, wet, or stony.
- c.—Deep-rooted legumes open up the subsoil, thus increasing permeability; they are especially important on heavy soils and on soils that have a hardpan or fragipan.
- d.—Deep-rooted legumes utilize plant nutrients and water from the lower layers of the soil.
- e.—Deep-rooted legumes, such as alfalfa and birdsfoot trefoil, are strong foragers for phosphorus after the seedling year but require adequate fertilization with potash.

3.—Select crop sequences that produce the highest yields and provide for the best control of weeds, insects, and diseases.
- a.—Use short rotations on row-crop and grain-crop farms and longer rotations on dairy farms.
- b.—On level soils of good structure, use shorter rotations.
- c.—On sloping soils or on soils in poor tilth, use more years of sod.
- d.—Build the rotation around the dominant crop of the area.
- e.—Plan to obtain the largest possible net income per year on a continuing or permanent basis.
- f.—Adjust the lime and fertilizer applications for best results.
- g.—Building up fertility when prices are favorable is a good way to hedge against periods when prices are low. It also results in maximum yields during unusually favorable growing seasons.
- h.—Allow for some flexibility in crop sequences to fit changing circumstances.

4.—Select crops that provide sufficient feed for the livestock on the farm.
- a.—The amount of home-grown feed is a big factor in profitable livestock farming.
- b.—In dairy farming, design the cropping system, insofar as possible, to meet the requirements for feed. Consider—
  - (1)—Pasturage, which is most important and profitable on dairy farms.
  - (2)—Early-cut forage, high in legumes; grass silage, wilted, makes best quality hay; conditioning and barn drying makes early cutting easier.
  - (3)—Corn silage.
  - (4)—Bedding.
  - (5)—Concentrates.
- c.—Allow 10 to 15 percent more feed than actual needs to provide for emergencies.

5.—Insofar as practicable, select crops that will provide for good distribution of labor and equipment.
- a.—Avoid labor peaks and the use of large amounts of labor, both of which are costly.
- b.—Use early-, medium-, and late-maturing crops to even out harvest peaks and especially to get hay and corn silage of high feeding value.
- c.—Use as much modern machinery as feasible, planning for efficient acreage for each type of machine needed.
- d.—Generally two, sometimes one, occasionally three crop rotations are needed for an individual farm. Different fields for which rotations of the same length are used, such as corn, oats, hay, hay, hay, hay, may need different combinations of forage seedings or different varieties of corn, each of which is suited to the soils of a particular field.

Emergency adjustments in rotations may become necessary because of crop failures or unfavorable weather. The following are possible adjustments to consider.

1.—If legumes in the hay mixture fail—
- a.—Plow the field and plant corn, and keep the legume-grass sod on another equal-sized field for 1 year longer.

b.—Apply extra nitrogen early in spring to the remaining grass, to boost yield.

2.—If a new seeding fails—

a.—Reseed in oats, and use the oats for silage or pasture.

b.—Reseed alone and use chemicals to control weeds.

c.—In areas where the growing season is longer, prepare the ground for summer seeding, if you learn of seeding failure early enough. Do this if there is a good heavy rain late in July or early in August; reseed right after the rain, using only alfalfa, brome, or timothy—no clover or birdsfoot trefoil. Do not seed unless there is a heavy rain. If the rain does not come, seed the following spring with a spring grain, overseed fall grain, or seed alone, using chemicals to control weeds.

3.—If spring is wet and planting has to be delayed until it is too late to grow a good crop of oats, try a regular- or short-season hybrid corn. Sudangrass, hybrid sorghum, or millet can also be used.

4.—Winter barley may follow oats or some heavily fertilized short-season cash crop, such as snap beans or canning peas.

5.—Winter rye for pasture may follow oats on well-drained soils; then either corn or sudangrass may be planted the following year.

6.—If corn is grown, a winter cover crop of ryegrass or of ryegrass and alfalfa can be planted (but not if atrazine chemical weed control is used). Such cover crops help to conserve soil and fertility, increase the organic-matter content, and help to maintain soil structure. A cover crop in corn also improves traction for machinery at harvesttime.

Supporting Practices.—In addition to a suitable cropping system, practices are needed that will conserve water, remove excess water, and control erosion. Water is needed to dissolve most plant nutrients and to make them available to plants. Too much water or too little water, however, is commonly the limiting factor in the growth of plants. Loss of water through excessive runoff, besides causing plants to lack moisture, increases the risk of erosion on cultivated fields.

How beneficial rainfall is depends largely on how much water infiltrates the soil. Some factors that affect the rate of infiltration are (1) the amount of surface cover available to break the impact of falling raindrops; (2) the amount of pore space and the degree of aggregation of soil particles; (3) the clay content of the soil; and (4) the slope of the soil. A farm operator can do something about some of these factors. For example, by growing grasses and legumes in the cropping system, he can improve the aggregation and aeration of the soil and thereby increase the rate of infiltration. Minimum tillage for preparation of seedbeds preserves soil aggregation, increases the rate of infiltration of air and water, and reduces the costs of crop production. Cultivating on the contour slows down the rate of runoff, decreases the risk of erosion, and permits more water to enter the soil. On steeper soils that have rapid runoff, diversion terraces break the length of the slope and safely remove excess water.

Because of a high water table or an impervious layer, some soils are seasonally saturated with water; as a consequence, plants are damaged by too much water and too little air. Such soils are cold and wet in the early part of the growing season, but later in the growing season they may become very dry. When the soils are wet, plants are able to develop only shallow roots. Then, when the soils dry out, the roots are too shallow to obtain a good supply of water. Figure 5 shows that the roots in very wet, or poorly drained, soils extend to a depth of only a few inches; in contrast, the roots in well-drained soils may extend to a depth of about 36 inches or more, unless restricted by a fragipan or by rock.

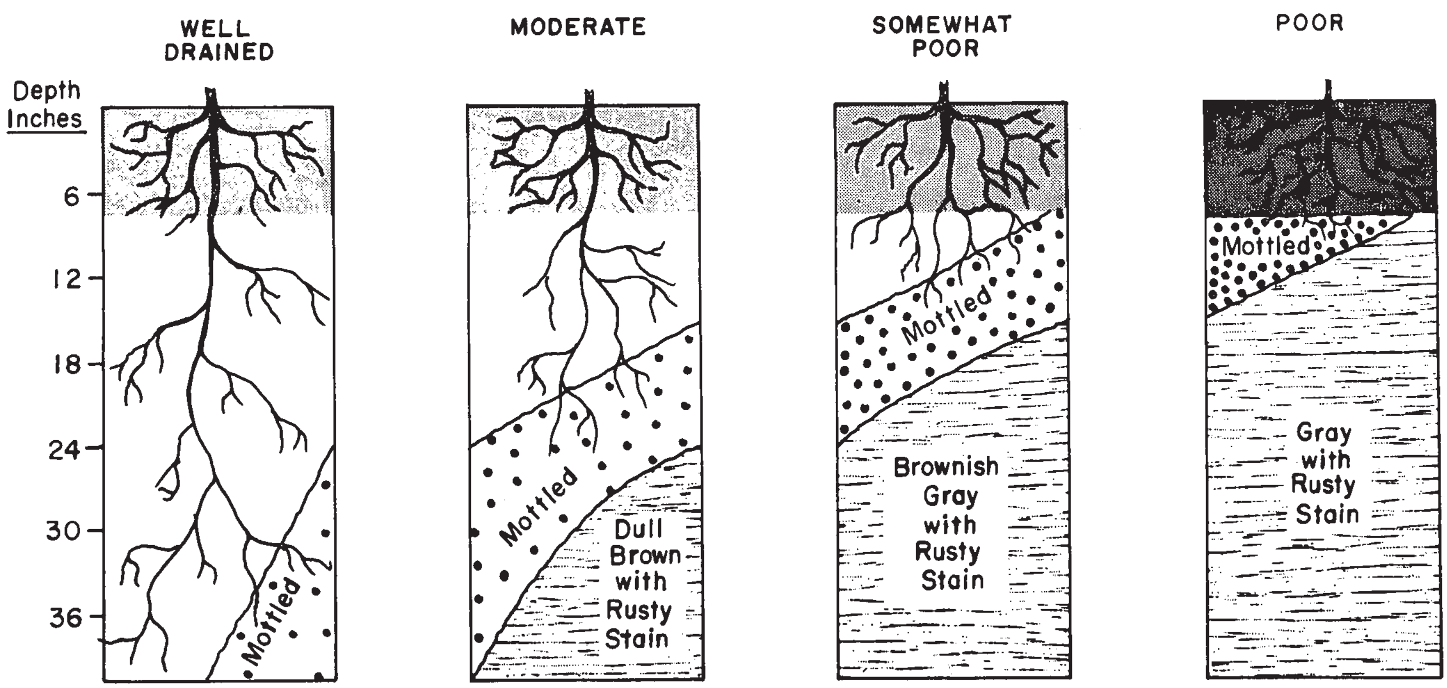

Figure 5.—**Effect of soil drainage on root development.**

Artificial drainage can be installed in most of the wet soils, at least in those that lack a firm fragipan. In planning a drainage system, a farm operator needs to consider the cost involved and the kind of drainage needed. It is best to consult a drainage engineer to determine whether artificial drainage is feasible on a particular soil or field.

Practices and structures suggested for conserving water, removing excess water, and controlling erosion are as follows:

Cross-slope tillage.—Tilling the soil across the general direction of the slope, so that the rate of runoff is reduced and more water enters the soil.

Contour stripcropping.—Growing crops in strips on the contour and at right angles to the natural slope of the land. Strips of grass or other close-growing crops alternate with strips of clean-tilled crops. In *graded stripcropping* the strips have a grade of not more than 2 percent and are laid out from a guideline in the center of the strip. Rows and furrows grade to a grassed waterway. Graded strips should be used on soils that are both wet and sloping. They help drain the soil and control erosion.

Diversion terrace.—A shallow channel that is graded or dug and that has a supporting ridge on the lower side. The channel curves around the slope at a gentle gradient; this helps to control erosion, and if the channel is deep enough it intercepts and safely diverts seepage water. The diversion empties the water into a protected waterway or a natural drainageway; from the drainageway the water can be transported without causing excessive erosion.

Field stripcropping.—Alternate strips of different crops grown across the direction of the slope. Field stripcropping is like contour stripcropping, except that it does not follow the contour as closely. Field stripcropping is also similar to cross-slope tillage, except that different kinds of crops are grown in strips.

Open ditches or drains.—Drainageways constructed to remove excess water, generally from very wet soils.

Acidity relationships of the soils

The natural lime content (pH profile) of Tompkins County soils ranges from very low to high. Figure 6 illustrates the relationship of the different lime levels to a depth of 60 inches in four different profiles. The general location in the county of the soils in each of these pH profile groups is shown in figure 7.

High-lime soils are neutral or slightly acid in the upper part and become less acid with depth. They generally have free lime at a depth of 16 to 30 inches. Medium-lime soils are strongly acid to a depth of more than 12 inches, but become less acid with depth. Free lime generally occurs below a depth of 30 or 40 inches. Low-lime soils are strongly acid to a depth of 24 inches but have slightly acid or neutral material below that depth and free lime deep in the substratum. Very low-lime soils are very strongly acid to a depth of more than 24 inches but may have neutral material deep in the substratum, commonly beyond the reach of plant roots.

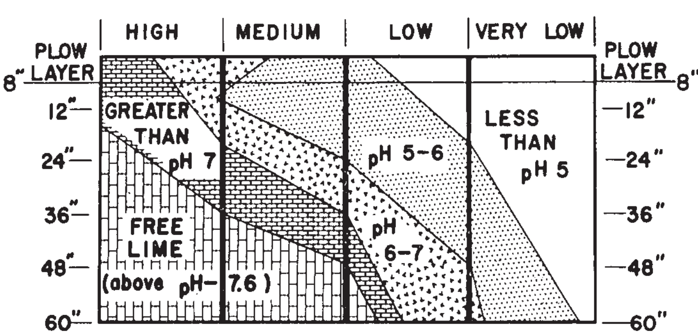

Figure 6.—**Lime level of different soil profiles in Tompkins County.**

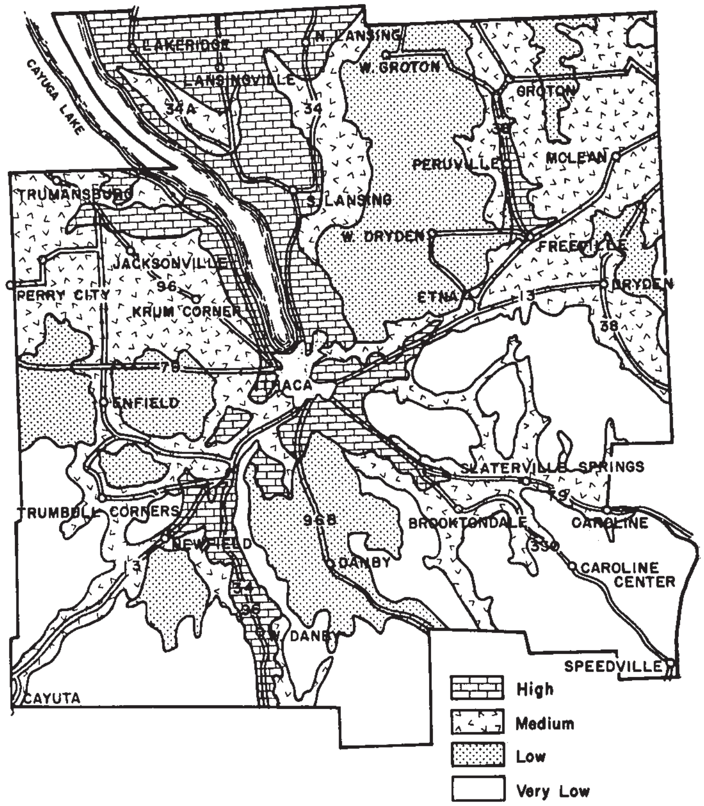

Figure 7.—**Lime content (pH profile) of Tompkins County soils.**

High crop yields can be obtained on high-lime soils with little or no liming. For good crop yields on medium-, low-, and very low-lime soils of equivalent texture and organic-matter content, applications of lime are needed to get a favorable pH in the plowed layer. Despite equivalent pH in the plowed layer, the higher the pH in the subsoil, the higher the crop yields that farmers usually obtain, because crops are able to utilize nutrients and soil moisture from greater depths.

Many soil characteristics that have to be considered in managing a soil, or that affect crop yields, are closely associated with the natural lime content or pH profile of the soil. For example, most low-lime or very low-lime, medium-textured soils that have developed from glacial till have a dense layer called a fragipan, popularly known as a hardpan, in the subsoil. The fragipan tends to restrict the movement of air and water in the soil and to limit root penetration. Soils that have a fragipan close to the surface are highly erodible when row cropped, because during heavy rains the part of the soil profile above the pan becomes saturated with water and any excess water runs off. Diversion terraces are especially effective soil-conservation measures in successful management of fragipan soils. Farm ponds in such soils rarely leak. The distribution of fragipan soils in Tompkins County is shown in figure 8.

Nearly all of the high-lime and medium-lime soils have in the subsoil a clayey layer that has blocky structure. Soils that have a clayey subsoil range from very high to medium in potassium-supplying power (compare figures 8 and 11). Crops root deeply in these soils if drainage is good, and high yields are easily obtained. Tile drainage is effective in moderately well drained to very poorly drained, medium-textured soils that have a blocky structure and a clayey accumulation in the subsoil; open-ditch drainage is more effective in the fine-textured soils.

The amount of lime (ground limestone) that is required to change the pH of the plowed layer of a soil a given amount depends on (1) organic-matter content, (2) texture (amount of clay, silt, and sand), (3) kind of clay (dominantly illite and vermiculite in Tompkins County), (4) depth of plowing, (5) present and desired pH, (6) placement and degree of mixing, and (7) timing of the application. Of these, the organic-matter content and texture have the greatest effect on the amount of lime needed. Because current recommendations for crop production are changed from time to time as the results of additional research become available, the user of this report is referred to the section on liming in the current issue of "Cornell Recommends for Field Crops" and to the current revision of "More Lime On Your Land," Cornell Extension Bulletin Number 822, for specific recommendations. A pH of 5.2 to 5.4 is currently suggested

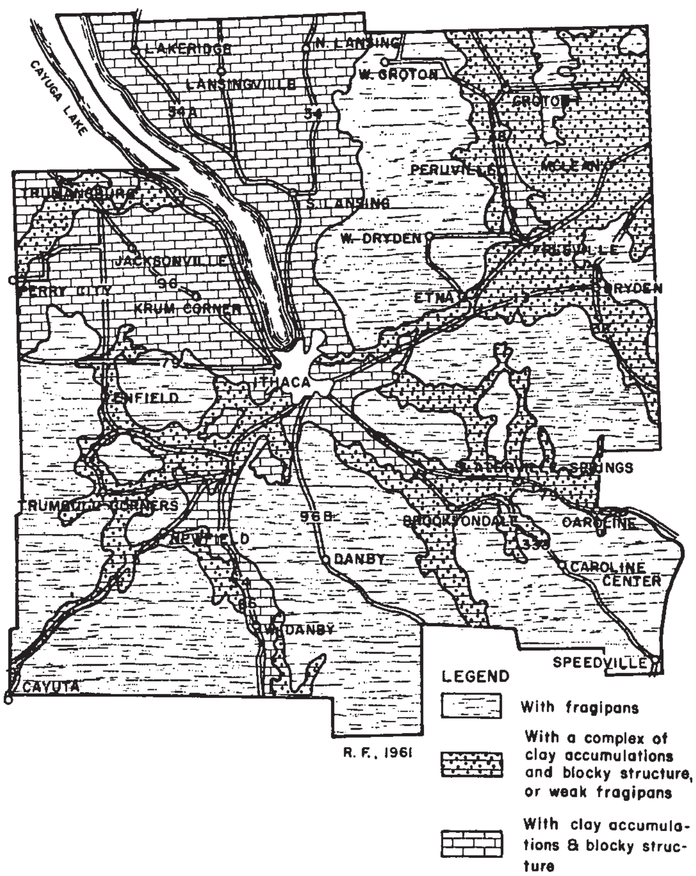

Figure 8.—**Subsoil characteristics of Tompkins County soils.**

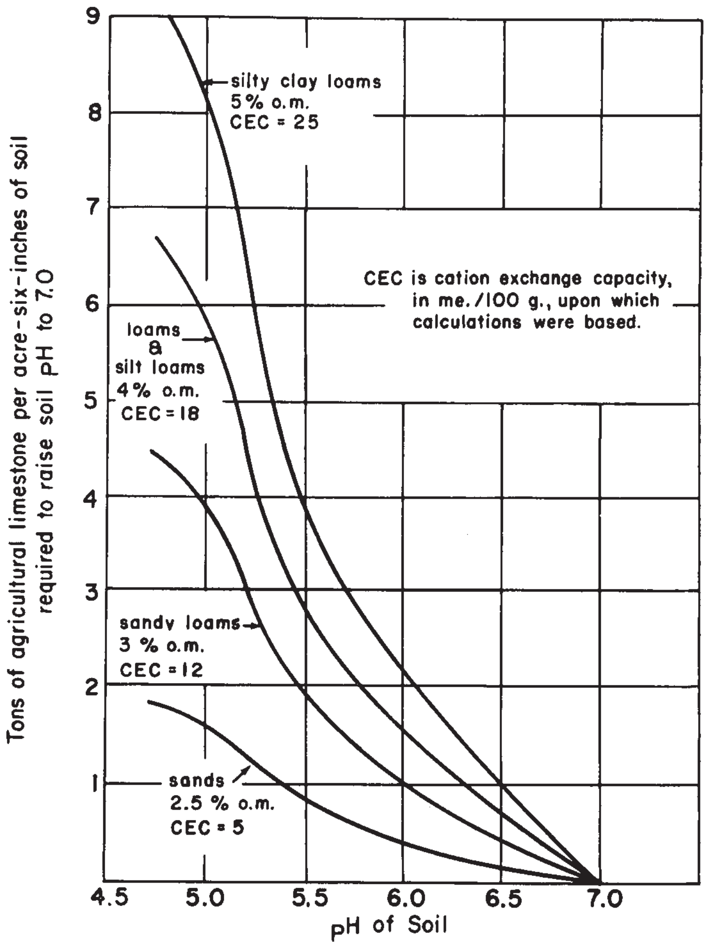

Figure 9.—**Lime requirement vs. soil pH.**

for potatoes; a pH of 6.4 for birdsfoot trefoil; and a pH of 6.8 for alfalfa.

Recent liming research by Peech[5] has resulted in the development of the buffer curves shown in figure 9. These curves show the amount of lime needed to change the pH of the 6-inch plowed layer of a soil from any given pH value to a higher given value. Adjustments in amounts according to thickness of the plowed layer can readily be calculated. Adjustments to allow for differences in organic-matter content are made as follows: For each 1 percent of organic-matter content, add 2 to the cation-exchange capacity for that texture and then read a "projected" curve, which will be adjacent to and essentially parallel with the curve shown for that texture in figure 12. If the percentage of organic-matter content is less than that shown, subtract 2 from the cation-exchange capacity for each 1 percent.

It generally takes at least 2 years, under field conditions in Tompkins County, for most of the lime applied to and well mixed into a soil to react and change the pH.

Because rainfall exceeds evaporation in Tompkins County, lime continually moves downward through the soil profile, and some leaches into the substratum. The

[5] PEECH, M. LIME REQUIREMENT VS. SOIL PH CURVES FOR SOILS OF NEW YORK STATE. 1961. Unpublished. Copy on file at Dept. of Agron., Cornell Univ., Ithaca, N.Y.

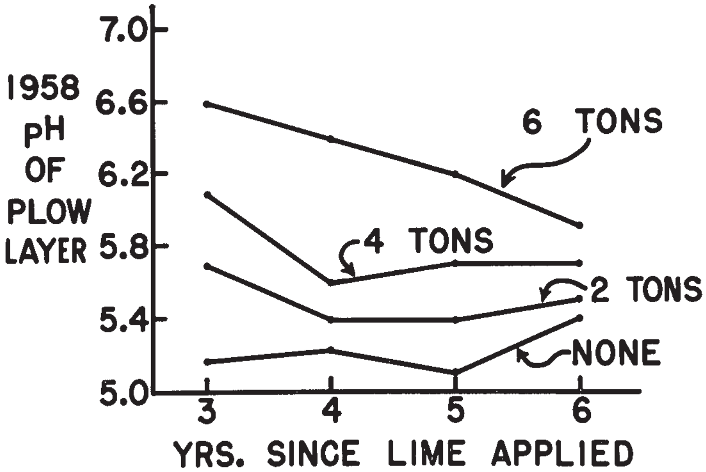

Figure 10.—Effect of lime rate and elapsed time on soil pH.

average rate of downward movement of lime in a silt loam, the most common surface-soil texture in the county, is about one-half inch per year. Soils that support a sod of deep-rooted legumes and grasses are likely to have only slight losses from leaching. The removal of lime by crops is considerable; a ton of legume-grass hay ordinarily removes 50 pounds of lime (calcium carbonate). Therefore, it is to be expected that periodic application of lime, usually once each rotation sequence, will be necessary to maintain the desired pH in the plowed layer. The rate of drop in pH after liming of a 9-inch plowed layer of Mardin channery silt loam on the Mt. Pleasant Agronomy Research Farm in Tompkins County is illustrated in figure 10. The long-term residual effects of lime applied to a nearby area of Mardin channery silt loam on this same farm are shown by the following 4-year average yields of a mixture of widely adapted, deep-rooted legumes and grasses—Narragansett alfalfa, Viking birdsfoot trefoil, and Climax timothy—seeded in 1959 (see table 2). The lime was applied in 1950 to a previous rotation sequence. At the lower pH values, the yield is mainly birdsfoot trefoil and timothy, whereas at the higher pH the yield is predominantly alfalfa and timothy. This is an excellent illustration of the influence of crop characteristics and crop-management factors on the yield obtainable from a soil.

TABLE 2.—*Long-term residual effects of lime applied to Mardin channery silt loam, Mt. Pleasant Research Farm, Tompkins County, 1,700-foot elevation*

Lime applied, 1950	pH of plowed layer, 1961	Average yields per year from two cuts of N-V-C hay,[1] 1960-1963	Increase in yield per year attributable to the residual effects of lime applied in 1950
Tons	*pH*	*Tons*	*Tons*
0	5.2	2.4	0
2	5.5	2.9	0.5
4	5.8	3.5	1.1
6	6.0	3.9	1.5

[1] Mixture of Narragansett alfalfa, Viking birdsfoot trefoil, and Climax timothy.

Table 3 shows the tonnages of lime used in the county in specified years and the acreage limed in comparison to the total acreage used for crops and cropland used for pasture.

TABLE 3.—*Use of lime in specified years*

Year	Tons	Acres limed	Acres of cropland harvested and pastured
1954	11,700	7,800	93,600
1959	20,100	9,700	84,400

A summary of 942 complete soil tests of Tompkins County soils by the Cornell Soil Testing Laboratory in the period 1957–58 is shown in the following tabulation.

pH range	*Percent of 942 samples*
5.5 and below	17
5.6 to 5.9	23
6.0 to 6.4	35
6.5 and above	25

A study made in two counties where the soils and the farming methods are similar to those of Tompkins County showed that the soils tested in Tompkins County are slightly less acid than average.

The effect of low pH was still the major factor limiting efficient crop production on most Tompkins County soils when this report was written.

Nitrogen relationships of the soils

Nitrogen is the most soluble and the most easily leached of the three major plant-nutrient elements. In most Tompkins County soils the plowed layer is 3 to 6 percent organic matter. From 3,000 to 6,000 pounds of nitrogen per acre is contained in this amount of organic matter, but most of it is in complex organic forms unusable by plants. Only a very small amount is in available forms in unfertilized soils at any one time. The activity of soil microbes, if pH is favorable (generally 6.0 to 7.0), and chemical decomposition will release considerable quantities of nitrogen—30 to 100 or more pounds annually during the summer growing season. Additional amounts become available from crop and root residues, animal manures, and commercial fertilizers. The rate of release is most rapid during warm, moist periods, which usually correspond to the periods when most crop plants have a high requirement for available nitrogen. Consequently, on well-managed Tompkins County soils, the need for applied nitrogen fertilizer to supplement nitrogen made available from the soil, from crop residues, and from manure, is greatest during the cool months in spring, when annual crops are small and perennial crops that have high nitrogen requirements, such as grasses, winter grains, and fruit trees, are making maximum growth.

The more acid the plow layer, the less efficient the organic-matter transformation by soil microbes. Tompkins County has large areas of acid soils (see figure 6), and many of the nitrifying bacteria are essentially nonactive in strongly acid soils. Some crops—blueberries and most conifers, for example—require a strongly acid soil. A fungus-nitrogen relationship that is essential to the growth of such crops is adversely affected by liming, and this relationship does not exist in high-lime soils.

Potatoes are grown on strongly acid soils, to reduce the danger of potato scab. The organism that causes scab is abundant in most soils where potatoes are grown continuously or in very short rotations, unless the plowed layer is maintained at pH 5.2 or below. Consequently, large amounts of nitrogen and phosphorus fertilizers have to be added annually to grow high yields of potatoes in Tompkins County.

Plants readily take up nitrogen in available forms and, if large amounts are available, often take more than they require. Consequently, the supply of available nitrogen should be adjusted to each situation.

Heavy rains cause available nitrogen to move downward in the soil. Excessive dryness causes it to move upward and often causes so-called "burning" (dehydration) and death of germinating seeds if nitrogen fertilizer is placed incorrectly in relation to the seed. Large quantities of nitrogen fertilizer placed close to the seed at planting time greatly increase the likelihood of fertilizer "burning." On the other hand, unless there is a growing crop that will utilize the nitrogen, fall applications of nitrogen fertilizers on Tompkins County soils are entirely lost by leaching and volatilization before the next spring. In spring, once tillage is possible, rains heavy enough to leach the entire root zone are rare. Thus, plowing down nitrogen in spring for certain annual crops, such as corn, is highly efficient. In addition, small amounts of nitrogen should be applied at planting time.

Crops vary considerably in their need for and response to nitrogen. Legumes can get all of their nitrogen requirements from the air if the proper symbiotic nitrogen-fixing microbes are actively growing on the legume roots. Successfully inoculated legumes, such as alfalfa or birdsfoot trefoil, can, when grown in combination with grasses, supply enough nitrogen for high yields of both the legumes and the grasses. Orchardgrass is more responsive to nitrogen fertilizer than is smooth brome, timothy, or bluegrass. Spring-sown small grains have a high requirement for nitrogen. If excessive amounts are applied or if the past management of the soil has been conducive to rapid release of available nitrogen, the grains will lodge. Grain varieties differ in this respect because of genetic differences in stem stiffness and height. Corn has a high nitrogen requirement; its greatest need usually coincides with the most rapid rate of release of nitrogen from organic matter, crop residues, and animal manures. Winter grains, such as wheat and barley, have a small need for nitrogen in fall and a large need early in spring, when these crops begin to grow very rapidly and the rate of release from the cold soil is slow. Rapidly growing annual crops that have small root systems, such as many vegetables, require large amounts of available nitrogen.

The efficient utilization of nitrogen as a nutrient element in economic crop production on Tompkins County soils requires recognition of these basic relationships and adjustment of the management used to produce a specific crop on a specific soil.

Current recommendations for nitrogen fertilization and management of crops grown in Tompkins County are contained in the annual revisions of "Cornell Recommends for Field Crops"; in Cornell Miscellaneous Bulletin Number 55, "Fertilizers for Field Crops"; in "Cornell Recommends for Vegetable Crops"; and in Cornell publications on fruit, lawn, tree, and floricultural crops.

Phosphorus relationships of the soils

Phosphorus is the least soluble of the three major nutrients. The plowed layer of Tompkins County soils may contain 1,500 to 2,000 pounds per acre of phosphorus, expressd as the element P.[6] From 25 to 75 percent is in unavailable organic compounds in the soil organic matter. Much of the remainder exists as iron and aluminum phosphates, also unavailable to plants.

Tompkins County soils are naturally low in ability to supply phosphorus, and the addition of appropriate amounts of phosphates in the form of commercial fertilizers is essential for good crop yields. The moderately fine textured and fine textured clayey soils can release more phosphorus annually in forms available to plants than the medium-textured soils. The unfertilized corn-oats-alfalfa-alfalfa rotation in progress since 1911 on a moderately fine textured Collamer-Hudson intergrade soil on the Caldwell Field Research Farm near Ithaca still yields about 2 tons of alfalfa hay per year. This yield is equivalent to a release of approximately 20 to 25 pounds of P_2O_5 (phosphate) per year. The 1954–61 check yields from two separate experiments on medium-textured soils high in potassium-supplying power—Honeoye soils, Lima soils, and tile-drained Kendaia soils—on the Aurora Research Farm in adjoining Cayuga County were about 0.9 ton of alfalfa. This is equivalent to a release of about 10 pounds of P_2O_5 per year. These findings agree closely with findings in Ohio experiments on similar soils.

Liming an acid soil increases the rate of release, or mineralization, of phosphorus from organic forms by encouraging the bacteria whose activity causes the decay of organic matter. Liming an acid soil also tends to convert some of the aluminum and iron phosphates to calcium phosphates, which are somewhat more readily available to crop roots. Crops vary greatly in their ability to utilize phosphates in the soil. Legumes are more effective than the small grains in this respect; oats is more effective than wheat; and corn is especially effective after the seedling stage of growth.

Phosphorus applied in the form of commercial fertilizer is rapidly fixed in unavailable forms. Crops rarely recover more than 20 to 25 percent of it during the year of application, and decreasing percentages are recovered in succeeding years. Band placement of phosphate fertilizer stimulates the early growth of legumes and facilitates recovery of the phosphate. Once past the seedling stage, legumes and corn can recover considerable phosphorus from the soil. On soils that have been fertilized with phosphate for several years, field crops may not respond to more than about 25 pounds of P_2O_5 used as a starter fertilizer, but this starter is essential. On soils that have not previously been fertilized with phosphate, larger amounts may be needed to establish legumes. If pH and moisture are favorable, soil microbes will release considerable phosphorus as a soil warms up during the growing season.

An efficient method of reducing the effects of soil fixation of added phosphates is to add superphosphate to farm manures. The practice of phosphating manure on dairy farms was much more common between 1930 and 1950. Since that time, the emphasis has shifted to mixed fertil-

[6] To convert phosphorus (P) to phosphate (P_2O_5), multiply these values by 2.3; to convert P_2O_5 to P, multiply by 0.43.

izer. Since 1950, new higher yielding crop varieties and the reduced use of phosphate have resulted in low levels of this nutrient in more and more Tompkins County soils. The results of complete soil tests show this trend. Of 942 complete soil tests during 1957–58, 58 percent showed low readings, 21 percent showed medium readings, and 21 percent showed high readings. A skillful farmer who is aware of this condition can, by the use of soil tests and appropriately timed applications of phosphate fertilizer, profitably increase his crop yields.

A summary of 20 years of crop production on medium-textured soils of medium potassium-supplying power—Mardin and Volusia silt loams—in the fertility-level experiment at Mt. Pleasant Research Farm near Ithaca showed that, with a pH of about 6.0, annual additions of 30 pounds of P_2O_5 (phosphate) still resulted in low soil-test readings, whereas annual additions of 60 pounds of P_2O_5 gave slightly higher yields and had built up soil-test readings to high-medium. It is likely that with the use of the new high-yielding varieties of forage crops, greater yield increases would be expected at the 60-pound level.

The average annual amount of P_2O_5 suggested for field-crop rotations, as a supplement to the P_2O_5 supplied by a soil, is about 30 pounds. This is more than is commonly used. For high yields of field crops, however, 40 to 60 pounds of P_2O_5 annually is considered necessary and profitable by skillful farmers. Most agronomic authorities in New York emphasize adequate fertilization for the crop, rather than attempts to build the available phosphorus level of a soil.

Potassium relationships of the soils

Potassium is the third of the three major plant nutrients required in adequate quantities for high yields of crops. The soils of this county generally have a very large total reserve of potassium, most of which is held in the clay (illite or vermiculite) particles. Clayey soils, such as those of the Hudson series, have 40,000 to 50,000 pounds per acre of potassium, expressed as the element K, in the plowed layer. These clayey soils that have a blocky structure and a clayey accumulation in the subsoil generally release, or convert into chemical forms usable by crop plants, approximately 120 pounds of potash, K_2O,[7] annually (see figures 8 and 11). This is enough potash to produce about 3 tons of legume-grass hay if other soil fertility and moisture conditions are satisfactory. Such soils have very high potassium-supplying power.

Medium-textured soils that have a clayey accumulation in the subsoil, such as Honeoye and Lansing soils, have high potassium-supplying power (see figure 11). Such soils can supply approximately 70 to 80 pounds of potash annually to deep-rooted forage legumes, enough for about 2-ton yields of hay. This amount has been confirmed by means of extensive research trials on Honeoye, Lima, and Kendaia soils at the Aurora Research Farm, in adjoining Cayuga County. A Collamer-Hudson intergrade, on which a rotation consisting of corn for grain, oats for grain, alfalfa, alfalfa has been in progress since 1911 at the Caldwell Experimental Field in Ithaca, has never received applications of commercial fertilizers or manure. This soil, which also has a clayey layer in the subsoil and from

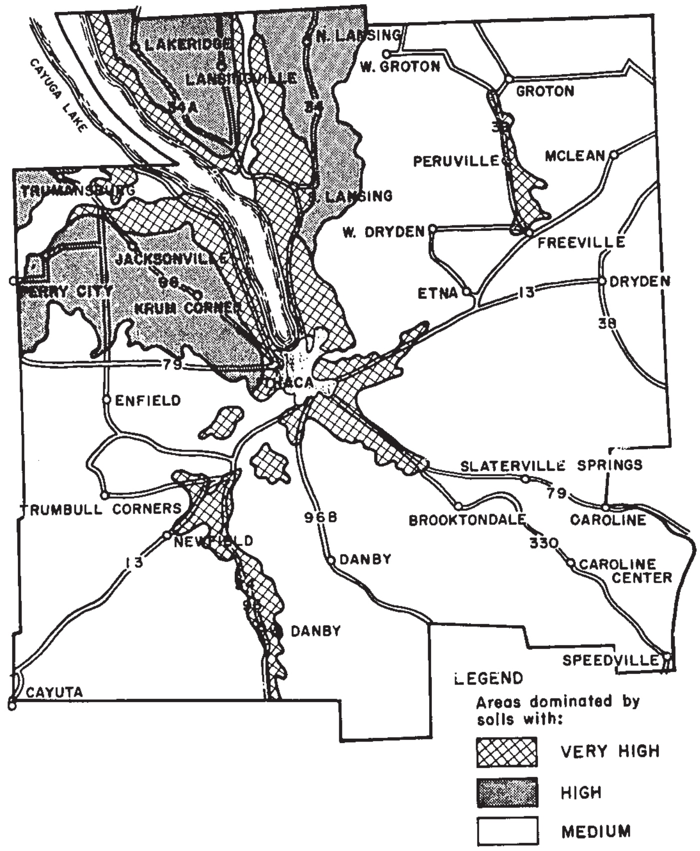

Figure 11.—**Potassium-supplying power of Tompkins County soils.**

which yields of 2 tons of alfalfa have been obtained, has been the basis for the high potassium-supplying rating assigned by Feuer[8] to similar soils.

All of the acid, medium-textured, fragipan soils have medium potassium-supplying power, according to the results of long-time research on Erie soils at the Virgil Research Field in Cortland County, and on Volusia soils at the Allegany County Research Field. Howard and Chenango soils are also in this group. Soils that have medium potassium-supplying power can supply about 50 pounds of potassium per year to deep-rooted legumes, enough for about 1¼-ton yields of legume-grass hay.

The distribution of areas dominated by soils of very high, high, and medium potassium-supplying power in Tompkins County is shown in figure 14. In the section "Descriptions of the Soils," an estimate is given of the potassium-supplying power of each soil series in Tompkins County.

In Tompkins County soils, potassium occurs in many forms: in minerals, and as ions attached to the clay particles; thus, as nonexchangeable, exchangeable, and water-soluble potassium. These forms are, to some extent, slowly convertible in both directions. Potassium in other forms becomes water soluble as crops remove potassium in its water-soluble form and as the soil minerals weather. If large amounts of potassium are added to the soil, the shift in form is from water soluble to nonexchangeable. Liming

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[7] To convert K_2O to K, multiply by 0.83. To convert K to K_2O, multiply by 1.2.

[8] FEUER, R. POTASSIUM SUPPLYING POWER OF NEW YORK SOILS. Dept. of Agron., Cornell Univ., Mimeo. 982. 1956.

an acid soil will result in an initial increase in water-soluble potassium, presumably because of the mass action effect of calcium ions replacing potassium ions from the exchange complex. This increase is followed soon by a fairly large decrease in water-soluble potassium, presumably because, after the lime has reacted with the soil, the potassium ions are held more strongly than the calcium ions in the exchange complex. The practical implication of these conversions is twofold. First, acid soils that are limed tend to hold back the release of native soil potassium, and secondly, the more favorable pH conditions resulting from liming cause yield increases of most crops and removal of greater amounts of potassium from the soil. Both of these conditions increase the need for adequate potassium fertilization of crops grown on acid soils that have been limed.

Crops vary in depth of rooting and in ability to utilize the potassium in the soil. Ladino clover utilizes less than alfalfa or birdsfoot trefoil do. Some of the soils in the county have clayey layers, which contain a large amount of potassium. The roots of ladino clover ordinarily do not penetrate into these clayey layers. A predominance of white spots on leaves of ladino clover, a symptom of acute potassium deficiency, was observed in the early 1940's on the Hudson silt loam of the Caldwell Experimental Field in Tompkins County at the same time that an identically treated adjacent plot of alfalfa was perfectly healthy.[9] A similar observation was made by Feuer in 1959 [10] on two adjacent contour strips of Honeoye silt loam in Ontario County. Ladino clover was growing on one strip, and alfalfa on the other. Both had been unfertilized for 4 years. The leaves of the clover showed symptoms of extreme potassium deficiency: abundant white spots and marginal browning. The leaves of the alfalfa showed no evidence of potassium deficiency. The results of complete soil tests of the plowed layers of each strip showed almost equivalent low readings for potassium. Ladino clover is more likely than alfalfa to take up more potassium than it needs when the supply of potassium in water-soluble and in exchangeable forms is high.

Nonlegumes, especially the vigorous grasses, excel legumes in competing for potassium when there is not enough for both crops. This may account for the thinning out of legumes if applications of potassium are inadequate. Liming acid soils may reduce the tendency for potassium to leach. When first cropped to deep-rooted legumes, a soil may release a somewhat larger amount of potassium for a few years, presumably from the nonexchangeable forms, than it will release in the second or third rotation sequences. All these factors mean that efficient utilization of the potassium released by a given soil in crop production requires a good understanding of soil properties and of soil and crop management.

Deep-rooted legumes have a high requirement for potassium. According to the 1959 census, 14,600 acres, nearly 50 percent of the hay acreage in the county, was in alfalfa or alfalfa-grass mixtures. Farm management studies show that only about 3½ tons of manure is available per crop acre per year on dairy farms in this area (*6*). Ordinarily, this much manure returns only about 25 pounds of potash to the soil. According to the 1959 census, only 1 acre in 12 of the combined acreage of hay land harvested and cropland used only for pasture received any commercial fertilizer. A summary of the results of 942 complete tests of soils on Tompkins County farms, made in 1957 and 1958 at the Cornell Soil Testing laboratory, showed that 70 percent of the soils tested had either low or medium potassium readings. At these available-potassium levels, a yield response can usually be obtained by the use of additional potassium. For specific amounts needed by particular crops on a given soil, the user of this report is referred to the current editions of "Cornell Recommends for Field Crops," "Cornell Recommends for Vegetable Crops," and current soil-test interpretations and recommendations.

Crop adaptation relationships of the soils

The crop information in this section represents the best known to apply to conditions in Tompkins County in the early 1960's. It is to be expected that, as new varieties of more specific germ plasm are developed and results of new research and observation are put into use in the next 5 to 30 years, changes will be advocated. For example, even in the early 1960's generalized statements are still being made that alfalfa is adapted only to well-drained soils. Certain varieties of this crop, however, have been found to be well adapted, under New York conditions, to moderately drained soils and, in combination with specified varieties of birdsfoot trefoil, to be fairly well adapted to the more sloping phases of somewhat poorly drained soils. The choice of an adapted crop variety depends largely on the natural drainage class or the degree of artificial drainage.

The annually revised "Cornell Recommends" publications prepared by the staff of the New York State College of Agriculture at Cornell University are designed to keep New York farmers and those who advise farmers abreast of the latest applicable research findings in soil and crop management. The user of this report is strongly urged to use current editions of these publications.

ADAPTATION OF GRAIN CROPS TO SOIL DRAINAGE.—The adaptation of grain crops to soil drainage is shown in figure 12.

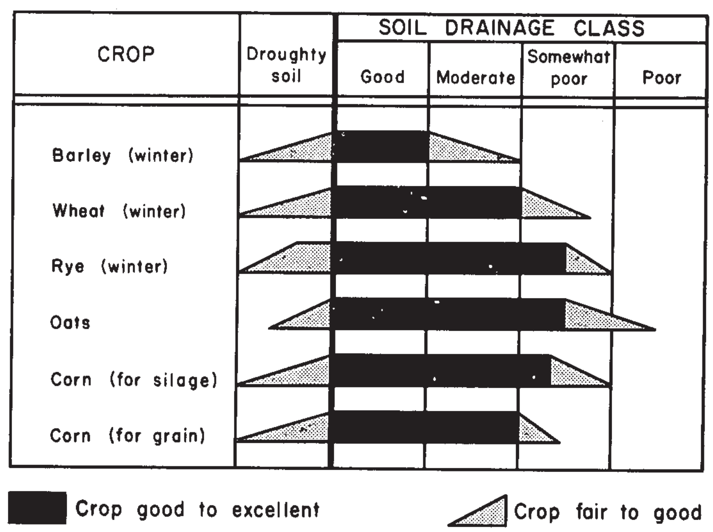

Figure 12.—Adaptation of grain crops to soil drainage.

[9] Personal communication of unpublished research findings by H. A. MACDONALD, Dept. of Agron., Cornell Univ.

[10] Field trip observations made during 1959 in Central Plains County Agricultural Agent Agronomy Training School.

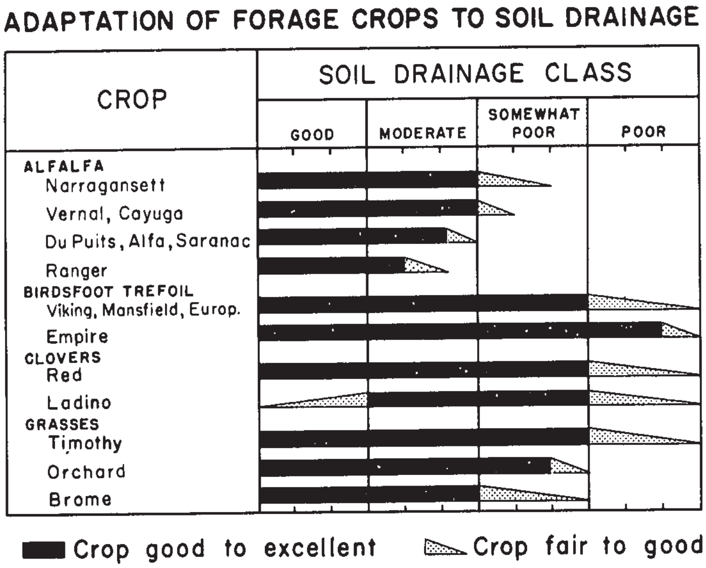

Figure 13.—Adaptation of forage crops to soil drainage.

Spring grains can tolerate somewhat poorly drained soils because these soils have less moisture during spring and summer than during winter. The earliest oat plantings, which result in the highest yields, can be made only on well-drained soils, the second earliest on moderately well drained soils, and later plantings on somewhat poorly drained soils. Fields that have diversion terraces can be planted 1 to 2 weeks earlier in spring than unterraced fields.

Of the fall-planted grains, barley is the one most sensitive to soil moisture. High yields of winter barley are possible only on well-drained soils. Winter wheat will tolerate more moisture, especially if planted early in fall.

For somewhat poorly drained soils, farmers should select shorter season varieties of field corn than are normally recommended for a specific elevation. In many years such fields are too wet in fall for machine harvesting of grain corn. Ryegrass or some other cover crop in the corn improves traction for machinery in fall, besides protecting the soil.

Adaptation of Forage Crops to Soil Drainage.—Good yields of forage crops depend not only on good liming and fertilization practices but also to a great extent upon adjusting choices of the varieties of grasses and legumes to the drainage of the soils on which they are to be grown. Figure 13 shows some varieties of grasses and legumes and the drainage conditions to which they are suited. Specific information related to the drainage class of each kind of soil in Tompkins County can be found in the section "Descriptions of the Soils."

Capability Groups of Soils [11]

The capability classification is a grouping of soils that shows, in a general way, how suitable the soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In Class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be as many as four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country, indicates 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 or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it are subject to little or no erosion hazard but have other limitations that limit their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils 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 identified by numbers assigned locally, for example, IIe-1 or IIIe-2.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible but unlikely major reclamation projects.

The eight classes in the capability system, and the subclasses and units in this county, are described in the list that follows.

Class I. Soils that have few limitations that restrict their use.

- Unit I-1. Deep, nearly level or very gently undulating, well-drained, loamy soils on uplands or outwash terraces.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

- Subclass IIe. Soils subject to moderate erosion if they are not protected.
  - Unit IIe-1. Deep, gently sloping, well-drained, loamy soils; slightly acid or neutral subsoil.
  - Unit IIe-2. Deep, nearly level and gently sloping, well-drained, acid, gravelly loam soils on alluvial fans.
  - Unit IIe-3. Deep, gently sloping, well-drained, acid, sandy soils.

[11] This section prepared by George C. Moore, conservation agronomist, Howard H. Wilson, soil conservationist, and Donald F. Flora, soil scientist, Soil Conservation Service.

Unit IIe-4. Deep, gently sloping, moderately well drained, acid, loamy soils; well-expressed fragipan.

Unit IIe-5. Deep, gently sloping, moderately well drained, loamy soils in gravelly material.

Unit IIe-6. Deep, gently sloping, moderately well drained soils high in silt and very fine sand; weak fragipan.

Unit IIe-7. Deep, gently sloping, moderately well drained, loamy soils; loamy to clayey subsoil; high and medium in lime content.

Unit IIe-8. Deep, gently sloping, moderately well drained to well drained, loamy soils; clayey subsoil.

Subclass IIw. Soils that have moderate limitations because of excess water.

Unit IIw-1. Deep, nearly level, moderately well drained, loamy soils formed in gravelly till or outwash material; compact, silty or loamy to clayey subsoil.

Unit IIw-2. Deep, nearly level, well-drained soils on bottom lands; occasional damaging overflow.

Unit IIw-3. Deep, nearly level, moderately well drained or well drained soils on bottom lands; occasional damaging overflow.

Class III. Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.

Unit IIIe-1. Deep, moderately sloping, well drained, loamy soils; loamy to clayey subsoil.

Unit IIIe-2. Deep, gently sloping, well-drained, eroded, loamy soils; loamy to clayey subsoil.

Unit IIIe-3. Deep and moderately deep, moderately sloping and gently sloping, well-drained, acid, loamy soils.

Unit IIIe-4. Deep, moderately sloping, well-drained gravelly loam soils on outwash terraces.

Unit IIIe-5. Deep, moderately sloping, well-drained, acid, fine sandy soils.

Unit IIIe-6. Deep, moderately sloping, moderately well drained, acid, loamy soils; well-expressed fragipan.

Unit IIIe-7. Deep, gently sloping, moderately well drained, eroded, acid, loamy soils; well-expressed fragipan.

Unit IIIe-8. Deep, gently sloping, moderately well drained, loamy, eroded soils.

Unit IIIe-9. Moderately deep, moderately sloping, somewhat poorly drained to moderately well drained soils.

Unit IIIe-10. Deep, gently sloping, moderately well drained, eroded, clayey soils.

Unit IIIe-11. Deep, moderately sloping, somewhat poorly drained silt loams; strongly expressed fragipan.

Subclass IIIw. Soils that have severe limitations because of excess water.

Unit IIIw-1. Deep, nearly level to gently sloping, somewhat poorly drained, loamy soils in gravelly material.

Unit IIIw-2. Deep, gently sloping, somewhat poorly drained, silty soils; slightly clayey subsoil.

Unit IIIw-3. Deep and moderately deep, nearly level, somewhat poorly drained, loamy soils; clayey subsoil.

Unit IIIw-4. Deep and moderately deep, gently sloping, poorly drained, loamy soils; clayey subsoil.

Unit IIIw-5. Deep, nearly level, poorly drained or very poorly drained, loamy soils in silty, sandy, and gravelly material.

Unit IIIw-6. Deep, gently sloping, somewhat poorly drained, loamy soils; strongly expressed fragipan.

Unit IIIw-7. Deep, gently sloping, somewhat poorly drained, loamy soils in limy glacial till.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.

Unit IVe-1. Deep, moderately sloping, well-drained, eroded, loamy soils; clayey subsoil.

Unit IVe-2. Deep or moderately deep, moderately steep, well-drained, loamy, acid soils.

Unit IVe-3. Deep or moderately deep, well-drained, moderately sloping, loamy, eroded, acid soils.

Unit IVe-4. Deep, moderately steep, moderately well drained, loamy soils; well-expressed fragipan.

Unit IVe-5. Deep, moderately sloping, moderately well drained, eroded soils; well-expressed fragipan.

Unit IVe-6. Deep, moderately sloping, somewhat poorly drained, eroded, clayey soils.

Unit IVe-7. Deep, moderately sloping and eroded or moderately steep, well drained to moderately well drained, eroded, clayey soils.

Unit IVe-8. Deep, rolling or moderately steep, well-drained to excessively drained, loamy soils formed in gravelly material.

Unit IVe-9. Deep, moderately steep, somewhat poorly drained, loamy soils; well-expressed fragipan.

Unit IVe-10. Deep, moderately sloping, somewhat poorly drained, eroded, loamy soils; well-expressed fragipan.

Unit IVe-11. Deep, gently sloping, somewhat poorly drained, eroded, loamy soils; well-expressed fragipan.

Subclass IVw. Soils that have very severe limitations for cultivation because of excess water.

Unit IVw-1. Deep, nearly level, poorly drained or very poorly drained, clayey soils.

Unit IVw-2. Deep, gently sloping, poorly drained, clayey soils.

Unit IVw-3. Deep, nearly level or gently sloping, somewhat poorly drained, poorly drained, or very poorly drained, loamy soils.

Unit IVw–4. Nearly level or gently sloping, poorly drained or somewhat poorly drained soils; shallow to moderately deep over bedrock.

Unit IVw–5. Deep, nearly level, somewhat poorly drained to very poorly drained soils on bottom lands; subject to damaging overflow.

Class V. Soils that are not likely to erode but have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture, woodland, or wildlife food and cover.

Subclass Vw. Soils too wet for cultivation; drainage or protection from flooding not feasible.

Unit Vw–1. Alluvial land frequently flooded; excessively drained to poorly drained soils on bottom lands.

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture, woodland, or wildlife food and cover.

Subclass VIe. Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.

Unit VIe–1. Deep and moderately deep, steep, well-drained soils.

Subclass VIs. Soils generally unsuitable for cultivation and limited for other uses by moisture capacity, depth to bedrock, or other features.

Unit VIs–1. Nearly level to steep, excessively drained to poorly drained, shallow soils.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation and that restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIe. Soils very severely limited, chiefly by risk of erosion if protective cover is not maintained.

Unit VIIe–1. Very steep, deep, excessively drained to well-drained soils in till or gravel.

Subclass VIIw. Soils very severely limited by excess water.

Unit VIIw–1. Very poorly drained, nearly level, organic soils.

Subclass VIIs. Soils very severely limited by low moisture-holding capacity, stones, or other soil features.

Unit VIIs–1. Moderately deep to shallow, well-drained, very steep, droughty, ledgy soils.

Class VIII. Soils and landforms that have limitations that preclude their use, without major reclamation, for commercial production of plants and that restrict their use to recreation, wildlife, or esthetic purposes.

Subclass VIIIw. Extremely wet or marshy land.

Unit VIIIw–1. Fresh water marsh.

Subclass VIIIs. Rock or soil materials that have little potential for production of vegetation.

Unit VIIIs–1. Rock outcrop.

Class I. Soils that have few limitations that restrict their use

UNIT I–1

The soils of this unit are deep, well drained, and nearly level or gently undulating. All but Palmyra soils are slightly acid to medium acid in the subsoil. These soils are on the uplands or on glacial outwash terraces. They are—

Bath channery silt loam, 2 to 5 percent slopes.
Chenango gravelly loam, 0 to 5 percent slopes.
Howard gravelly loam, 0 to 5 percent slopes.
Lansing gravelly silt loam, 0 to 3 percent slopes.
Palmyra gravelly loam, 0 to 5 percent slopes.

Palmyra soils have a slightly acid and neutral subsoil and free lime at a depth of 15 to 30 inches.

These are the most productive soils in the county. They are easy to work, and they respond well to good management. They are moderate to high in capacity to hold moisture and in ability to supply plant nutrients.

Use and management.—The soils in this unit are suited to all crops grown in the county, but deep-rooted crops are generally preferred because they are less susceptible to damage from drought. Yields may not be affected seriously by drought, however, for these soils can be tilled earlier in spring than many other soils.

Generally, these soils are more valuable for rotation crops than for permanent pasture. Many kinds of forage crops are grown, the kind depending on the intended use and management of the crops, the lime and fertility levels, and the length of time the soils are to be kept in sod. These soils lend themselves well to early spring field grazing. The following are suitable cropping systems and supporting practices.

Suitable cropping systems: [1]	*Supporting practices*
Rc–Rc–Rc; R–C–S; R–C–S–S–S; R–R–C–S–S–S.	Cover crop; minimum tillage; residue management; cross-slope tillage on 4- to 5-percent slopes.
C–S–S–S; S–S–S–S	None needed.

[1] Rc=row crop followed by cover crop; R=row crop; C=close-growing crop; S=sod-forming crop.

Liming and fertilizing according to soil tests and desired yields, minimum tillage of row crops, and good forage management are needed. Good management of sod crops is especially important for stands of more than 1 year's duration. Residue management is of vital importance in cropping systems that include few or no sod crops.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices

SUBCLASS IIe. SOILS SUBJECT TO MODERATE EROSION IF THEY ARE NOT PROTECTED

UNIT IIe–1

The soils of this unit are deep, well drained, and slightly acid or neutral in the subsoil. They are—

Honeoye gravelly silt loam, 2 to 8 percent slopes.
Lansing gravelly silt loam, 3 to 8 percent slopes.

The Honeoye soil has free lime at a depth of 16 to 30 inches, and the Lansing soil, at a depth of 30 to 42 inches.

These are among the best agricultural soils in the county. They are easy to work, and they respond well to good management. Their capacity to hold moisture is good, and their ability to supply plant nutrients is high

***Figure 14.*—Planting corn on the contour on a soil of subclass IIe. Soils of this subclass are subject to moderate erosion.**

to medium. Runoff is moderate; consequently, measures are needed to conserve moisture and control erosion (fig. 14).

Use and management.—The soils in this unit are suited to all crops grown in the county, except potatoes. Potatoes are susceptible to scab damage because of high pH in the tuber zone.

Many kinds of forage crops are grown. Generally, the high-yielding crops are selected. They allow a wide diversity both in management and in the length of time the soils may be kept in highly productive sod. Field grazing can be started almost as early as on the soils of capability unit I-1. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
R-R-C-S-S; R-C-S; R-C-S-S.	Contour tillage; minimum tillage.
400-foot slope—	
R-R-C-S-S; R-R-C-C-S-S; R-R-C-C-S-S-S.	Contour stripcropping; minimum tillage; contour cultivation.
600-foot slope—	
R-R-C-S-S; R-R-C-C-S-S; R-R-C-C-S-S-S.	Contour stripcropping; minimum tillage; diversions spaced about 400 feet apart if outlets are adequate and possible leakage is taken care of by tile.
C-S-S-S; S-S-S-S	None needed.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

These soils should be limed and fertilized according to soil tests and past experience and at a sufficiently high level to produce a profitable yield. Even though the subsoil has a high content of lime, the surface soil may be acid enough to make liming necessary. Practices to preserve soil structure are necessary if no sod-forming crop is included in the rotation.

UNIT IIe-2

Chenango gravelly loam, fan, 0 to 8 percent slopes, is the only soil in this unit. It is a deep, well-drained, acid soil on old alluvial fans.

This soil is easy to work, and it responds well to good management. Moisture capacity is generally moderate. The ability to supply plant nutrients is fair to good. The hazard of erosion is slight on the more sloping parts. Measures to conserve moisture are desirable. Good yields of most crops grown in the county can be obtained.

Use and management.—The soil in this unit is suited to most of the crops grown in the county. The most common are corn for silage and grain, oats, and grass-legume forage crops. Deep-rooted legumes are preferred because the moisture-holding capacity is only moderate. The forage mixture used varies according to the intended use and management of the crop, the lime and fertility levels, and the length of time the soils are to remain in sod. Field grazing can be started early in spring. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
Rc-Rc	Cross-slope cultivation.
400-foot slope—	
R-Csl; R-C-S	Contour cultivation.
600-foot slope—	
R-C-S-S	Contour stripcropping on 6 to 8 percent slopes.
C-S-S-S; S-S-S-S	None needed.

[1] Rc=row crop followed by cover crop; R=row crop; C=close-growing crop; S=sod-forming crop; Csl=close-growing crop seeded with legume.

Liming is generally necessary, and fertilizing should be profitable.

UNIT IIe-3

The one soil in this unit, Arkport fine sandy loam, 2 to 6 percent slopes, is deep and well drained. The surface soil is acid. The lime content generally increases with depth.

This soil is among the more productive in the county. It is easy to work, and it responds well to good management. Its ability to retain and supply applied plant nutrients and its capacity to store moisture are fair to good. The hazard of erosion is slight to moderate. Measures to conserve moisture are desirable.

Use and management.—This soil is especially useful if tillage early in spring is a factor. It is well suited to corn, oats, wheat, dry beans, potatoes, and forage crops. Deep-rooted forage crops are preferred because of the drought hazard. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
Rc-R-C-S; R-C-S; R-C-S-S.	Contour cultivation.
400-foot slope—	
Rc-R-C-S-S; R-C-C-S-S	Contour cultivation.
600-foot slope—	
Rc-Csl; R-C-S; R-C-S-S	Contour stripcropping.
C-S-S-S; S-S-S-S	None needed.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; Csl=close-growing crop seeded with legume; S=sod-forming crop.

Applications of nitrogen and potash are usually needed more than once during each growing season. Cover crops should be especially useful in reducing leaching and erosion after harvest.

UNIT IIe–4

This unit consists of deep, moderately well drained, acid soils that have a well-expressed fragipan at a depth of 15 to 24 inches. These soils are—

Langford channery silt loam, 2 to 8 percent slopes.
Mardin channery silt loam, 2 to 8 percent slopes.

The pan in the Mardin soils is acid, and that in the Langford soils is slightly acid or neutral.

If well managed, these soils are productive. The fragipan causes slight wetness, which may delay planting in spring. It also results in moderate moisture capacity and restricts the zone of nutrient availability. The hazard of erosion is moderate, so measures to conserve soil and moisture are needed.

Use and management.—If adequately limed, these soils are productive of most crops. They are used most extensively for livestock feed crops. A fairly short growing season justifies the use of early maturing varieties of corn. Because of the firm fragipan, these soils are suited to deep-rooted legumes only in mixture with shallow-rooted types. Yields of forage crops generally are higher in rotational pasture than in field-grazed permanent pasture. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
Rc–R–C–S–S; R–C–S–S	Contour cultivation.
400-foot slope—	
Rc–R–C–S–S–S–S; R–C–S–S–S.	Contour cultivation.
R–C–S–S; R–C–S–S–S	Contour stripcropping.
600-foot slope—	
R–C–S–S; R–C–S–S–S	Contour stripcropping; diversions spaced about 400 feet apart, with tile to take care of any leakage.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Spot drainage may be needed to eliminate local wet areas. A most important measure is to meet the lime requirement. Minimum tillage and the return of crop residues to the soils should aid in increasing infiltration. Special effort is needed to encourage infiltration during the growing season because rain often falls faster than the soils can absorb it.

UNIT IIe–5

The one soil in this unit, Phelps gravelly silt loam, 3 to 8 percent slopes, is deep and moderately well drained. Reaction in the surface soil ranges from medium acid to slightly acid. The lime content increases with depth.

If properly managed, this soil is highly productive. It is easy to work. Its capacity to store moisture and its ability to retain and supply plant nutrients are very good. Its moderate drainage results mainly from a seasonal high water table. Slight wetness may somewhat delay planting in spring. The sloping areas are moderately erodible, so measures to conserve soil and moisture are desirable.

Use and management.—This soil is suited to all crops grown in the county. All high-yielding varieties respond well to good management. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
Rc–R–C–S–S; R–C–S–S	Contour cultivation.
400-foot slope—	
Rc–R–C–S–S–S–S; R–S–S–S.	Contour cultivation.
R–C–S–S; R–C–S–S–S	Contour stripcropping.
600-foot slope—	
R–C–S–S; R–C–S–S–S	Contour stripcropping; diversions spaced 400 feet apart.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Measures to conserve moisture and to control erosion are important. Spot drainage to take care of wet spots may be desirable. Liming and fertilizing according to soil tests are generally profitable. Minimum tillage and crop-residue management are important in maintaining soil structure and good infiltration rates.

UNIT IIe–6

The one soil in this unit, Williamson very fine sandy loam, 2 to 6 percent slopes, is deep, moderately well drained, and acid. It has a high content of silt and very fine sand, which gives it a "floury" texture. Its moderate drainage results from a weak fragipan at a depth of 16 to 24 inches, or from a high water table, or from both.

If properly managed, this soil is highly productive. It is easy to work, but it tends to crust and to form plowpans easily. Its capacity to store moisture is good. Its ability to retain and supply applied plant nutrients is very good. It is highly erodible, however, even on gentle slopes, so measures are needed to conserve soil and moisture.

Use and management.—This soil is suited to all crops commonly grown in the county, if acidity is corrected. Yields of intertilled crops are most dependable if the drainage limitations have been removed. If they are not, forage legumes tolerant of moderate wetness for short periods should be selected. Wetness may delay planting of oats and may thus decrease yields. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
Rc–Rc–C–S–S	Contour tillage.
400-foot slope—	
Rc–C–S–S–S	Contour tillage.
Rc–C–S–S	Contour stripcropping.
600-foot slope—	
Rc–C–S–S	Contour stripcropping.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Because of the serious erosion hazard, all of the cropping systems should include sod-forming crops, though, theoretically, continuous row crops should be satisfactory in the more nearly level areas. If intensive use is planned, drainage is desirable. Cross-slope tillage should be practiced in preference to tillage up and down hill. Special effort should be made to grow cover crops and return all crop residues. Minimum tillage should be used to help combat compaction and crusting and to increase infiltration of moisture during the growing season.

UNIT IIe–7

This unit consists of deep, moderately well drained soils that have a loamy to clayey subsoil. The surface soil is acid to slightly acid. The lime content increases with depth. Free lime may occur at a depth of between 16 and 42 inches. These soils are—

Conesus gravelly silt loam, 3 to 8 percent slopes.
Lima silt loam, 3 to 8 percent slopes.

If properly managed these soils are highly productive. They are easy to work, although planting may be delayed briefly in spring because of slight wetness. Their capacity to hold moisture is high. These soils are moderately erodible; thus, measures to conserve soil and water are needed.

Use and management.—The soils in this unit are suited to all of the crops grown in the county. All high-yielding varieties respond well to good management. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
Rc–R–C–S–S; R–C–C–S	Contour tillage.
400-foot slope—	
R–C–S; Rc–R–S–S–S–S	Contour tillage.
Rc–Csl; Rc–R–C–S–S; R–C–S–S–S.	Contour Stripcropping.
600-foot slope—	
Rc–Csl; R–C–S–S	Contour stripcropping; diversions spaced about 400 feet apart, with tile to take care of leakage.
C–S–S–S; S–S–S–S	None needed.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; Csl=close-growing crop seeded with legume; S=sod-forming crop.

Diversions for surface drainage, with tile to take care of any leakage, and tile for spot drainage are desirable. Minimum tillage is advisable, and fertilization according to soil tests, past history, and the desired crop yields should be profitable. Special attention should be given to maintenance of soil structure, unless sod-forming crops are included in the cropping system. High-residue crops and winter cover crops are necessary for erosion control.

UNIT IIe–8

This unit is made up of deep, moderately well drained to well drained soils that have a clayey subsoil. The surface soil is acid to slightly acid. The lime content increases with depth. These soils are—

Hudson silty clay loam, 2 to 6 percent slopes.
Hudson-Cayuga silt loams, 2 to 6 percent slopes.
Hudson and Collamer silt loams, 2 to 6 percent slopes.

If properly managed, these soils are highly productive. The clayey subsoil restricts water movement and results in slight wetness, which may delay planting briefly in spring. These soils are highly susceptible to erosion if they are left bare, so measures to conserve soil and water are needed. Good soil structure is difficult to maintain.

Use and management.—These soils are suited to most crops grown in the county, but they tend to crust or form clods when cultivated; therefore, sod crops that last for several years should be grown. Forage crops respond well to good management. Field grazing may be delayed slightly longer than on gravelly soils. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
Rc–R–C–S–S–S–S	Contour tillage.
400-foot slope—	
Rc–R–C–S–S–S–S–S	Contour tillage.
R–C–S–S	Contour stripcropping.
600-foot slope—	
Rc–R–C–S–S–S; R–C–S–S.	Contour stripcropping; diversions spaced 400 feet apart.
C–S–S–S; S–S–S–S	None needed.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Minimum tillage is highly desirable because it helps to maintain good structure and improve infiltration. Because of the erodibility of these soils, a winter cover crop should be planted after the first row crop, if two or more row crops are used in the cropping system. Preferably, a cover crop should be planted after every row crop if the cover crop does not volunteer in the following grain crop. The possibility of more than 1 year of a row crop is shown in the suggested cropping system, but generally it is better to include only one row crop, at least on slopes of nearly 6 percent. These soils are highly erodible if plowed more than 1 year after a sod crop or a cover crop has been grown. Close attention should be given residue management, which helps to form good soil structure.

SUBCLASS IIw. SOILS THAT HAVE MODERATE LIMITATIONS BECAUSE OF EXCESS WATER

UNIT IIw–1

The soils in this unit are deep and moderately well drained. They are—

Braceville gravelly silt loam, 0 to 5 percent slopes.
Conesus gravelly silt loam, 0 to 3 percent slopes.
Lima silt loam, 0 to 3 percent slopes.
Phelps gravelly silt loam, 0 to 3 percent slopes.

Phelps, Lima, and Conesus soils have a loamy to clayey subsoil, and Braceville soils have a weak fragipan at a depth of 15 to 26 inches. Either may cause the drainage to be only moderately good; or the moderately good drainage may result entirely from a high water table. Braceville soils are acid throughout. Phelps, Conesus, and Lima soils are acid to slightly acid in the surface soil. The lime content increases with depth.

Though slight wetness may delay planting briefly in spring, these soils are easy to work. Their capacity to store moisture and their ability to retain and supply plant nutrients is excellent. They respond very well to good management.

Use and management.—Most of the crops commonly grown in the county grow well on these soils. Forage mixtures suitable for well-drained soils do well if the necessary drainage has been provided. If drainage is not adequate, legumes in the forage mixture for hay or pasture should be tolerant of some wetness. Oats do well on these soils but may yield less than on well-drained soils because of a delay in planting, required by wetness. A suitable cropping system consists of continuous row crops, each followed by a cover crop. Drainage is the most important supporting practice but depends upon the outlets available.

The high potential productivity of these soils generally justifies intensive management, including ample use of lime and fertilizers. In suggesting a rotation of continuous row crops, it is presumed that an excellent cover crop will be grown after each row crop and that all crop residues will be returned. A rotation that includes a sod crop every 4 to 5 years would help to restore structure. Minimum tillage is important. On the 3- to 5-percent slopes, cross-slope tillage is needed to conserve water.

UNIT IIw-2

The one soil in this unit, Genesee silt loam, is deep and well drained. It is on bottom lands and occasionally receives damaging overflow. It is slightly acid or neutral and may have free lime in the lower part.

If properly managed, this soil is one of the most productive in the county. It has excellent moisture-holding capacity and good ability to retain and furnish plant nutrients.

Use and management.—This soil is suited to all crops grown in the county. Generally, it is more valuable for intertilled crops than for pasture. The good drainage and the high lime content, however, favor the growth of deep-rooted legumes, alone or mixed with grass. A suitable cropping system consists of continuous row crops, each followed by a cover crop. Streambank protection and channel improvement are important supporting practices. Occasionally, diking to prevent overflow may be helpful.

Depending upon the hazard of overflow damage, this soil can be used for a wide variety of crops ranging from continuous row crops to continuous hay. A high level of fertilization is generally justifiable.

UNIT IIw-3

This unit consists of deep, moderately well drained or well drained soils on bottom lands. These soils occasionally receive damaging overflow. They are—

Eel silt loam.
Middlebury and Tioga silt loams.

The moderately well drained Eel silt loam is slightly acid or neutral in the surface soil and may have free lime in the lower part. The well drained Tioga soils and the moderately well drained Middlebury soils are acid throughout.

These soils respond well to good management and are among the most productive in the county. Though planting on the moderately well drained soils may be delayed briefly in spring, these soils are easy to work. Their capacity to store moisture and their ability to retain and furnish plant nutrients are good to excellent.

Use and management.—These soils are suited to all crops grown in the county, except those that will not tolerate short periods of wetness. They are well suited to pasture and meadow, even where they are not drained or protected from overflow. They are the most productive soils on many farms, and for agricultural purposes they may be extremely important in areas where the upland soils are less productive.

Legumes used in forage mixtures on Eel and Middlebury soils should be somewhat tolerant of wetness. Corn for grain or silage grows well. Oats also grow well, but yields are not so high as on better drained soils. A suitable cropping system consists of continuous row crops, each followed by a cover crop. Streambank protection and channel improvement are important supporting practices. Diking to prevent overflow is needed in some places. Liming and fertilizing according to soil tests, past use, and expected yields should be highly profitable.

Class III. Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both

SUBCLASS IIIe. SOILS SUBJECT TO SEVERE EROSION IF THEY ARE CULTIVATED AND NOT PROTECTED

UNIT IIIe-1

This unit is made up of deep, well-drained soils that have a loamy to clayey subsoil. The surface soil is acid to slightly acid. The lime content increases with depth. These soils are—

Honeoye gravelly silt loam, 8 to 15 percent slopes.
Lansing gravelly silt loam, 8 to 15 percent slopes.

Slope restricts the use of these soils somewhat, but with good management good to excellent production can be expected. These soils are moderately erodible. Their capacity to store moisture is good, but surface runoff is such that measures to conserve both soil and moisture are needed. Their ability to retain and supply plant nutrients is good.

Use and management.—The soils in this unit are suited to the same crops as those in capability unit IIe-1; namely, all crops grown in the county except potatoes, which are susceptible to scab damage. A wide diversity of forage crops is possible, if long-term sod crops are included. Generally, the highest yielding kinds and varieties are selected. Field grazing can be started almost as early as on the gravelly soils in capability unit IIIe-4. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
R-C-S-S	Contour cultivation; minimum tillage.
400-foot slope—	
R-C-S-S-S	Contour cultivation; minimum tillage.
Rc-R-C-S-S	Contour stripcropping; minimum tillage.

See footnote at end of table.

600-foot slope— *Supporting practices*
Rc–R–C–C–S–S ---------- Contour stripcropping; minimum tillage; diversions about 400 feet apart and tile to take care of any leakage.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Measures to control runoff and erosion and to maintain soil structure are of prime importance because they increase infiltration of rainfall during the growing season when additional moisture is needed for high yields. Minimum tillage is important, and also good crop-residue management. Ample use of fertilizer helps to ensure high yields and large amounts of residue. Good stands of row crops are especially important because they give canopy protection and thus help to conserve water-stable aggregates. These aggregates break down rapidly if the cropping system includes more than one row crop.

UNIT IIIe–2

The one soil in this unit, Lansing gravelly silt loam, 3 to 8 percent slopes, eroded, is deep and well drained. Past erosion has depleted the organic-matter content and in places has exposed a clayey layer that is medium to slightly acid. The lime content increases with depth.

If good management, including use of soil-building rotations, is practiced, this soil is fairly productive. Its capacity to store moisture is fair to good. Its ability to retain and furnish applied plant nutrients is good. Past erosion has decreased the infiltration rate and thus increased runoff. Rills and gullies make control of runoff and erosion difficult.

Use and management.—This soil is suited to all crops grown in the county. High-yielding, deep-rooted legumes seeded with compatible grasses do well. Corn for silage and grain does fairly well. This soil is well suited to field grazing. The following are suitable cropping systems and supporting practices (fig. 15.)

Suitable cropping systems
according to length of slope:[1]
200-foot slope— *Supporting practices*
R–C–S–S ---------------- Cross-slope and minimum tillage.
400-foot slope—
R–C–S–S ---------------- Contour and minimum tillage.
R–C–S–S ---------------- Contour stripcropping and minimum tillage.
600-foot slope—
R–C–S–S–S -------------- Contour stripcropping and minimum tillage.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Because of past erosion, the increased erodibility of the remaining soil, and the decreased organic-matter content, any cropping system should include a sod-forming crop for control of erosion and restoration of soil structure. Full stands are important because they provide canopy protection. Minimum tillage helps to increase infiltration.

This soil needs more fertilizer and more intensive man-

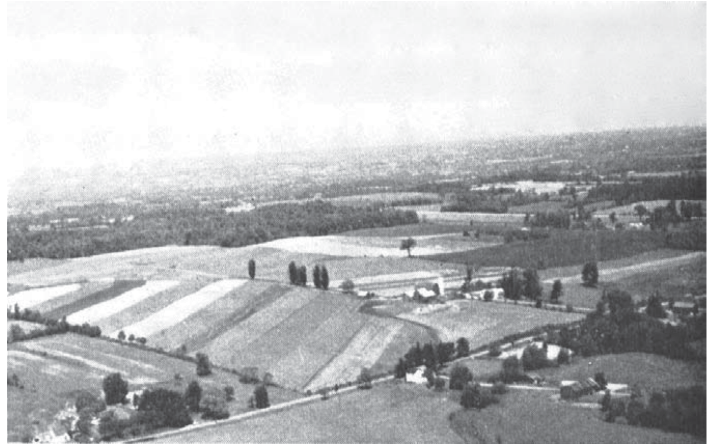

Figure 15.—**Contour stripcropping on soils of subclass IIIe.**

agement than Lansing gravelly silt loam, 3 to 8 percent slopes. If high yields of hay are desired, the field should be reseeded before the yield has declined to 2 tons per acre. Little improvement in yields can be expected, however, if the cropping system includes more than 3 years of hay.

UNIT IIIe–3

This unit consists of deep or moderately deep, well-drained soils that have an acid surface soil. These soils are—

Bath channery silt loam, 5 to 15 percent slopes.
Howard-Valois gravelly loams, 5 to 15 percent slopes.
Lordstown channery silt loam, 5 to 15 percent slopes.
Bath and Valois gravelly silt loams, 5 to 15 percent slopes.

The Bath soil has a moderate fragipan at a depth of 18 to 30 inches. The Lordstown soil is 20 to 40 inches deep over bedrock. The Howard soil is underlain by gravel and sand. Bath and Lordstown soils are acid throughout. The lime content in Valois and Howard soils increases below a depth of 36 to 42 inches.

If good management is practiced, fair to good yields can be expected. The capacity to store moisture is moderate to good. The ability to retain and furnish applied plant nutrients is good. Slope restricts the use of these soils and increases the possibility of runoff and erosion. Measures to conserve moisture and soil are especially needed on the steeper or longer slopes.

Use and management.—The soils in this unit are well suited to all crops grown in the county. Deep-rooted legumes are better suited than shallow-rooted kinds because of the moderate moisture-holding capacity. Deep placement of some of the lime applied is advisable, especially in Bath and Lordstown soils, to encourage deep rooting. Field grazing of forage can be started fairly early in spring. The following are suitable cropping systems and supporting practices.

Suitable cropping systems
according to length of slope:[1]
200-foot slope— *Supporting practices*
R–C–S; C–S–S------------ Contour tillage.
C–S–S–S ---------------- Cross-slope tillage.

See footnote at end of table.

	Supporting practices
400-foot slope—	
R–C–S–S; R–C–C–S–S	Contour tillage.
Rc–R–C–S; R–C–S–S	Contour stripcropping.
600-foot slope—	
Rc–R–C–S–S; R–C–S–S–S.	Contour stripcropping; diversions spaced 400 feet apart, with tile to take care of possible leakage.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Correction of acidity is of prime importance. Some of the other needs are as follows: Minimum tillage, which helps to prevent compaction and increase infiltration of rainfall during the growing season; full stands of crops for canopy protection; good residue management; and ample use of fertilizer. Diversions are seldom used on Lordstown, Howard, and Valois soils because of leakage. Also, some areas of Lordstown soils are shallow over bedrock, making the installation of diversions difficult. Where diversions cannot be installed on slopes of 600 feet or more, a rotation no more intense than R–C–S–S–S and stripcropping should be used.

UNIT IIIe–4

Deep, well-drained soils that formed on gravelly and sandy material make up this unit. They have a loamy subsoil and become coarse textured with increasing depth. These soils are—

Chenango gravelly loam, 5 to 15 percent slopes.
Howard gravelly loam, 5 to 15 percent simple slopes.
Palmyra gravelly loam, 5 to 15 percent simple slopes.

Chenango soils are acid to a depth of 5 feet or more. Howard soils are acid in the surface soil and subsoil and have free lime at a depth of 36 to 60 inches. Palmyra soils are acid to slightly acid in the surface soil and have free lime at a depth of 15 to 30 inches.

If properly managed, these soils can be fairly productive. Their ability to retain applied plant nutrients is fair to good. Slope restricts their use somewhat and increases the possibility of runoff. Their capacity to store moisture is moderate; therefore, measures to conserve moisture are desirable.

Use and management.—The soils in this unit are well suited to all crops grown in the county. In use suitability, needs, and limitations, they are similar to the soils in unit IIIe–3. Deep placement of part of the lime applied to Chenango soils is necessary to encourage deep rooting. Field grazing of forage can be started early in spring. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
Rc–R–C–S	Cross-slope tillage.
400-foot slope—	
Rc–R–C–S–S	Contour cultivation.
600-foot slope—	
Rc–R–C–S–S; R–C–S–S	Contour stripcropping.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Lack of moisture is one of the factors that limit growth of crops. Runoff should be controlled by minimum tillage and, where possible, cross-slope or contour tillage. Diversion terraces are impractical on these gravelly soils. For large yields, acidity will need to be corrected and fertilizer applied according to the results of soil tests. Because nutrients are leached out, even during the growing season, these soils may require applications of fertilizer more than once each year for maximum growth of crops. Especially important are applications, in spring, of potash on forage crops and nitrogen on grass crops, corn, and wheat.

UNIT IIIe–5

The one soil in this unit, Arkport fine sandy loam, 6 to 12 percent slopes, is deep and well drained. The surface soil generally is acid, and the lime content increases with depth.

If properly managed, this soil is fairly productive. Its ability to retain plant nutrients is fair. Slope restricts its use somewhat and causes moderate hazards of runoff and erosion. The capacity to store moisture is fair. Measures to conserve moisture and to prevent erosion are desirable.

Use and management.—This soil is best suited to the production of livestock feed. It allows early planting of oats. Moderate yields of corn for both silage and grain can be obtained. Mixtures of deep-rooted legumes and suitable grasses grow well under good management. Because its moisture-holding ability is only moderate, this soil is not well suited to shallow-rooted legumes. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
R–C–S–S	Contour tillage.
400-foot slope—	
R–C–S–S–S	Contour tillage.
Rc–R–C–S–S	Contour stripcropping.
600-foot slope—	
Rc–R–C–S–S–S	Contour stripcropping.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Erosion and droughtiness are the main obstacles to plant growth. As the close-growing crop, a winter grain, such as wheat, is preferable. Cover crops aid in preventing loss of nutrients by leaching. They provide protection during winter and to a small degree improve structure, thus increasing infiltration. Frequent applications of fertilizer are necessary because of the sandy texture. Plowing down nitrogen in cornfields is preferable to applying it as a surface side dressing.

UNIT IIIe–6

This unit consists of deep, moderately well drained soils that are acid in the surface soil and have a well-expressed fragipan at a depth of 15 to 24 inches. These soils are—

Langford channery silt loam, 8 to 15 percent slopes.
Mardin channery silt loam, 8 to 15 percent slopes.

The pan in Mardin soils is acid; that in Langford soils is slightly acid or neutral.

If well managed, these soils are fairly productive. Slope restricts their use somewhat and creates rapid runoff and a moderate hazard of erosion. The fragipan causes slight wetness in spring, makes the moisture-holding capacity moderate, and restricts the zone of nutrient availability. Measures to conserve soil and moisture are needed.

Use and management.—In general these soils are suited to most crops grown in the county. Because of wetness and risk of erosion, however, yields are less than on soils that require less intensive management. Good yields of corn for silage and of oats, wheat, and hay are obtained if these soils are properly managed. Early-maturing corn is preferable because the growing season is limited. On the steeper slopes, the use of modern machinery is barely possible. Forage crops should be selected for tolerance of seasonal wetness. Yields are better in rotation pastures than in permanent pastures. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
R–C–S–S–S	Cross-slope tillage.
400-foot slope—	
R–C–S–S–S	Contour tillage.
R–C–S–S	Contour stripcropping.
600-foot slope—	
R–C–S–S	Contour stripcropping; diversions spaced 400 feet apart, with tile to take care of possible leakage.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

If alfalfa is grown, lime should be plowed down to encourage deep rooting, and the crop should be fertilized for a yield equivalent to 4 tons of hay. The water-storage capacity is limited. Every effort should be made to conserve rainfall during the growing season by minimum tillage and good residue management. Full stands of crops, especially corn, are needed to aid in protecting the soil and to provide shade and thereby reduce loss of moisture through evaporation. Spot drainage may be needed to eliminate small wet areas.

UNIT IIIe–7

The one soil in this unit, Langford channery silt loam, 3 to 8 percent slopes, eroded, is deep and moderately well drained and has a well-expressed fragipan at a depth of 12 to 18 inches. Reaction is acid to slightly acid in the surface soil and medium acid to nearly neutral in the fragipan.

Fair yields of selected crops can be expected if management is good. Past erosion has depleted the organic-matter content and has decreased the depth to the fragipan by 4 to 6 inches. The decrease in the depth to the fragipan causes moderate wetness in spring, thus delaying planting and causing moisture deficiency in dry periods. The zone that supplies plant nutrients also has been made shallower. Soil-building rotations and measures to control erosion and conserve moisture are needed.

Use and management.—This soil is suitable for corn for silage, for oats, and for shallow-rooted forage crops tolerant of seasonal wetness. Yields tend to be lower because of past erosion. Intensive and consistently good management is required to offset effects of erosion. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
R–C–C–S	Graded rows; grassed waterways.
400-foot slope—	
R–C–S–S–S	Graded rows; grassed waterways.
R–C–S–S	Graded rows in stripcropping; grassed waterways.
600-foot slope—	
R–C–S–S–S	Graded rows in stripcropping; grassed waterways; diversions spaced 400 feet apart, with tile to take care of possible leakage.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Reducing the hazard of erosion as much as possible is the first objective. Other needs are the restoration of soil structure by minimum tillage and by close attention to residue management; a fertility program that corrects the low nutrient status of these eroded soils; and full stands of row crops to give canopy protection and limit evaporation. Because of the low moisture-holding capacity of the root zone, rainfall during the growing season should be conserved.

UNIT IIIe–8

The soils in this unit are deep and moderately well drained, are slightly acid or neutral in the surface soil, and generally have free lime at a depth of 18 to 20 inches. They are—

Conesus gravelly silt loam, 3 to 8 percent slopes, eroded.
Lima silt loam, 3 to 8 percent slopes, eroded.

If these soils are properly managed, good yields of selected crops can be expected. The capacity to store moisture is high, and the ability to retain and furnish plant nutrients is good. Past erosion has depleted the organic-matter content and in places has exposed a clayey surface soil. This eroded condition restricts the use of these soils somewhat. A pattern of rills and gullies makes it difficult to apply measures to control runoff and erosion. Maintaining good soil structure may be difficult.

Use and management.—These soils are suited to all crops commonly grown in the county, including corn for silage and grain, oats, wheat, and beans. Yields, however, will probably be less than on the uneroded Conesus and Lima soils. Deep-rooted legumes, alone or mixed with grass, grow well. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]

	Supporting practices
200-foot slope—	
R–C–S–S–S	Graded rows; grassed waterways; cross-slope tillage.
400-foot slope—	
R–C–S–S–S–S	Graded rows; grassed waterways; cross-slope tillage.
R–C–S–S	Graded rows; grassed waterways; stripcropping.
600-foot slope—	
R–C–S–S–S	Graded rows; grassed waterways; stripcropping; occasional diversions.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Intensive management of these soils should be profitable. Controlling erosion is the first step. Minimum tillage helps to improve or maintain soil structure. Spot drainage may be desirable to eliminate wet spots. Careful crop-residue management and fertilization in excess of the minimum requirements shown by tests are highly desirable. A full stand of row crops is needed to furnish canopy protection. If possible, the close-growing crop after a row crop should be a winter grain, which protects the soils during winter. If spring grain is planted instead, a cover crop of grass should not be grown, because it will volunteer in the following grain and hay crops.

UNIT IIIe–9

This unit consists of Ovid and Rhinebeck silt loams, moderately deep, 6 to 12 percent slopes, an undifferentiated unit of somewhat poorly drained to moderately well drained clayey soils. The depth to bedrock ranges from 20 to 40 inches. The reaction in the surface soil is moderately acid to slightly acid. The lime content increases with depth.

A combination of factors restricts the use of these soils, but under adequate management, fair to good yields of selected crops can be obtained. Runoff is rapid, and these soils are erodible. Moderate wetness in spring and during wet periods delays planting and slightly affects the growth of crops. Maintaining good soil structure is difficult. Corrective drainage measures may be difficult to apply because these soils are shallow over bedrock.

Use and management.—Oats, corn for silage, and legumes that are tolerant of seasonal wetness are the best choices of crops. These soils are not suited to field grazing early in spring. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]

	Supporting practices
200-foot slope—	
Rc–C–S–S	Graded rows; grassed waterways.
400-foot slope—	
C–S–S	Graded rows; grassed waterways.
Rc–C–S–S–S	Graded rows; grassed waterways; stripcropping.
600-foot slope—	
Rc–C–S–S–S–S	Graded rows; stripcropping; grassed waterways; diversions (if the soils are deep enough over bedrock).

See footnote at end of table.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Because wheat may be undependable on these soils, a cover crop should follow the row crop. If the cover crop volunteers in the spring grain crop, then a cropping system utilizing long-term hay may be advisable, particularly if drainage improvements are limited and most of the acreage consists of the steeper soils and is subject to severe erosion.

UNIT IIIe–10

This unit consists of Hudson-Cayuga silt loams, 2 to 6 percent slopes, eroded, a complex of moderately well drained clayey soils. Erosion has depleted the organic-matter content and exposed a clayey layer.

Several factors restrict the use of these soils, but if runoff and erosion are controlled and management is good otherwise, fair to good yields can be expected. Maintaining good soil structure is very difficult. Though these soils may be slightly wet in spring, their ability to supply moisture during dry periods may be restricted somewhat. Control of runoff and erosion may be difficult because of rills and gullies.

Use and management.—These soils are suited to all crops grown in the county. Deep-rooted legumes mixed with grass do well on them. These soils require more intensive management than the uneroded Hudson-Cayuga soils of similar slope. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]

	Supporting practices
200-foot slope—	
R–C–S–S	Contour tillage.
400-foot slope—	
R–C–C–S–S–S	Contour tillage.
R–C–C–S–S	Contour stripcropping.
600-foot slope—	
R–C–C–S–S–S	Contour stripcropping.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

The first step in management is to control erosion. The row crop should be either beans or corn. Beans can be harvested early enough to allow planting of winter grain to give good winter protection. If corn is grown, the grain can be harvested and the stover left to serve as over-winter ground protection. A cover crop should not be grown before a spring grain, because it will volunteer in the grain crop. Minimum tillage helps to preserve soil structure. Timely tillage is important. Fall plowing should be avoided. These are productive soils, and they should be fertilized to ensure good yields.

UNIT IIIe-11

This unit consists of deep, somewhat poorly drained soils that have a strongly expressed fragipan. The depth to the pan is 12 to 18 inches. The surface soil is acid. These soils are—

Volusia channery silt loam, 8 to 15 percent slopes.
Erie channery silt loam, 8 to 15 percent slopes.

The pan in the Volusia soil is acid, and that in the Erie soil is slightly acid or neutral.

A combination of factors restricts the use of these soils, but fair yields of selected crops can be expected if erosion is controlled, drainage is improved, and management is good otherwise. Runoff is rapid, and the hazard of erosion is serious. Shallowness to the pan causes moderate wetness that delays planting and affects crop growth in spring and during wet periods. The moisture supply may be deficient during dry periods. The zone in which plant nutrients are available is restricted by the fragipan.

Use and management.—Wetness and steepness limit the suitability of these soils for crops. The soils remain cold long enough in spring to shorten the growing season. Corn for silage, oats, and forage crops are the principal crops. Shallow-rooted legumes mixed with grass are the usual forage crops. If these soils are drained, deep-rooted legumes will live long enough to give good yields. The life of the stand can be lengthened by planting legumes that are tolerant of moisture. The forage may be of just as high quality as that grown on better drained soils, but the yield will be less. Rotation pastures produce more forage than average permanent pastures. These soils are not suited to field grazing early in spring. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
R–C–S–S–S–S	Graded rows; spot drainage; grassed waterways.
400-foot slope—	
R–C–S–S–S–S–S–S	Graded rows; spot drainage; grassed waterways.
R–C–S–S–S–S	Graded rows; stripcropping; grassed waterways.
600-foot slope—	
R–C–S–S–S	Graded rows; stripcropping; grassed waterways; diversions spaced 250 feet apart.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Drainage diversions, combined with spot drainage by means of tiling, outlets, and waterways, should reduce the excess of moisture in spring. Minimum tillage, rotations that include not more than one row crop, and graded rows should increase infiltration and conserve moisture during the growing season. Low fertility and high acidity need to be corrected to make moderate yields possible. There is only 12 to 18 inches of friable soil over the firm fragipan; therefore, special effort is needed to control erosion and conserve the workable soil material. No row crops should be grown except where water is controlled. Even if these soils are drained, yields of row crops may not be high enough to be profitable, especially at elevations of 1,500 feet and more.

733-022—65——3

SUBCLASS IIIw. SOILS THAT HAVE SEVERE LIMITATIONS BECAUSE OF EXCESS WATER

UNIT IIIw-1

This unit consists of deep, somewhat poorly drained soils that formed in gravelly material. The somewhat poor drainage results mainly from a high water table. These soils are—

Fredon silt loam, 0 to 5 percent slopes.
Red Hook gravelly silt loam, 0 to 5 percent slopes.

The Red Hook soil has a weak fragipan and is acid throughout. The Fredon soil is moderately acid to slightly acid in the surface soil; the lime content increases with depth.

These soils have good capacity for supplying moisture and nutrients to plants. If they are drained and otherwise well managed, good yields of most crops can be obtained. If undrained, these soils have limited use.

Use and management.—If these soils are artificially drained to the degree that they are moderately well drained, they are suited to the feed crops commonly grown in the county, mainly corn for silage, oats, and grass-legume mixtures. If partially drained, they are best suited to forage crops, and the mixtures should contain legumes tolerant of wetness. In undrained areas, only mixtures suited to poorly drained soils should be grown and only fair yields of forage can be expected. The time when field grazing can be started in spring depends largely on the degree of artificial drainage provided. The following are suitable cropping systems and supporting practices.

Suitable cropping systems:[1]	*Supporting practices*
Rc–Rc	Tile drainage; suitable outlets.
C–S–S–S	None needed.

[1] Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

The improvement of drainage is of first importance; tiling is appropriate if outlets are available. Liming is important, especially if legumes are included in the cropping system. Special attention should be given to maintenance of soil structure if the rotation is short, especially if it lacks a sod crop. In such a system, the return of all crop residues and a good growth of cover crop is essential.

Generally these soils can be drained only to the extent that alfalfa-trefoil hay can be grown. After they are drained they need adequate liming, annual applications of fertilizer according to soil analysis, and good forage management for moderate yields.

UNIT IIIw-2

The one soil in this unit, Niagara silt loam, 2 to 6 percent slopes, is deep, silty, and somewhat poorly drained. The surface soil is acid and is slightly lighter textured than the subsoil. The lime content increases with depth.

Undrained, this soil has limited use. Under good management that includes drainage and control of erosion, good yields of most crops can be expected. This soil has good capacity for moisture and nutrients available for plants. It is highly erodible. Surface crusts and plowpans form easily.

Use and management.—If drained, this soil is suited to most crops grown in the county for livestock feed. It should not be counted on for field grazing early in spring. Legumes tolerant of wetness should be chosen. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
Rc–Rc–C–S–S	Graded rows; grassed waterways.
400-foot slope—	
Rc–Rc–C–S–S–S–S; R–C–S–S.	Graded rows; grassed waterways.
R–C–R–C	Graded rows in strips; grassed waterways.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Cover crops following row crops are important for soil protection during winter, but they should be omitted if they volunteer in the succeeding close-growing crop. Timely and minimum tillage helps to maintain structure and to reduce damage from compaction, such as crusting and the formation of a plowpan. Liming is essential if legumes are grown. Fertilization should be planned for moderate yields.

UNIT IIIw-3

This unit consists of deep and moderately deep, somewhat poorly drained soils that are acid to slightly acid in the surface layer. The lime content increases with depth. A heavy clay subsoil restricts drainage. The depth to bedrock ranges from 20 to 40 inches in the moderately deep soils. These soils are—

Ovid and Rhinebeck silt loams, moderately deep, 0 to 2 percent slopes.
Rhinebeck silt loam, 0 to 2 percent slopes.

Unless these soils are drained, their use is restricted. Moderate wetness delays planting and affects plant growth during wet periods. Maintaining good soil structure may be difficult. Under good management, good yields of selected crops can be expected.

Use and management.—These soils can produce satisfactory yields of corn only if they are properly drained. On most sites the drainage can be improved to a level that will support a fair crop of oats or of grasses and legumes that are tolerant of seasonal wetness. For undrained areas, only sod crops tolerant of wetness should be chosen. Field grazing, except in midsummer, is usually difficult. The following are suitable cropping systems and supporting practices.

Suitable cropping systems:[1]	*Supporting practices*
C–S–S–S–S	None needed.
R–C–S–S	Close spacing of tile.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Draining these nearly level soils is very difficult. Some areas can be drained enough to grow alfalfa and birdsfoot trefoil. If closely spaced tile drains are installed, good yields of cash crops can be obtained. Special attention to good crop-residue management and to cover crops is essential to maintenance of good soil structure. Minimum tillage should be practiced.

UNIT IIIw-4

This unit consists of deep or moderately deep, somewhat poorly drained soils that are acid to slightly acid in the surface layer. The lime content increases with depth. A heavy, clayey subsoil restricts drainage. Depth to bedrock ranges from 20 to 40 inches in the moderately deep soils. These soils are—

Darien gravelly silt loam, 2 to 8 percent slopes.
Ovid silt loam, 0 to 6 percent slopes.
Ovid and Rhinebeck silt loams, moderately deep, 2 to 6 percent slopes.
Rhinebeck silt loam, 2 to 6 percent slopes.

Unless these soils are drained, their use is restricted. Moderate wetness delays planting and affects plant growth during wet periods. Maintaining good structure may be difficult. These soils are also erodible. Consequently, measures to improve drainage and to control erosion are needed. If these and other good management practices are applied, good yields of selected crops can be expected.

Use and management.—If drained, these soils are suitable mainly for production of livestock feed. Legumes tolerant of seasonal wetness should be chosen. Unless drained, these soils are best suited to sod crops that tolerate moderate wetness. Field grazing generally is feasible only in midsummer. Partial drainage could advance the grazing season somewhat, but probably not enough to allow grazing of the first growth in a rotation system of grazing. Complete and adequate drainage makes it possible to grow mixtures that include alfalfa and also permits grazing early in spring. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
R–C–S–S	Cross-slope tillage; spot drainage.
400-foot slope—	
R–C–S–S–S	Cross-slope tillage; diversions; spot drainage.
Rc–R–C–S–S	Graded stripcropping; diversions; spot drainage.
600-foot slope—	
R–C–S	Graded stripcropping; diversions spaced 400 feet apart; sod waterways; spot drainage.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Lack of adequate drainage is one of the main obstacles to plant growth and to timely tillage. Tile or open ditches generally improve drainage. After a row crop, the more sloping areas need to be protected from erosion during winter. Wheat is not well suited to Ovid and Rhinebeck silt loams. As a close-growing crop in the cropping system, however, it is preferable to oats because it covers the ground during winter, and a cover crop of ryegrass or annual brome may volunteer in the oats and hay seedings. The suggested 3-year rotation on 600-foot slopes is possible, but actually a minimum of 2 years of hay is needed for control of erosion by means of strip-cropping. All of these soils need lime. Fertilizer should be applied according to soil analysis. If good management practices are used, mixtures that include alfalfa can be grown. Unless these soils are drained, mediocre yields of crops are common and grass-type agriculture is often more feasible.

UNIT IIIw-5

This unit consists of deep, poorly drained and very poorly drained, loamy soils formed in silty, sandy, and gravelly material. In their natural state, these soils are very wet and may have a mucky surface soil. The wetness is caused mainly by a high water table. Reaction in the surface soil is generally slightly acid. The lime content increases with depth. These soils are—

Canandaigua and Lamson soils.
Halsey silt loam.
Halsey mucky silt loam.

Undrained, these soils are too wet for cropping. They have good capacity for holding moisture and nutrients available to plants. Consequently, if they are drained and well managed, good yields of most crops can be obtained.

Use and management.—These soils, except where the surface soil is mucky, generally are suited to long-term sod consisting of mixtures of grasses and legumes tolerant of wetness. If drained they are suited to corn for silage, oats, and legumes tolerant of seasonal wetness. Early field grazing damages sod by "punching." The following are suitable cropping systems and supporting practices.

Suitable cropping systems:[1]	*Supporting practices*
S-S-S-S	None needed, except on the soils that have a mucky surface soil and that require tile or open-ditch drainage.
R-R-C-S-S; R-C-S-S	Tile drainage; suitable outlets.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

If the water table can be lowered enough, these soils can be cropped in a rotation that includes a row crop. Otherwise good yields can be obtained only by growing continuous grass-sod crops and using open ditches for drainage. Annual fertilization, particularly with nitrogen, is needed.

UNIT IIIw-6

This unit consists of deep, somewhat poorly drained soils formed in glacial till. These soils have an acid surface soil and a strong fragipan at a depth of 12 to 18 inches. They are—

Erie channery silt loam, 3 to 8 percent slopes.
Volusia channery silt loam, 3 to 8 percent slopes.

The pan in the Volusia soil is acid; that in the Erie soil is slightly acid or neutral. These fragipans restrict drainage and limit the amount of water and nutrients available for plant use. The dominant limitation is wetness, but these soils are also susceptible to erosion. If good management practices are used, including measures to conserve soil and moisture and to improve drainage, fair to good yields of forage crops can be expected.

Use and management.—These soils are suitable for corn for silage, oats, and forage crops tolerant of seasonal wetness. On the Erie soil, corn for grain is fairly dependable. If the drainage is improved, moderate yields can be obtained from alfalfa in mixture with birdsfoot trefoil and grass. Unless these soils are drained, about the only crops that can be grown are an occasional crop of corn for silage, oats, and mixtures of long-term sod crops tolerant of wetness. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
R-C-S-S	Graded rows; grassed waterways.
400-foot slope—	
R-C-S-S-S	Graded stripcropping; grassed waterways.
R-C-S-S	Graded rows in stripcropping; grassed waterways; diversions spaced about 250 feet apart.

[1] R=row crop; C=close-growing; S=sod-forming crop.

Drainage diversions, waterways, outlets, tile in places, and graded rows and strips are applicable and beneficial. Plow-planting or other minimum tillage is important because of the shortness of the growing season at high elevations. Moisture conservation by means of graded rows during the growing season is desirable because of the low moisture-storage capacity. The low infiltration capacity can be improved by maintaining soil structure. Good soil structure can be maintained by using a rotation that includes only 1 year of a row crop. The acidity of these soils must be corrected. Deep placement of some of the lime is important. Row crops should not be grown on slopes where water- and erosion-control measures are lacking.

UNIT IIIw-7

The one soil in this unit, Kendaia silt loam, 3 to 8 percent slopes, is deep and somewhat poorly drained. It formed in limy glacial till. Reaction in the surface soil is slightly acid or neutral.

Undrained, this soil has limited use. Moderate wetness delays planting and affects plant growth during wet periods. There is also a moderate hazard of erosion. Measures to correct drainage and control erosion are therefore desirable. If these measures and other good management practices are applied, good to excellent yields of most crops can be expected. The capacity of this soil to store moisture and supply plant nutrients is excellent.

Use and management.—If this soil is drained, it is suited to most of the crops commonly grown in the county, including corn for silage and grain, oats, wheat, and alfalfa in mixtures. If undrained, it is best suited to long-term sod crops tolerant of wetness late in spring. Field grazing cannot begin until slightly later than on gravelly soils. Early grazing damages the sod by "punching." The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope: [1]	*Supporting practices*
200-foot slope—	
Rc–R–C–S–S–S	Cross-slope tillage; grassed waterways; drainage.
400-foot slope—	
Rc–R–C–S–S–S–S–S	Cross-slope tillage; grassed waterways; drainage.
600-foot slope—	
Rc–R–C–S	Graded stripcropping; grassed waterways; drainage.
S–S–S–S–S	None needed.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Drainage is of great importance and should be highly beneficial if there are satisfactory outlets. Diverting the runoff from higher lying land is the first step. Tiling is the next. If this soil is drained, the choice of crops and the fertilization should be directed toward high yields. Liming to correct acidity of the surface soil may be necessary. If undrained, this soil produces only average yields, and the choice of legumes may be limited to birdsfoot trefoil.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both

Subclass IVe. Soils Subject to Very Severe Erosion if They Are Cultivated and Not Protected

unit IVe–1

This unit consists of deep, well-drained soils. Past erosion has depleted the organic-matter content and in places has exposed a clayey layer. Reaction in the present surface soil is slightly acid or neutral. These soils are—

Honeoye gravelly silt loam, 8 to 15 percent slopes, eroded.
Lansing gravelly silt loam, 8 to 15 percent slopes, eroded.

Free lime is ordinarily at a depth of 16 to 30 inches in the Honeoye soil and at greater depth in the Lansing soil, but in severely eroded areas it is closer to the surface.

The capacity to store moisture is good, and the ability to supply plant nutrients is fair. Maintaining good soil structure may be difficult. The erosion hazard is moderate to severe. Because of rills and gullies resulting from past erosion, erosion control may be difficult. If adequate erosion control and other good management are provided, fair yields of most crops can be expected.

Use and management.—The soils in this unit are suited to all the crops grown in the county, except potatoes. Potatoes are subject to scab damage, which results from high pH in the tuber zone. Because of the reduced thickness of the surface soil, shallow-rooted crops like small grain are susceptible to drought damage when rainfall is below average.

A number of forage crops can be grown on these soils. High-yielding crops are generally selected. They allow wide diversity in management and in the length of time the land can be kept in productive sod crops. Field grazing can be started almost as early as on more gravelly soils or on the uneroded Honeoye and Lansing soils. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope: [1]	*Supporting practices*
200-foot slope—	
R–C–S–S–S	Contour tillage; grassed waterways.
400-foot slope—	
C–C–S–S	Contour tillage; grassed waterways.
R–C–S–S–S	Contour stripcropping; grassed waterways.
600-foot slope—	
R–C–S–S–S–S	Contour stripcropping; grassed waterways.
S–S–S–S	None needed.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Restoring favorable soil structure is important. The number of row crops in the cropping system should be limited, and tillage for preparation of seedbeds should be kept to a minimum. With good management and ample fertilization according to the results of soil tests, above-average yields can be obtained.

unit IVe–2

This unit consists of deep or moderately deep, well-drained soils that have an acid surface soil. These soils are—

Bath channery silt loam, 15 to 25 percent slopes.
Bath and Valois gravelly silt loams, 15 to 25 percent slopes.
Howard-Valois gravelly loams, 15 to 25 percent slopes.
Lordstown channery silt loam, 15 to 25 percent slopes.

Bath soils have a moderately strong fragipan at a depth of 18 to 30 inches. The Lordstown soil is 20 to 40 inches deep over bedrock. The Howard soil is underlain by gravel and sand. Bath and Lordstown soils are acid throughout. The lime content of Valois and Howard soils increases below a depth of 36 to 42 inches.

Steepness and excessive runoff restrict the use of these soils. Because of rapid runoff, the amount of moisture retained for plant use may be limited. These soils are also susceptible to erosion. Measures to conserve moisture and soil are very desirable.

Use and management.—These soils are suited to all the crops grown in the county, but only the moderately sloping areas should be used for row crops. Slopes of approximately 20 percent or more, on which the use of modern machinery is impractical, should be in long-term sod. On the steeper slopes especially, field grazing may be the most practical method of harvesting forage. Such grazing can be started early in spring. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope: [1]	*Supporting practices*
200-foot slope—	
R–C–S–S–S–S	Contour tillage; grassed waterways.
400-foot slope—	
R–C–S–S–S	Contour stripcropping; grassed waterways.
600-foot slope—	
R–C–S–S–S–S [2]	Contour stripcropping; grassed waterways.
C–S–S–S–S	None needed.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.
[2] On slopes of 15 to 18 percent only.

Correcting the high acidity and fertilizing according to the results of soil tests are most important if long-term legumes are grown. Deep placement of lime in Bath and Lordstown soils is desirable, to encourage deep rooting. Minimum tillage and good residue management should help to improve infiltration capacity. Full stands of row crops that provide canopy protection are desirable.

UNIT IVe–3

This unit consists of deep or moderately deep, well-drained soils. These soils are—

- Bath channery silt loam, 5 to 15 percent slopes, eroded.
- Bath and Valois gravelly silt loams, 5 to 15 percent slopes, eroded.
- Lordstown channery silt loam, 5 to 15 percent slopes, eroded.

Past erosion has depleted the organic-matter content of these soils. In the Bath soil, erosion has reduced the depth to the fragipan by 4 to 6 inches, and in the Lordstown soil it has reduced the depth to bedrock by about the same amount. Bath and Lordstown soils are acid throughout. Valois soils are slightly acid to neutral in the substratum.

Use and management.—The soils in this unit are suited to all of the crops commonly grown in the county, but because of erosion their capacity to produce high yields is limited. Cash crops, such as wheat, for example, are generally grown on the more gently sloping areas. On the steeper areas more emphasis is placed on forage crops, especially on sod that will last for several years. Field grazing can be started early in spring. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope: [1]	*Supporting practices*
R–C–S–S–S	Contour tillage; grassed waterways.
400-foot slope—	
R–C–S–S–S–S	Contour tillage; grassed waterways.
R–C–S–S–S	Contour stripcropping: grassed waterways.
600-foot slope—	
R–C–S–S–S–S	Contour stripcropping; grassed waterways; diversion terraces on Bath and Valois soils.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Restoring the fertility, soil structure, and infiltration rate is important. Lime and fertilizer should be applied according to test results. Minimum tillage and good crop-residue management should help improve infiltration. As an aid in combating drought, Bath and Lordstown soils should have some of the lime placed as deeply as possible, in order to encourage deeper root growth, especially of legumes.

UNIT IVe–4

This unit consists of Mardin and Langford soils, 15 to 25 percent slopes, an undifferentiated unit of moderately well drained, loamy soils that are acid in the surface soil and have a well-expressed fragipan at a depth of 15 to 24 inches. The pan in Mardin soils is acid, and that in Langford soils is slightly acid or neutral.

Runoff is rapid to very rapid on these moderately steep slopes, and the hazard of erosion is serious. The moisture capacity is moderate, but the amount retained for plant growth is small enough to be limiting. Measures to conserve soil and moisture are needed for the most effective use of these soils, which, if properly managed, will respond fairly well.

Use and management.—For the most part, these soils are used to grow feed crops to support livestock farming. Rotations that include long-lived sods are preferred. Field grazing is prevalent on the steeper slopes, for it is impractical to use heavy machinery on slopes of more than 20 percent. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope: [1]	*Supporting practices*
R–C–S–S–S–S	Cross-slope tillage.
400-foot slope—	
R–C–S–S–S–S	Contour tillage.
600-foot slope—	
R–C–S–S–S–S [2]	Contour stripcropping.
S–S–S–S	None needed.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.
[2] Only on slopes of 15 to 18 percent.

Row crops should not be grown on these soils if mildly sloping soils are available; at the most, they should be grown only once every 5 or 6 years.

Both of these soils need enough fertilizer to support moderate yields. Both need lime in the plowed layer, and the Mardin soil needs lime in the lower layers, to encourage deep rooting of legumes. Minimum tillage and the canopy protection afforded by full stands of row crops should help preserve soil structure and increase infiltration of moisture during the growing season.

UNIT IVe–5

This unit consists of deep, moderately well drained soils that are acid to slightly acid in the surface soil and have a well-expressed fragipan. Past erosion has depleted the organic-matter content and has decreased the depth to the fragipan to 10 to 12 inches. These soils are—

- Langford channery silt loam, 8 to 15 percent slopes, eroded.
- Mardin channery silt loam, 8 to 15 percent slopes, eroded.

The pan in the Mardin soil is acid, and that in the Langford soil is neutral. The reduction in depth to the pan results in moderate wetness in spring, which delays planting, and in moisture deficiency during dry periods. It also restricts the zone from which plants can obtain nutrients. The hazards of runoff and erosion are increased. Soil-building rotations and measures to control erosion and conserve moisture are needed. Fair yields of selected crops can be expected if these soils are well managed.

Use and management.—These soils generally are suited to most of the crops grown in the county, but because of wetness and risk of further erosion, they may be less productive than drier, uneroded soils. Early-maturing corn is desirable because the growing season is limited. The use of modern machinery is barely possible on the steeper slopes.

Forage crops tolerant of seasonal wetness should be selected. Yields generally are better in rotation pastures than in permanent pastures. Moreover, these soils are not suited to grazing early in spring. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
R–C–S–S–S–S	Contour tillage; graded rows.
400-foot slope—	
C–C–S–S	Cross-slope tillage in strips.
R–C–S–S–S–S	Graded rows in strips; grassed waterways.
600-foot slope—	
R–C–S–S–S–S	Graded rows in strips; grassed waterways; diversion terraces.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Rebuilding these soils is a prime need. Liming and fertilizing according to soil tests, deep placement of part of the lime in the Mardin soil, and good crop-residue management are essential. In order to reduce the hazard of erosion, only one row crop should be grown in 6 years. Minimum tillage aids in maintaining soil structure.

UNIT IVe–6

This unit consists of deep, somewhat poorly drained clayey soils. Erosion has depleted the organic-matter content and has exposed a clayey layer. The reaction is slightly acid or neutral in the present surface soil. The lime content increases with depth. These soils are—

Ovid silty clay loam, 6 to 12 percent slopes, eroded.
Rhinebeck silty clay loam, 6 to 12 percent slopes, eroded.

These soils are highly erodible. Moderate wetness in spring and during wet periods delays planting and affects the growth of crops. Maintaining good soil structure is very difficult. Control of runoff and erosion are needed, and also soil-building practices. Some measures are difficult to apply because of existing rills and gullies. If management is adequate, fair yields of selected crops can be expected.

Use and management.—Generally, these soils are best suited to silage corn, oats, and hay—all livestock feed crops. In wet springs, planting may be delayed long enough to justify using short-season varieties. Wheat may be grown on the more favored sites. Rotations in which hay crops are grown more than half of the time are desirable. Forage varieties tolerant of seasonal wetness should be selected. Wetness often delays grazing early in spring. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
R–C–S–S–S	Contour tillage; grassed waterways.
400-foot slope—	
C–S–S	Contour tillage.
R–C–S–S–S	Contour stripcropping; grassed waterways.
600-foot slope—	
R–C–C–S–S–S	Contour stripcropping; grassed waterways.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Whenever possible, the close-growing crop should be a winter grain, which will serve as a cover crop. If a winter grain is not feasible, a high-residue row crop, such as corn for grain, should be grown for winter protection. As a third choice, a winter cover crop could be sown during the last cultivation of the row crop; this practice, however, is inadvisable because the cover crop may volunteer in spring-planted grain and in subsequent seedings.

Because of the serious past erosion and the potential erodibility of these soils, minimum exposure should always be the objective. Up- and down-hill tillage should not be practiced if the cropping system includes a row crop. Minimum tillage helps to preserve structure, reduce crusting, and increase infiltration of moisture during the growing season. Good residue management, ample use of farm manure, and fertilization as indicated by soil analysis are desirable.

UNIT IVe–7

This unit consists of well drained to moderately well drained, clayey soils. Erosion has depleted the organic-matter content and has exposed a clayey layer, except in the Hudson-Cayuga silt loams, 12 to 20 percent slopes. The reaction of the present surface soil is slightly acid or neutral. The lime content increases with depth. These soils are—

Hudson-Cayuga silt loams, 6 to 12 percent slopes, eroded.
Hudson-Cayuga silt loams, 12 to 20 percent slopes.
Hudson silty clay loam, 6 to 12 percent slopes, eroded.

Though these soils may be slightly wet in spring, their capacity to supply moisture during dry periods may be restricted because of rapid runoff. Maintaining good soil structure is very difficult. The erosion hazard is serious. Control of erosion may be difficult because of rills and gullies, but if adequate measures are taken, fair yields of selected crops can be expected.

Use and management.—Corn, oats, wheat, alfalfa, and birdsfoot trefoil with bromegrass and timothy are the common crops for which these soils are suitable. On the upper slopes long-term hay is preferred.

High potential productivity justifies the intensive management needed to grow long-term sod. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	Supporting practices
400-foot slope—	
C–S–S–S	Contour tillage.
R–C–S–S–S	Contour stripcropping; grassed waterways.
R–C–C–S–S	Contour stripcropping; grassed waterways.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Reducing the hazard of erosion and rebuilding productivity are the primary objectives, and long-term sod is the most satisfactory means of achieving these objectives. On the lower slopes, shorter rotations are possible. Fall plowing should be avoided. Minimum tillage helps to preserve soil structure and increase infiltration. The amount of fertilizer and lime applied should equal or exceed the amounts indicated by soil tests because of the depleted condition of these soils. Good crop-residue management and applications of manure are especially important.

UNIT IVe–8

Deep, well-drained to excessively drained soils from gravelly and sandy material make up this unit. They have a loamy subsoil and become coarse textured with depth. These soils are—

- Chenango gravelly loam, 15 to 25 percent slopes.
- Howard gravelly loam, 5 to 15 percent complex slopes.
- Howard gravelly loam, 15 to 25 percent slopes.
- Palmyra gravelly loam, 5 to 15 percent complex slopes.
- Palmyra gravelly loam, 15 to 25 percent slopes.

Chenango soil is acid to a depth of 5 feet or more. The Howard soil has an acid surface soil and subsoil and free lime at a depth of 36 to 60 inches. The Palmyra soil is acid or slightly acid in the surface soil and has free lime at a depth of 15 to 30 inches.

The moderately steep or rolling slopes restrict the use of these soils somewhat. Runoff is rapid, and the capacity to store moisture is only moderate; thus, measures to conserve moisture are desirable. If these soils are well managed, they can be fairly productive.

Use and management.—These soils are suited to most of the crops ordinarily grown in the county, but the slopes of more than 15 to 18 percent present safety hazards in the operation of some machinery. Accordingly, the steeper slopes are most often left in long-term hay. Because of droughtiness, deep-rooted crops are to be preferred. These soils are suited to very early field grazing and will support the machinery needed in early planting. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1,2]	Supporting practices
200-foot slope—	
R–C–S–S–S	Cross-slope tillage.
R–C–C–S–S	Cross-slope tillage.
C–S–S–S or S–S–S–S	None needed.
400-foot slope—	
R–C–S–S–S	Cross-slope tillage.
R–C–C–S–S–S	Cross-slope tillage.
C–S–S–S or S–S–S–S	None needed.
600-foot slope—	
R–C–S–S–S–S	Contour stripcropping.
C–S–S–S or S–S–S–S	None needed.

See footnotes at end of table.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.
[2] Where slopes are complex, a cropping system of C–S–S–S or S–S–S–S is more feasible and provides better erosion control than a cropping system that requires supporting practices.

Diversion terraces are impractical on these gravelly soils. Infiltration of water can be increased by minimum tillage and by as close adherence to contouring as practical. To offset leaching, it may be necessary to apply fertilizer as a side dressing subsequent to application in the row and to fertilize sod crops more than once each growing season. The application of nitrogen to wheat and to grass sod in spring will generally be profitable. Lime should be applied according to the results of soil tests.

UNIT IVe–9

This unit consists of Volusia and Erie soils, 15 to 25 percent slopes, an undifferentiated unit of deep, somewhat poorly drained soils that have a strongly expressed fragipan. The depth to the pan ranges from 10 to 18 inches. The surface soil is acid. The pan in the Volusia soil is acid, and that in the Erie soil is slightly acid or neutral.

Runoff is rapid on these moderately steep slopes, and the erosion hazard is serious. Though these soils are moderately wet in spring and during wet periods, the moisture supply may be deficient during dry periods because of shallowness to the fragipan. If these soils are well managed, fair yields of selected crops can be expected.

Use and management.—The slope restricts the use of modern farm machinery. For this reason, oats and long-term sod are the logical choices of crops. Forage crops are limited to those tolerant of spring wetness and of midsummer drought resulting from the shallow root zone. These soils are not suited to early field grazing. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	Supporting practices
200-foot slope—	
C–S–S	Graded rows.
400-foot slope—	
C–S–S–S–S–S	Reseeding across slope; grassed waterways.
600-foot slope—	
C–S–S	Reseeding in graded strips; grassed waterways; diversion terraces spaced 200 to 250 feet apart on 15 to 17 percent slopes.

[1] C=close-growing crop; S=sod-forming crop.

Deep placement of part of the lime applied to the Volusia soil, fertilizing for moderate yields, and maintaining a full-time cover are desirable practices.

UNIT IVe–10

This unit consists of deep, somewhat poorly drained, moderately sloping soils that have a well-expressed fragipan. Past erosion has depleted the organic-matter content and has reduced the depth to the fragipan, so that it is generally just below the plowed layer. Where erosion has been most serious, some of the pan material may be incorporated in the plowed layer. These soils are—

Erie channery silt loam, 8 to 15 percent slopes, eroded.
Volusia channery silt loam, 8 to 15 percent slopes, eroded.

These soils are wet in spring, and the zone that supplies plant nutrients and moisture is seriously restricted by the fragipan. Runoff is rapid. Soil-building rotations and adequate measures to conserve soil and moisture are needed for the most efficient use of these soils.

Use and management.—Though row crops and oats can be grown, sod crops tolerant of seasonal wetness are the most suitable crops. Short-season varieties of corn are the best choices, considering the relatively high elevation of these soils. Erosion is a further limitation. Only the less sloping areas should be used for row crops. Others need the protection from further erosion that can be afforded by reseeding sod crops. Field grazing is delayed somewhat by spring wetness. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
400-foot slope—	
C–S–S–S	Cross-slope tillage; diversion terraces; grassed waterways.
600-foot slope—	
R–C–S–S–S–S	Graded stripcropping; diversion terraces; grassed waterways.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

These soils should be limed and fertilized for moderate yields, according to the results of soil tests. Deep placement of some of the lime applied to the Volusia soil should encourage deeper rooting. Drainage of wet spots may be needed. Fall plowing should be avoided. Minimum and timely tillage in spring should aid in maintaining and improving soil structure, especially if row crops are grown.

UNIT IVe–11

This unit consists of deep, somewhat poorly drained, gently sloping soils that have a well-expressed fragipan. Past erosion has depleted the organic-matter content and has reduced the depth to the pan, so that it is generally just under the plowed layer. These soils are—

Erie channery silt loam, 3 to 8 percent slopes, eroded.
Volusia channery silt loam, 3 to 8 percent slopes, eroded.

These soils are wet in spring and during wet periods because of shallowness to the fragipan. The zone that supplies plant nutrients and moisture is also seriously restricted. Soil-building rotations and measures to improve drainage and to conserve soil and moisture are needed for the most efficient use of these soils.

Use and management.—Short-season corn for silage (suitable only for the most favorable sites), oats, and grass-legume hay are the chief crops. The legumes and grasses need to be those that are tolerant of spring wetness. Because the soils are eroded, sod crops are to be preferred. The sod should be managed for moderate yields. These soils are not suited to early field grazing. The slopes are suitable for mechanized farming. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
200-foot slope—	
R–C–S–S–S–S	Graded rows; grassed waterways.
C–S–S	Cross-slope tillage.
400-foot slope—	
R–C–S–S	Graded stripcropping; diversion terraces; grassed waterways.
600-foot slope—	
R–C–S–S–S	Graded stripcropping; diversion terraces; grassed waterways.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Drainage of wet spots may be necessary. Deep placement of part of the lime applied to the Volusia soil should aid in deeper rooting. Somewhat more fertilizer than is indicated by soil analysis would help rebuild these depleted and eroded soils. Minimum and timely tillage and spring plowing help to maintain soil structure and to improve infiltration.

SUBCLASS IVw. SOILS THAT HAVE VERY SEVERE LIMITATIONS FOR CULTIVATION BECAUSE OF EXCESS WATER

UNIT IVw–1

This unit consists of deep, poorly drained or very poorly drained soils that have an acid to slightly acid surface soil. The lime content increases with depth. These soils are—

Ilion silty clay loam, 0 to 2 percent slopes.
Madalin silty clay loam.
Madalin mucky silty clay loam.

Unless drained, these soils are unsuited to most crops. If they are cultivated, the difficulty of maintaining good soil structure poses additional limitations. Their use and response depend on the effectiveness of measures to overcome these limitations.

Use and management.—If drained, these soils are suited to corn, oats, and hay. If only partially drained, they are not suited to corn and can be depended upon for forage only from late spring to midsummer. They are not suited to early spring grazing. Drained areas can be grazed somewhat earlier. The following are suitable cropping systems and supporting practices.

Suitable cropping systems:[1]	*Supporting practices*
S–S–S	None needed.
C–S–S	Partial drainage.
R–C–S–S–S	Open ditches; tile drainage.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Drainage is necessary for growing row crops but is generally difficult to accomplish. Minimum and timely tillage help to preserve soil structure. Good residue management and fertilization according to the results of soil tests are justifiable if these soils are adequately drained.

UNIT IVw-2

The one soil in this unit, Ilion silty clay loam, 2 to 6 percent slopes, is deep and poorly drained. The reaction in the surface soil is acid or slightly acid. The lime content increases with depth. A clayey subsoil causes wet conditions in spring and during wet periods, delaying planting and affecting growth, and may also cause slight moisture deficiency during dry periods. If this soil is cultivated, maintaining good soil structure is difficult.

The erosion hazard is slight to moderate on these gentle slopes. The use and response of this soil depend on the effectiveness of the measures used to overcome the limitations of wetness and erosion.

Use and management.—Unless drained, this soil is suited only to shallow-rooted crops tolerant of wetness. If drained, it is suited to corn for silage, oats, and mixtures of deep- and shallow-rooted forage crops. Field grazing will likely be delayed somewhat on account of wetness. The following are suitable cropping systems and supporting practices.

Suitable cropping systems according to length of slope:[1]	*Supporting practices*
400-foot slope—	
C-S-S-S-S-S	Diversion of water from adjoining slopes.
Rc-R-C-S	Tile drainage; diversions; graded rows; graded stripcropping on steeper slopes.
600-foot slope —	
Rc-R-C-S-S	Tile drainage; diversions; graded rows; graded stripcropping on steeper slopes.

[1] R=row crop; Rc=row crop followed by cover crop; C=close-growing crop; S=sod-forming crop.

Drainage is necessary if row crops are grown. Minimum and timely tillage helps to preserve soil structure and to aid infiltration. The surface soil should be limed according to the results of soil tests and fertilized for moderate yields. A cover crop after the first row crop is advisable if two are grown in the rotation, for it reduces the hazard of winter erosion, especially on the steeper slopes.

UNIT IVw-3

This unit consists of complexes and undifferentiated units of soils that are somewhat poorly drained, poorly drained, or very poorly drained. These soils are—

Ellery, Chippewa, and Alden soils, 0 to 8 percent slopes.
Erie-Ellery channery silt loams, 0 to 3 percent slopes.
Kendaia and Lyons silt loams, 0 to 3 percent slopes.
Lyons silt loam.
Volusia-Chippewa channery silt loams, 0 to 3 percent slopes.

Lyons, Ellery, Chippewa, and Alden soils are poorly drained and very poorly drained. Volusia, Erie, and Kendaia soils are somewhat poorly drained, but all of these soils are so closely associated that their use depends on

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the effectiveness of drainage measures used for the wetter soils.

Unless drained, these soils are unsuited to most crops. Except for Ellery, Chippewa, and Alden soils, 0 to 8 percent slopes, these soils are nearly level and do not require extensive measures for erosion control.

Use and management.—The following are suitable cropping systems and supporting practices.

Suitable cropping systems:[1, 2]	*Supporting practices*
C-S-S-S or S-S-S-S	Cross-slope tillage; graded rows; grassed waterways.
R-C-S-S-S	Cross-slope tillage; graded rows; grassed waterways; drainage.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.
[2] Row crops suitable only on steeper slopes of Ellery, Chippewa, and Alden soils.

Drainage can seldom be improved enough to make these soils suitable for crops other than long-term sod crops that are tolerant of wetness. Liming and fertilizing according to the results of soil tests are necessary for even moderate yields. Field grazing is limited to the drier periods of the growing season.

UNIT IVw-4

The one soil in this unit, Tuller channery silt loam, 0 to 6 percent slopes, is acid and poorly drained or somewhat poorly drained. At a depth of 14 to 24 inches, it is underlain by siltstone, sandstone, or coarse shale bedrock, which restricts drainage and causes wetness in spring and during wet periods, delays planting, affects crop growth, and also may cause moisture deficiency during dry periods.

Unless drained, this soil is unsuited to most crops. Drainage may not be practical in some places because of the shallowness of the soil and the nature of the bedrock. Before drainage of individual areas is attempted, pits should be dug to determine the feasibility.

Use and management.—The crop grown with least difficulty is a grass-legume mixture. Late planting and wetness create too much uncertainty for row crops. After adequate drainage it would be possible to grow corn for silage, preferably a short-season variety. The following are suitable cropping systems and supporting practices.

Suitable cropping systems:[1]	*Supporting practices*
C-S-S-S-S or S-S-S-S-S	None needed.
R-C-S-S-S	Graded rows; drainage.

[1] R=row crop; C=close-growing crop; S=sod-forming crop.

Drainage is desirable where possible. This soil should be limed and fertilized for moderate yields of sod crops.

UNIT IVw-5

This unit consists of undifferentiated units of deep, somewhat poorly drained to very poorly drained soils on bottom lands. These soils may flood frequently during the growing season. They are—

Holly and Papakating soils.
Wayland and Sloan silt loams.

These are fertile soils. Undrained, however, they have limited use for growing crops. Drainage may be difficult to establish because of the low positions and the high water table. Where drainage can be provided and other good management practices applied, good yields of selected crops can be expected.

Use and management.—Most areas can be only partially drained. Consequently, these soils are best suited to sod crops. Mixtures of grasses and legumes that have shallow roots and that tolerate wetness are most suitable. In areas that are adequately drained, corn and oats can be grown, but lodging and damage by floods can seriously reduce yields.

These soils are used mainly for forage. Good growth often occurs during dry periods in the grazing season. Field grazing early in spring is impractical because of the risk of damage from "punching" by the hooves of cattle.

A suitable cropping system consists of 1 year of a close-growing crop followed by 5 years of a sod-forming crop. No supporting practices are needed. Drainage is difficult, and the hazard of frequent flooding generally limits the use of these soils to long-term hay or pasture based on birdsfoot trefoil. These soils are generally managed and fertilized for moderate yields. Even where drainage is improved somewhat by means of open ditches, they are not well suited to row crops. Where adequate drainage and flood-control measures are provided, these soils have potential for intensive use, such as continuous row crops with cover crops.

Class V. Soils that are not likely to erode but have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture, woodland, or wildlife food and cover

Subclass Vw. Soils Too Wet for Cultivation; Drainage or Protection from Flooding Not Feasible.

unit Vw–1

This unit consists of Alluvial land, a miscellaneous land type that is flooded frequently. Drainage is predominantly poor but ranges from excessive to very poor.

The texture ranges from coarse to fine. These areas are not suitable for cultivation in their present condition, but they are suitable for permanent vegetation or grazing.

Only long-lived plants tolerant of extremes in moisture supply should be selected for these soils. Where good forage management can be practiced, productivity can be moderate. Liming and fertilizing need to be adjusted to that level of productivity.

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture, woodland, or wildlife food and cover

Subclass VIe. Soils Severely Limited, Chiefly by Risk of Erosion if Protective Cover Is Not Maintained

unit VIe–1

This unit consists of well-drained soils that are steep enough to make the use of farm machinery extremely difficult and hazardous. These soils have good to fair moisture-holding capacity but have very rapid runoff and thus lose considerable water during most of the growing season. Because erosion is a constant threat, they should be left in permanent sod or trees. These soils are—

- Bath and Valois soils, 25 to 35 percent slopes.
- Howard and Palmyra soils, 25 to 35 percent slopes.
- Hudson silty clay loam, 12 to 20 percent slopes, eroded.
- Hudson and Dunkirk soils, 20 to 45 percent slopes.
- Lordstown channery silt loam, 25 to 35 percent slopes.

Some areas of Hudson silty clay loam, 12 to 20 percent slopes, eroded, are only moderately well drained. This soil is less steep but more clayey and eroded than the other soils in this unit, and is likely to have greater runoff. It cannot be grazed as early in spring as the other soils.

On the lesser slopes, where lime and fertilizer can be spread and mowers operated, it is worthwhile to manage and improve these soils and grow long-lived pasture grasses and legumes. Moderately good growth of suitable pasture plants can be expected in the first part of the growing season. These soils are suited to early field grazing.

Subclass VIs. Soils Generally Unsuitable for Cultivation and Limited for Other Uses by Moisture Capacity, Depth to Bedrock, or Other Features

unit VIs–1

This unit consists of soils that are excessively drained to poorly drained and predominantly 10 to 12 inches thick over bedrock. These soils are—

- Lordstown, Tuller, and Ovid soils, shallow and very shallow, 0 to 15 percent slopes.
- Lordstown, Tuller, and Ovid soils, shallow and very shallow, 15 to 35 percent slopes.

Outcrops of bedrock are common. Because of these outcrops and the shallowness of the soil, the use of farm machinery is difficult and in fact hazardous on the steeper slopes. Consequently, these soils should be left in permanent sod or woodland.

Only long-lived crops tolerant of spring wetness and summer drought are suitable for these soils. Management should be based upon maximum encouragement of early season growth and on harvest by field grazing. Because deep placement of some of the lime needed for legumes may be impossible, the most dependable forage crop may be a grass sod topdressed annually early in spring with fertilizer, principally nitrogen.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation and that restrict their use largely to grazing, woodland, or wildlife

Subclass VIIe. Soils Very Severely Limited, Chiefly by Risk of Erosion if Protective Cover Is Not Maintained

unit VIIe–1

This unit consists of deep, well-drained to excessively drained soils. The extreme steepness of slope makes these soils unsuitable for cultivation and limits their use largely to grazing, woodland, or wildlife. These soils are—

- Bath, Valois, and Lansing soils, 35 to 60 percent slopes.
- Howard and Palmyra soils, 35 to 60 percent slopes.

These slopes are too steep to allow the use of machinery for liming, fertilizing, or mowing. Encouragement of long-lived legumes would be possible only on the lesser slopes where hand or aerial application of limited amounts of lime and fertilizer might be feasible.

These slopes are grazed mostly as a salvage operation and only in case of unusual need. Field grazing, however, is the only method of harvest. It should be regulated so that a protective cover is left on the soils.

SUBCLASS VIIw. SOILS VERY SEVERELY LIMITED BY EXCESS WATER

UNIT VIIw-1

This unit consists of Muck and Peat, which are nearly level, very poorly drained organic soils that are wet during the entire year. In Tompkins County these soils are not commonly drained for cropping. Undrained, they are best suited to woodland or wildlife.

SUBCLASS VIIs. SOILS VERY SEVERELY LIMITED BY LOW MOISTURE-HOLDING CAPACITY, STONES, OR OTHER SOIL FEATURES

UNIT VIIs-1

This unit consists of Lordstown soils, 35 to 70 percent slopes. These soils are moderately deep to shallow, well drained, droughty, and ledgy. They are not suited to cultivation. Their use is limited largely to grazing and to woodland or wildlife.

Class VIII. Soils and landforms that have limitations that preclude their use, without major reclamation, for commercial production of plants and that restrict their use to recreation, wildlife, or esthetic purposes

SUBCLASS VIIIw. EXTREMELY WET OR MARSHY LAND

UNIT VIIIw-1

The one miscellaneous land type in the unit, Fresh water marsh, consists of areas along the margins of lakes and ponds. These areas are permanently saturated to the surface, and drainage is not considered feasible, because the water level is determined by the lake level. Wetness precludes the use of these areas for commercial production of plants and restricts their use to recreation, wildlife, or water supply.

SUBCLASS VIIIs. ROCK OR SOIL MATERIALS THAT HAVE LITTLE POTENTIAL FOR PRODUCTION OF VEGETATION

UNIT VIIIs-1

The one miscellaneous land type in this unit, Rock outcrop, consists largely of rock-cut gorges and is not suitable for commercial production of plants. Its use is restricted to recreation or wildlife or to esthetic purposes.

Estimated Crop Yields [12]

The rapidly changing commercial agriculture in New York State during the 1950's and 1960's has greatly increased the crop yields obtained by the most skillful farmers. The average yields obtained, however, show only a slight upward trend, except when a major shift has occurred, such as the adoption of an improved crop variety by nearly all farmers. An outstanding example in New York was the almost complete shift, in the midfifties, to the high-yielding, disease-resistant Garry variety of oats, a shift that increased average oat yields by about 20 bushels per acre.

The average yields of selected crops in Tompkins County in 1949, 1954, and 1959, according to the census data, are shown in table 4.

TABLE 4.—*Yields of selected crops in stated years*

Crop	1949	1954	1959
Red clover-timothy hay ---------tons/acre--	1. 5	1. 7	1. 9
Alfalfa or alfalfa-grass mixtures--tons/acre--	2. 0	2. 2	2. 5
Corn, silage------------------tons/acre--	9. 6	8. 2	10. 8
Corn, grain----------------bushels/acre--	43	43	56
Oats, grain ----------------bushels/acre--	32	37	55
Wheat, grain----------------bushels/acre--	30	31	31

A farm-management study of a 10-percent sample of the commercial dairy farms of the Plateau (Southern Tier) Region of southern New York covered 1,085 farms, of which 32 were in Tompkins County (*6*). The soil resources of the counties throughout the Plateau Region are similar. The pertinent crop-yield data reported in tables 5 and 6 constitute the best available benchmark of average yields obtained and management practices used by Tompkins County farmers in the Plateau Region. Yields reported from 16 counties that have similar soil resources [13] differ only a little. The fact that the crop yields in Tompkins County and the hay equivalents produced per cow were near the top for the region is believed to be in part a result of the "Green Acres" extension forage program emphasized in the county during the 1940's.[14]

In reviewing data for Tompkins County from the Plateau Region Farm Management Survey, it was noted that those farms on which yields of oats were highest had only moderate yields of hay, and that those on which yields of hay were high tended to have high yields of corn silage but only moderate yields of oats. More than likely, the data so noted result from interactions of the

TABLE 5.—*Average crop yields on 823 hill and 252 valley commercial dairy farms, Plateau Region, N.Y., 1957–58; and of 371 dairy farms, Central Plains, 1953–54*

Farms	All hay	Corn silage	Oats
Plateau region dairy farms:	*Tons/acre*	*Tons/acre*	*Bu./acre*
Hill farms (Mardin, Langford, and related soils)------------------	1. 8	9. 2	53
Valley farms (Chenango, Howard, and related soils)---------------	2. 1	10. 8	57
Average, 1075 farms---------------	1. 9	9. 7	54
Central Plain dairy farms (Honeoye, Lima, and related soils)---------	2. 5	11. 6	54

[12] This section prepared by REESHON FEUER, associate professor of agronomy, Cornell University.

[13] CUNNINGHAM, L. C. Dept. Agr. Econ., Cornell Univ., Ithaca, N.Y. Mimeo No. 276. 1959.

[14] Personal statement of the county agricultural agent, ERNEST J. COLE, February, 1962.

seven factors influencing crop yields, which have been previously discussed.

Further evidence of increased yields, especially of hay, are those yields obtained during 1957–62 (see table 7) by operators of the top five farms in the Farm Business Management Group in Tompkins County, who generally practice a higher than average level of management. These yields are mostly equal to or slightly more than those obtained in 1961 by the top 10 percent of New York State business farmers, which were: hay, 3.5 tons; corn silage, 16 tons; and oats, 80 bushels.

It is highly probable that the operators of the top five farms in the Tompkins County Farm Business Management Group are operating well within the "B," or "Par," level of soil-, water-, and crop-management skill for the production of hay and oats, but not for production of corn (see table 6 and accompanying text). Supporting evidence is that these top farms use larger amounts of the four agronomic inputs—lime, commercial fertilizers, seeds, and sprays—in order to increase production.

TABLE 6.—*Average crop yields on 32 commercial dairy farms, Tompkins County, N.Y., Plateau Region, 1957–58*

[Based on Cunningham (*6*) and unpublished data. Each crop—hay, corn silage, oats—is independent of the other crops because the yields are not necessarily from the same farms. The 32 farms are 10 percent of the commercial dairy farms in the Plateau Region of Tompkins County]

Farms	Hay	Corn silage	Oats
	Tons/acre	*Tons/acre*	*Bu./acre*
23 hill farms [1]	2. 0	11	56
Top five	3. 1	14	77
Lowest five	1. 1	7	40
9 valley farms [1]	2. 3	11	53
Top three	3. 2	12	76
Lowest three	1. 5	9	34
32 farms, average	2. 1	11	55

[1] See also table 5.

TABLE 7.—*Average crop yields obtained by Farm Business Management farmers in Tompkins County, 1957–1962*

[Each crop—hay, corn silage, or oats—is independent of the other crops]

Year	Number of farms	Hay (tons per acre)			Corn silage (tons per acre)			Oats (bushels per acre)		
		All farms	Top five farms	Lowest five farms	All farms	Top five farms	Lowest five farms	All farms	Top five farms	Lowest five farms
1957	24	2.5	3.8	1.8	11.5	16.2	7.4	57	84	38
1958	31	2.8	4.3	1.8	8.7	15.4	4.5	51	74	33
1959	27	2.5	3.6	1.6	11.7	15.9	7.9	56	72	44
1960	27	2.8	4.2	1.8	10.0	14.0	5.8	55	72	38
1961 [1]	29	2.8	3.8	1.9	12.0	16.0	6.8	46	69	22
1962 [2]	25	1.7	2.5	0.9	11.0	14.8	6.8	38	50	25

[1] Wet year: growing-season rainfall (April 1 to September 30) at Mt. Pleasant (1,700 feet elevation) was 31 inches.

[2] Dry year: growing-season rainfall (April 1 to September 30) at Mt. Pleasant (1,700 feet elevation) was 18 inches.

Table 8 gives estimates of the average yields of the principal crops grown in Tompkins County, under two levels of management.

Level A represents the level of management and combinations of soil-conservation and water-conservation practices followed by most farmers in the county. At this level, approximately 10 tons of manure and a sod crop, with or without legumes, are plowed into the soil in preparation for a corn crop on dairy farms. The lime status is pH 6.0 or less. Applications of nitrogen, phosphorus, and potassium (N, P, and K) are approximately 50 percent of those suggested in "Cornell Recommends." [15]

[15] The 10 percent of the commercial dairy farmers in Tompkins County included in the Plateau Region Farm Management Survey spent an average of $8.00 per crop-acre per year for crop expense during 1957–58. Crop expense includes all expenditures for lime, fertilizer, seed, and spray. During the early 1960's, Tompkins County farmers in the Farm Business Management group spent an average of $7.00 per crop-acre per year for crop expense. If the recommendations in "Cornell Recommends for Field Crops" were fully applied, the average expenditure per crop per year would be approximately $16.00. The average yields in New York State during the past 25 years have been approximately two-thirds of those of the top Cost Account farmers, who keep cost accounts in cooperation with Cornell University.

Level B represents the level of management and combination of soil-conservation and water-conservation practices followed by good conservation farmers in the county. At this level, land is being used within its capability. Conservation cropping systems and other practices needed to conserve soil and moisture, to improve drainage, to maintain organic-matter content, and to preserve soil structure are used. Lime and fertilizer are used according to the needs of the crop in relation to the soil, which are determined by soil tests, research, and field observations. "Cornell Recommends" is used as a guide. Recommended methods and good timing are followed most of the time.

The estimated yields at level B correspond closely to the yield levels defined as "Par" and published on pages 4 and 5 of the 1962 edition of "Cornell Recommends for Field Crops." These figures were based on numerous sources of crop-research knowledge; the opinions of experienced county agricultural agents, soil conservationists, soil scientists, crop researchers, and extension specialists; and data from many farm-management surveys. In the opinion of many people, the "Par" yields represent what the top 25 percent of New York State farmers were obtaining during the early 1960's.

TABLE 8.—*Estimated average acre yields of specified crops under two levels of management*

[GEORGE C. MOORE, conservation agronomist, Soil Conservation Service, assisted in the preparation of this table. The estimates are based on yields during the 1960's. Where no rating is given, the crop is considered unsuitable or is not commonly grown, or no information is available on which to base an estimate. Steep and severely eroded soils, shallow and very shallow soils, Alluvial land, Fresh water marsh, Made land, Muck and Peat, and Rock outcrop are not included]

Soil	Crops [1]								Forage mixtures (hay) [2]									
	Corn				Oats		Wheat		Alfalfa-grass				Alfalfa-birdsfoot trefoil-grass		Birdsfoot trefoil-grass			
	Silage		Grain						2- to 3-yr. stands [3]		3- to 5-yr. stands [4]		3- to 5-yr. stands [5]		3- to 6-yr. stands [6]		4- to 10-yr. stands [7]	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Arkport fine sandy loam, 2 to 6 percent slopes	11	15	50	85	45	60	35	50	2.5	3 5	2.0	3.0	----	----	----	----	----	----
Arkport fine sandy loam, 6 to 12 percent slopes	11	15	50	85	45	60	35	50	2.5	3.5	2.0	3.0	----	----	----	----	----	----
Bath channery silt loam, 2 to 5 percent slopes	10	15	50	80	50	70	30	45	3.0	4.0	2.5	3.5	2.5	3.5	2.0	3.0	2.0	2.5
Bath channery silt loam, 5 to 15 percent slopes	9	14	45	75	45	65	30	45	3.0	4.0	2.5	3.5	2.5	3.5	2.0	3.0	2.0	2.5
Bath channery silt loam, 5 to 15 percent slopes, eroded	8	13	40	70	40	60	25	40	2.5	3.5	2.0	3.0	2.0	3.0	2.0	3.0	1.5	2.5
Bath channery silt loam, 15 to 25 percent slopes	----	----	----	----	40	60	([1])	----	----	----	2.0	3.0	2.0	3.0	2.0	3.0	1.5	2.5
Bath and Valois gravelly silt loams, 5 to 15 percent slopes	11	15	50	80	50	70	30	50	3.0	4.0	2.5	4.0	2.5	4.0	2.5	3.0	2.0	2.5
Bath and Valois gravelly silt loams, 5 to 15 percent slopes, eroded	9	14	40	70	40	60	25	40	3.0	3.5	2.5	3.5	2.5	3.5	2.0	3.0	1.5	2.5
Bath and Valois gravelly silt loams, 15 to 25 percent slopes	----	----	----	----	40	60	----	----	----	----	2.0	3.0	2.0	3.0	2.0	3.0	1.5	2.5
Braceville gravelly silt loam, 0 to 5 percent slopes	9	14	45	75	40	60	30	45	3. 0	4. 0	2. 5	3. 5	2. 5	3. 5	2. 0	3. 0	2. 0	2. 5
Canandaigua and Lamson soils	----	10	----	----	30	40	----	----	----	----	----	----	----	2. 0	1. 0	2. 0	1. 0	1. 5
Chenango gravelly loam, 0 to 5 percent slopes	11	15	55	85	45	65	35	50	3. 5	4. 5	3. 0	4. 0	----	----	----	----	----	----
Chenango gravelly loam, 5 to 15 percent slopes	11	15	50	85	45	65	30	45	3. 5	4. 5	3. 0	4. 0	----	----	----	----	----	----
Chenango gravelly loam, 15 to 25 percent slopes	----	----	----	----	40	55	----	----	----	----	2. 5	3. 5	----	----	2. 0	3. 0	1. 5	2. 5
Chenango gravelly loam, fan, 0 to 8 percent slopes	9	13	45	75	40	55	25	45	3. 0	4. 0	3. 0	3. 5	----	----	----	----	----	----
Conesus gravelly silt loam, 0 to 3 percent slopes	11	15	50	80	50	70	35	50	3. 0	4. 0	3. 0	4. 0	2. 5	3. 5	2. 5	3. 0	2. 0	2. 5
Conesus gravelly silt loam, 3 to 8 percent slopes	12	16	55	90	55	75	30	50	3. 0	4. 0	3. 0	4. 0	2. 5	3. 5	2. 5	3. 0	2. 0	2. 5
Conesus gravelly silt loam, 3 to 8 percent slopes, eroded	10	14	45	75	45	65	30	45	3. 0	4. 0	3. 0	3. 5	2. 5	3. 5	2. 0	3. 0	1. 5	2. 0
Darien gravelly silt loam, 2 to 8 percent slopes	10	12	35	65	40	55	25	40	----	----	2. 5	3. 5	2. 0	3. 0	2. 0	3. 0	1. 5	2. 0
Eel silt loam	13	18	65	95	55	75	35	50	3. 5	4. 0	3. 5	4. 0	3. 0	3. 5	3. 0	3. 5	2. 0	2. 5
Ellery, Chippewa, and Alden soils, 0 to 8 percent slopes	----	----	----	----	20	30	----	----	----	----	----	----	----	----	1. 5	2. 5	1. 5	2. 0
Erie-Ellery channery silt loams, 0 to 3 percent slopes	----	----	----	----	30	45	----	----	----	----	----	----	----	----	1. 5	2. 5	1. 0	2. 0
Erie channery silt loam, 3 to 8 percent slopes	8	11	----	----	35	45	----	----	----	----	----	----	2. 0	3. 0	2. 0	3. 0	1. 5	2. 5
Erie channery silt loam, 3 to 8 percent slopes, eroded	7	10	----	----	30	40	----	----	----	----	----	----	2. 0	3. 0	1. 5	2. 5	1. 0	2. 0
Erie channery silt loam, 8 to 15 percent slopes	7	10	----	----	35	45	----	----	----	----	----	----	2. 0	3. 0	2. 0	3. 0	1. 5	2. 5
Erie channery silt loam, 8 to 15 percent slopes, eroded	6	9	----	----	30	40	----	----	----	----	----	----	2. 0	3. 0	1. 5	2. 5	1. 5	2. 0
Fredon silt loam, 0 to 5 percent slopes	----	14	----	----	30	45	----	----	----	----	----	----	----	3. 0	2. 0	3. 0	1. 5	2. 5
Genesee silt loam	14	18	65	100	55	75	35	50	4. 0	5. 0	3. 0	4. 5	----	----	----	----	----	----
Halsey silt loam	----	----	----	----	30	50	----	----	----	----	----	----	----	3. 0	2. 0	3. 0	1. 5	2. 0
Halsey mucky silt loam	----	----	----	----	----	40	----	----	----	----	----	----	----	----	1. 5	2. 5	1. 0	2. 0

See footnotes at end of table.

TABLE 8.—*Estimated average acre yields of specified crops under two levels of management*—Continued

Soil	Crops [1]								Forage mixtures (hay) [2]									
	Corn				Oats		Wheat		Alfalfa-grass				Alfalfa-birdsfoot trefoil-grass		Birdsfoot trefoil-grass			
	Silage		Grain						2- to 3-yr. stands [3]		3- to 5-yr. stands [4]		3- to 5-yr. stands [5]		3- to 6-yr. stands [6]		4- to 10-yr. stands [7]	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Holly and Papakating soils	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	2.0	1.0	1.5
Honeoye gravelly silt loam, 2 to 8 percent slopes	12	17	60	100	55	75	40	55	3.5	4.5	3.0	4.0	3.0	4.0	2.5	3.0	2.0	2.5
Honeoye gravelly silt loam, 8 to 15 percent slopes	12	17	60	100	55	75	40	55	3.5	4.5	3.0	4.0	--	--	2.5	3.0	2.0	2.5
Honeoye gravelly silt loam, 8 to 15 percent slopes, eroded	11	15	50	80	50	70	30	45	3.0	4.0	2.5	3.5	2.5	3.5	2.5	3.0	2.0	2.5
Howard gravelly loam, 0 to 5 percent slopes	11	15	50	85	50	70	35	50	3.5	4.5	3.0	4.0	--	--	--	--	--	--
Howard gravelly loam, 5 to 15 percent simple slopes	11	15	50	85	50	70	35	50	3.5	4.0	3.0	4.0	--	--	--	--	--	--
Howard gravelly loam, 5 to 15 percent complex slopes	11	15	50	85	50	70	30	45	3.5	4.0	2.5	3.5	--	--	2.0	3.0	2.0	2.5
Howard gravelly loam, 15 to 25 percent slopes	--	--	--	--	40	60	--	--	--	--	2.0	3.5	--	--	2.0	2.5	1.5	2.5
Howard-Valois gravelly loams, 5 to 15 percent slopes	11	15	50	85	50	70	30	45	3.5	4.0	2.5	3.5	--	--	--	3.0	--	2.5
Howard-Valois gravelly loams, 15 to 25 percent slopes	--	--	--	--	40	60	--	--	--	--	2.0	3.5	--	--	2.0	2.5	1.5	2.0
Hudson silty clay loam, 2 to 6 percent slopes	11	16	45	80	50	70	35	50	3.0	4.0	3.0	4.0	3.0	4.0	2.0	3.0	1.5	2.5
Hudson silty clay loam, 6 to 12 percent slopes, eroded	10	14	40	70	40	60	30	40	3.0	4.0	2.5	3.5	2.5	3.5	2.0	3.0	1.5	2.5
Hudson silty clay loam, 12 to 20 percent slopes, eroded	9	12	35	60	35	50	--	--	--	--	2.5	3.5	2.5	3.5	1.5	3.0	1.5	2.5
Hudson-Cayuga silt loams, 2 to 6 percent slopes	11	16	50	85	50	70	35	50	3.0	4.5	3.0	4.0	3.0	4.0	2.5	3.0	2.0	2.5
Hudson-Cayuga silt loams, 2 to 6 percent slopes, eroded	10	14	40	70	40	60	30	40	3.0	4.0	3.0	4.0	3.0	4.0	2.0	3.0	1.5	2.5
Hudson-Cayuga silt loams, 6 to 12 percent slopes, eroded	10	14	40	70	40	60	30	40	3.0	4.0	2.5	3.5	2.5	3.5	2.0	3.0	1.5	2.5
Hudson-Cayuga silt loams, 12 to 20 percent slopes	10	12	40	70	35	50	--	--	--	--	2.5	3.5	2.5	3.5	2.0	3.0	1.5	2.5
Hudson and Collamer silt loams, 2 to 6 percent slopes	11	16	45	80	50	70	35	50	3.0	4.5	3.0	4.0	3.0	4.0	2.5	3.0	2.0	2.5
Ilion silty clay loam, 0 to 2 percent slopes	--	--	--	--	30	50	--	--	--	--	--	--	2.0	3.0	2.0	3.0	1.5	2.5
Ilion silty clay loam, 2 to 6 percent slopes	--	10	--	--	30	50	--	--	--	--	--	--	--	--	2.0	2.5	1.5	2.0
Kendaia and Lyons silt loams, 0 to 3 percent slopes	9	12	40	70	35	55	30	45	--	--	2.0	3.5	2.0	3.5	2.0	3.0	2.0	2.5
Kendaia silt loam, 3 to 8 percent slopes	10	16	40	90	50	70	30	45	--	--	--	3.0	--	3.0	2.0	3.0	2.0	2.5
Langford channery silt loam, 2 to 8 percent slopes	10	14	35	70	45	60	30	45	3.0	4.0	2.5	3.5	2.5	3.5	2.0	3.0	2.0	2.5
Langford channery silt loam, 3 to 8 percent slopes, eroded	9	13	30	65	40	55	25	40	2.5	3.5	2.5	3.5	2.5	3.5	1.5	2.5	1.5	2.0
Langford channery silt loam, 8 to 15 percent slopes	10	14	35	70	45	60	30	45	3.0	4.0	2.5	4.0	2.5	3.5	2.0	3.0	2.0	2.5
Langford channery silt loam, 8 to 15 percent slopes, eroded	9	13	30	65	40	55	25	40	2.5	3.5	2.0	3.0	2.0	3.0	1.5	2.5	1.5	2.0
Lansing gravelly silt loam, 0 to 3 percent slopes	11	17	50	100	50	70	35	50	4.0	4.5	3.0	4.0	3.0	4.0	2.5	3.0	2.0	2.5
Lansing gravelly silt loam, 3 to 8 percent slopes	11	17	50	100	50	70	35	50	4.0	4.5	3.0	4.0	3.0	4.0	2.5	3.0	2.0	2.5
Lansing gravelly silt loam, 3 to 8 percent slopes, eroded	10	15	40	80	45	65	30	45	3.5	4.0	2.5	3.5	2.5	3.5	2.0	2.5	1.5	2.0

See footnotes at end of table.

TABLE 8.—*Estimated average acre yields of specified crops under two levels of management*—Continued

Soil	Crops [1]								Forage mixtures (hay) [2]									
	Corn				Oats		Wheat		Alfalfa-grass				Alfalfa-birdsfoot trefoil-grass		Birdsfoot trefoil-grass			
	Silage		Grain						2- to 3-yr. stands [3]		3- to 5-yr. stands [4]		3- to 5-yr. stands [5]		3- to 6-yr. stands [6]		4- to 10-yr. stands [7]	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Lansing gravelly silt loam, 8 to 15 percent slopes	11	15	50	80	50	70	35	45	4.0	4.5	3.0	4.0	3.0	4.0	2.5	3.0	2.0	2.5
Lansing gravelly silt loam, 8 to 15 percent slopes, eroded	10	14	40	70	40	60	30	40	3.0	4.0	2.5	3.5	2.5	3.5	2.0	2.5	1.5	2.0
Lima silt loam, 0 to 3 percent slopes	10	16	40	90	50	75	35	50	3.0	4.0	2.5	4.0	2.5	4.0	2.5	3.0	2.0	2.5
Lima silt loam, 3 to 8 percent slopes	11	16	45	90	50	75	35	50	3.5	4.5	2.5	4.0	2.5	4.0	2.5	3.0	2.0	2.5
Lima silt loam, 3 to 8 percent slopes, eroded	10	14	40	75	45	70	30	45	3.0	4.0	2.0	3.5	2.0	3.5	2.0	3.0	1.5	2.5
Lordstown channery silt loam, 5 to 15 percent slopes	8	12	30	70	40	60	----	----	2.5	3.5	2.0	3.0	2.0	3.0	1.5	2.5	1.5	2.0
Lordstown channery silt loam, 5 to 15 percent slopes, eroded	7	11	30	60	35	50	----	----	2.0	3.0	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.0
Lordstown channery silt loam, 15 to 25 percent slopes	----	----	----	----	30	50	----	----	----	----	1.5	2.5	1.5	2.5	1.5	2.5	1.5	2.0
Lyons silt loam	----	14	----	----	----	45	----	----	----	----	----	----	----	2.5	1.5	2.5	1.0	2.0
Madalin silty clay loam	----	10	----	----	25	50	----	----	----	----	----	----	----	3.0	2.0	3.0	1.5	2.5
Madalin mucky silty clay loam	----	----	----	----	----	40	----	----	----	----	----	----	----	----	1.5	3.0	1.0	2.5
Mardin channery silt loam, 2 to 8 percent slopes	9	13	35	65	35	55	----	----	----	----	2.5	3.5	2.5	3.5	2.0	3.0	1.5	2.5
Mardin channery silt loam, 8 to 15 percent slopes	9	13	35	70	40	60	----	----	----	----	2.5	3.5	2.5	3.5	2.0	3.0	1.5	2.5
Mardin channery silt loam, 8 to 15 percent slopes, eroded	8	12	30	60	30	50	----	----	----	----	2.0	3.0	2.0	3.0	1.5	2.5	1.5	2.0
Mardin and Langford soils, 15 to 25 percent slopes	----	----	----	----	30	50	----	----	----	----	2.0	3.0	2.0	3.0	2.0	3.0	1.5	2.0
Middlebury and Tioga silt loams	14	18	65	100	55	75	35	50	3.0	4.0	3.0	4.5	3.0	4.5	2.5	3.0	2.0	2.5
Niagara silt loam, 2 to 6 percent slopes	9	12	----	70	40	55	----	----	----	----	----	3.0	2.5	3.5	2.0	3.0	2.0	2.5
Ovid silt loam, 0 to 6 percent slopes	10	14	45	75	50	70	30	45	----	----	3.0	4.0	3.0	4.0	2.5	3.0	1.0	2.5
Ovid silty clay loam, 6 to 12 percent slopes, eroded	8	12	35	65	40	60	30	40	----	----	2.5	3.5	2.5	3.5	2.5	3.0	2.0	2.5
Ovid and Rhinebeck silt loams, moderately deep, 0 to 2 percent slopes	----	----	----	----	30	50	----	----	----	----	----	----	2.0	3.0	2.0	3.0	1.5	2.5
Ovid and Rhinebeck silt loams, moderately deep, 2 to 6 percent slopes	9	12	35	65	35	50	----	----	----	----	----	----	2.0	3.0	2.0	3.0	1.5	2.5
Ovid and Rhinebeck silt loams, moderately deep, 6 to 12 percent slopes	8	12	35	65	40	55	----	----	----	----	----	----	2.0	3.0	2.0	3.0	1.5	2.5
Palmyra gravelly loam, 0 to 5 percent slopes	11	15	50	85	50	70	35	50	3.5	4.5	3.0	4.0	----	----	----	----	----	----
Palmyra gravelly loam, 5 to 15 percent simple slopes	11	15	50	85	50	70	35	50	3.5	4.0	3.0	4.0	----	----	----	----	----	----
Palmyra gravelly loam, 5 to 15 percent complex slopes	11	15	50	85	50	70	30	45	3.0	4.0	3.0	4.0	----	----	2.0	3.0	2.0	2.5
Palmyra gravelly loam, 15 to 25 percent slopes	----	----	----	----	40	60	----	----	----	----	2.0	3.5	----	----	2.0	3.0	1.5	2.0
Phelps gravelly silt loam, 0 to 3 percent slopes	11	15	50	80	50	70	30	50	3.0	4.0	3.0	4.0	3.0	4.0	2.0	3.0	2.0	2.5
Phelps gravelly silt loam, 3 to 8 percent slopes	11	15	50	85	50	70	30	50	3.0	4.0	3.0	4.0	3.0	4.0	2.0	3.0	2.0	2.5
Red Hook gravelly silt loam, 0 to 5 percent slopes	----	----	----	----	40	65	----	----	----	----	----	----	----	3.0	2.0	3.0	1.5	2.0
Rhinebeck silt loam, 0 to 2 percent slopes	8	12	----	----	30	45	----	----	----	----	----	----	2.5	3.5	2.5	3.0	2.0	2.5
Rhinebeck silt loam, 2 to 6 percent slopes	8	12	----	----	40	55	----	----	----	----	----	----	2.5	3.5	2.5	3.0	2.0	2.5

See footnotes at end of table.

TABLE 8.—*Estimated average acre yields of specified crops under two levels of management*—Continued

Soil	Crops [1]								Forage mixtures (hay) [2]									
	Corn				Oats		Wheat		Alfalfa-grass				Alfalfa-birdsfoot trefoil-grass		Birdsfoot trefoil-grass			
	Silage		Grain						2- to 3-yr. stands [3]		3- to 5-yr. stands [4]		3- to 5-yr. stands [5]		3- to 6-yr. stands [6]		4- to 10-yr. stands [7]	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Rhinebeck silty clay loam, 6 to 12 percent slopes, eroded	9	12	---	---	40	55	---	---	---	---	---	---	2. 5	3. 5	2. 5	3. 0	2. 0	2. 5
Volusia channery silt loam, 3 to 8 percent slopes	6	10	---	---	30	45	---	---	---	---	---	---	---	2. 5	1. 5	2. 5	1. 5	2. 0
Volusia channery silt loam, 3 to 8 percent slopes, eroded	---	---	---	---	25	40	---	---	---	---	---	---	---	2. 0	1. 0	2. 0	1. 5	2. 0
Volusia channery silt loam, 8 to 15 percent slopes	7	10	---	---	35	45	---	---	---	---	---	---	---	2. 5	1. 5	2. 5	1. 5	2. 0
Volusia channery silt loam, 8 to 15 percent slopes, eroded	---	---	---	---	35	40	---	---	---	---	---	---	---	2. 0	1. 0	2. 0	1. 5	2. 0
Volusia-Chippewa channery silt loams, 0 to 3 percent slopes	---	---	---	---	30	40	---	---	---	---	---	---	---	---	1. 5	2. 5	1. 5	2. 0
Volusia and Erie soils, 15 to 25 percent slopes	---	---	---	---	30	40	---	---	---	---	---	---	---	2. 0	1. 0	2. 0	1. 0	2. 0
Wayland and Sloan silt loams	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1. 0	2. 0	1. 0	1. 5
Williamson very fine sandy loam, 2 to 6 percent slopes	9	12	40	70	40	55	---	---	---	---	2. 5	4. 0	2. 5	4. 0	2. 0	3. 0	2. 0	2. 5

[1] Assumes the variety best suited to local soil and climate will be used. Variations of 20 percent (either more or less) from these estimates are to be expected from one year to another because of variations in weather. Estimates are rounded to the nearest 5-bushel interval for grains and to the nearest ton for corn silage.

[2] Estimated as tons of hay equivalent for hay, silage, or pasture. Estimates are rounded to the nearest half-ton interval. Estimates are for the perennial legume and grass varieties and mixtures recommended and commonly grown in Tompkins County during the early 1960's. Readers of this section should refer to current recommendations, which will incorporate the best available varieties and mixtures. It is expected that yields, especially at the B level, will increase 10 to 25 percent by 1975 as a result of the development of new varieties and improved technology of production. Yields increased approximately 2 percent per year in New York State during the 1950's.

[3] DuPuits, Alfa, Saranac, or Cayuga alfalfa mixed with Saratoga smooth brome, commercial orchardgrass, or common timothy; intensively managed; three cuts per year; life of stand ordinarily 2 or 3 years, but Cayuga variety generally lasts 2 to 4 years.

[4] Narragansett or Vernal alfalfa mixed with Saratoga smooth brome or with Climax, Essex, or common timothy; two cuts per year; life of stand ordinarily 3 to 5 years.

[5] Narragansett alfalfa and Viking birdsfoot trefoil mixed with Climax timothy; two cuts per year; life of stand ordinarily 3 to 5 years.

[6] Viking birdsfoot trefoil mixed with Climax or Essex timothy; two cuts per year; life of stand ordinarily 3 to 6 years.

[7] Empire trefoil mixed with Climax or Essex timothy; two cuts per year; life of stand ordinarily 4 to 10 years.

The relationship between yields obtained under B-level management and potential yields, or soil productivity, should be emphasized. Soil productivity may be defined as the quality of a soil that determines its potential for production of specified plants under defined systems of management practices. Because so many interactions of the seven variable factors affect yields, the potential yield is seldom obtainable unless all factors are favorable in a given year. Research and careful observation have shown that a potential yield may be 25 to 50 percent more than that which a skilled farmer can reasonably expect to obtain in 4 years out of 5. In Tompkins County, the term B-level yield means a reasonably expectable yield.

A final word of caution concerning the B-level yield estimates is appropriate. Since the late 1950's, the more skillful New York State farmers have not been following generalized recommendations but are adjusting combinations of soil-, water-, and crop-management practices to each particular soil to obtain the yields that support their individual operations.

Woodland [16]

Woodland covers 105,000 acres in Tompkins County, more than 30 percent of the acreage. The State owns more than 4,000 acres. The average size of farm woodlots is 21 acres, and an estimated 25 percent of farm woodland is grazed by livestock.

In the extreme northern part of the county, the beech-birch-maple type of the northern hardwood complex is found. Though not extensive, it is economically by far the most important woodland type in the county. In many places the birch is poor or lacking and has been replaced by white ash.

[16] This section prepared by ROBERT E. SMITH, JR., woodland specialist, Soil Conservation Service, and EARL L. STONE, professor of forest soils, Cornell University. The descriptions of woodland regions are based on Atlas of Forestry in New York (1958), State University College of Forestry, by NEIL J. STOUT, (*18*), and on personal correspondence with ED KARSH, a New York State forester.

The most extensive forest type in the county, though second in economic importance, is the oak type—a holdover from the oak-chestnut type, which before 1920 covered most of the county. The associated species are red maple, beech, and hard maple.

In the southern part of the county, especially on the coarser textured soils, white pine and aspen forest types are found. They are of limited economic importance.

The Eastern Lake Plains woodland region extends into the northwestern corner of the county (fig. 16). About one-fifth of the acreage is in woodland. Included are excellent forest sites on which trees of superior form grow rapidly. Stands of elm and soft maple, common on the poorly drained soils, make up the bulk of the natural forest now remaining.

Oak and hickory occur on the driest sites. White ash, hard maple, basswood, walnut, and tulip-poplar are found on sites that are neither too wet nor too dry. Scattered clumps of black locust are found. Woodlot grazing has reduced the quality and amount of wood produced.

The rest of the county is in the Appalachian Highlands geographic region. Forests predominantly of hard maple, beech, black cherry, white ash, basswood, and hemlock cover one-third of the Northeastern Appalachian Region in the county and occur as scattered farm woodlots. Hard maple and basswood attain superior quality. Farm use of wood and sale of wood products is important in the rural economy. Maple sirup is one of the chief products. This area presents outstanding opportunities for growing high-quality hardwoods.

Forests cover one-third of the Southern Finger Lakes woodland region of the county. Oak forest types are widespread, and there are small tracts of white pine, hemlock-hardwood, and pure stands of northern hardwoods.

More than 40 percent of the Tioga Uplands region in the southern part of the county is wooded. Forests are concentrated on valley sides and steep slopes. Oak is most commonly found on dry, south-facing slopes, but some of the best oak stands in New York are found in this area on deep soils having north and east exposures. There are also stands of high-quality white ash, basswood, hard maple, and black cherry. Hemlock is found along the streams.

Basic to increased production of wood crops is practical knowledge of soil conditions that influence germination, survival, composition, and growth rates. Such information is presented in table 9, Suitability of the Soils for Woodland, and in the descriptions of the woodland suitability groups. Table 9, although somewhat generalized, gives ratings of productivity; evaluations of the hazards of plant competition, equipment limitations, erosion hazard, and windthrow hazard; and suggestions for native species priority. Any exceptions to the generalized ratings are discussed in the descriptions of the woodland suitability groups.

Woodland group 16, which consists of land types and undifferentiated units, is omitted from table 9, because the soil and land conditions are too variable to rate unless a critical on-site evaluation is made.

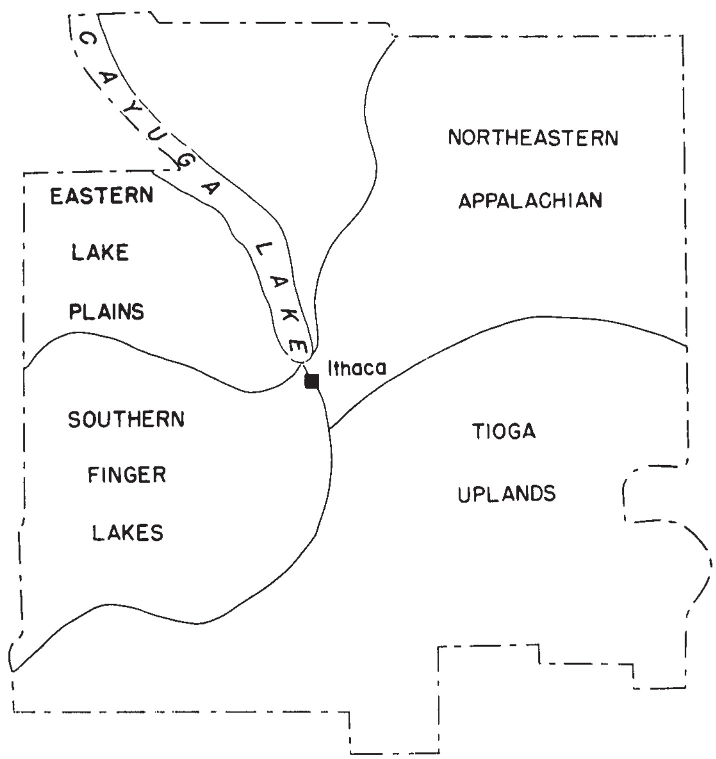

Figure 16.—**Woodland regions in Tompkins County.**

For woodland interpretations, the soils of Tompkins County have been placed in woodland suitability groups. Texture, drainage, available moisture capacity, nutrient-supplying power, depth to bedrock or fragipan, slope, and erosion were considered in making up the groups. These groupings are based on existing information and on the best estimates of foresters and soil scientists. Each mapping unit within a group includes other soils, or phases of soils, areas of which are too small to be mapped separately. For example, Lordstown channery silt loam, 5 to 15 percent slopes, may contain inclusions of the sloping Bath soils or the gently sloping Mardin soils. The ratings, recommendations, and comments necessarily are based on the soil named and not on the inclusions.

A woodland suitability group consists of soils that can be expected to produce similar kinds of wood crops, that need similar management to produce these crops, and that have about the same potential productivity. Each group is rated on the basis of productivity, plant competition, equipment limitation, and erosion and windthrow hazards. Some groups are divided into subgroups because the soils, though similar for other interpretations, differ in equipment limitations and in erosion and windthrow hazards.

The native species priority for each group is a list of the individual, or the associations of, hardwoods that appear to be best suited to the soils within the group. Priority is based on the natural adaptation of the species, the soil requirements of the species, and the commercial demand.

The potential productivity ratings assigned to each group are based on such soil features as drainage, texture, depth, slope, and erosion. No consideration is given to management. A rating of good indicates that valuable

Table 9.—*Suitability of the soils for woodland*

Woodland groups	Estimated ratings for—					Native species priority
	Potential productivity	Plant competition	Equipment limitations	Erosion hazard	Windthrow hazard	
Group 1. Well-drained, medium-textured and moderately coarse textured, dominantly acid soils.						
1a—0 to 15 percent slopes: Arkport (ArB, ArC); Howard(HdA, HdC, HdCK); Palmyra (PaA, PaC, PaCK); Chenango (CdA, CdC, CnB); Howard-Valois (HrC).	Good	Moderate	Slight	Slight	Slight	Sugar maple, black cherry, white ash, basswood, red oak.
1b—15 to 35 percent slopes: Chenango (CdD); Howard (HdD); Howard and Palmyra (HpE); Howard-Valois (HrD); Palmyra (PaD).	Good	Moderate	Moderate	Slight	Slight	Sugar maple, black cherry, white ash, basswood, red oak.
Group 2. Well drained and moderately well drained, medium-textured, slightly acid or neutral soils.						
0 to 15 percent slopes: Honeoye (HmB, HmC, HmC3); Lima (LmA, LmB, LmB3); Phelps (PhA, PhB).	Good	Moderate to severe.	Slight	Slight	Slight	White ash, black cherry, black walnut, tulip-poplar, sugar maple, red oak.
Group 3. Nearly level, well drained and moderately well drained, medium-textured, acid to neutral soils on flood plains.						
Eel (Em); Genesee (Gn); Middlebury and Tioga (Mo).	Good	Severe	Slight	Slight	Slight	White ash, basswood, cottonwood, sugar maple, oak.
Group 4. Well drained and moderately well drained, medium-textured, strongly acid to slightly acid soils.						
0 to 15 percent slopes: Conesus (CfA, CfB, CfB3); Lansing (LbA, LbB, LbB3, LbC, LbC3); Williamson (WrB).	Good to fair	Moderate to slight.	Slight	Slight	Slight	Sugar maple, white ash, black cherry, basswood, red oak.
Group 5. Well-drained, medium-textured, acid soils that have a fragipan.						
5a—2 to 15 percent slopes: Bath (BaB, BaC, BaC3); Bath and Valois (BgC, BgC3).	Fair to good	Moderate	Slight	Slight	Slight	Red oak, sugar maple, white ash, black cherry, white pine.
5b—15 to 35 percent slopes: Bath (BaD); Bath and Valois (BgD, BoE).	Fair to good	Moderate	Moderate	Moderate	Slight	Red oak, sugar maple, white ash, black cherry, white pine.
Group 6. Moderately well drained to well drained, medium-textured and fine-textured, medium acid to neutral soils.						
6a—2 to 12 percent slopes: Hudson (HsB, HsC3); Hudson-Cayuga (HuB, HuB3, HuC3); Hudson and Collamer (HwB).	Fair to good	Moderate to slight.	Moderate to slight.	Slight	Moderate	Sugar maple, white ash, basswood, red oak.
6b—12 to 20 percent slopes: Hudson (HsD3); Hudson-Cayuga (HuD).	Fair to good	Moderate to slight.	Moderate	Moderate	Moderate	Sugar maple, white ash, basswood, red oak.
6c—20 to 45 percent slopes: Hudson and Dunkirk (HzE).	Fair to good	Moderate to slight.	Severe	Severe	Moderate	Sugar maple, white ash, basswood, red oak.

TABLE 9.—*Suitability of the soils for woodland*—Continued

Woodland groups	Estimated ratings for—					Native species priority
	Potential productivity	Plant competition	Equipment limitations	Erosion hazard	Windthrow hazard	
Group 7. Well-drained, medium-textured and moderately coarse textured, medium acid to slightly acid soils.						
35 to 60 percent slopes: Howard and Palmyra (HpF).	Fair to good	Slight	Severe	Moderate	Slight	Red oak, sugar maple, black cherry, white ash.
Group 8. Moderately well drained, medium-textured, acid soils that have a fragipan.						
8a—2 to 15 percent slopes: Braceville (BvA): Langford (LaB, LaB3, LaC, LaC3); Mardin (MaB, MaC, MaC3).	Fair	Moderate	Slight	Slight	Slight	Sugar maple, white ash, basswood, black cherry, red oak.
8b—15 to 25 percent slopes: Mardin and Langford (MfD).	Fair	Moderate	Moderate	Moderate	Slight	Sugar maple, white ash, basswood, black cherry, red oak.
Group 9. Somewhat poorly drained, medium-textured, acid soils that have a fragipan.						
9a—0 to 15 percent slopes: Erie (EbB, EbC); Red Hook (RhA); Volusia (VbB, VbC).	Fair	Moderate	Slight	Slight	Moderate to severe.	Sugar maple, oak, hemlock.
9b—3 to 15 percent slopes, eroded: Erie (EbB3, EbC3); Volusia (VbB3, VbC3).	Poor	Slight	Slight	Moderate	Moderate to severe.	Sugar maple, oak, hemlock.
9c—15 to 25 percent slopes: Volusia and Erie (VrD).	Fair to poor	Moderate to slight.	Moderate	Moderate	Moderate to severe.	Sugar maple, oak, hemlock.
Group 10. Well-drained, medium-textured, medium acid to slightly acid soils. Bath soils have a fragipan.						
35 to 60 percent slopes: Bath, Valois, and Lansing (BtF).	Fair	Slight	Moderate to severe.	Moderate to severe.	Slight	Red oak, sugar maple, white ash, white pine, black cherry.
Group 11. Somewhat poorly drained and moderately well drained, medium-textured to fine-textured, medium acid to neutral soils.						
11a—0 to 8 percent slopes: Darien (DgB); Fredon (FdB); Kendaia (KaB); Niagara (NaB); Ovid (OaA); Ovid and Rhinebeck (OrA, OrB); Rhinebeck (RkA, RkB).	Fair to poor	Moderate	Moderate	Slight	Slight	Basswood, white ash, red oak, white oak.
11b—6 to 12 percent slopes: Ovid (OcC3); Ovid and Rhinebeck (OrC); Rhinebeck (RnC3).	Fair to poor	Moderate	Moderate	Moderate	Moderate	Basswood, white ash, red oak, white oak.
Group 12. Well-drained, medium-textured, acid soils; 20 to 40 inches to sandstone and shale bedrock.						
12a—5 to 15 percent slopes: Lordstown (LnC, LnC3).	Fair to poor	Slight	Slight	Slight	Slight to moderate.	Hemlock,[1] sugar maple,[1] white oak, red oak, black oak, white pine.
12b—15 to 35 percent slopes: Lordstown (LnD, LnE).	Fair to poor	Slight	Moderate	Moderate	Slight to moderate.	Hemlock,[1] sugar maple,[1] white oak, red oak, black oak, white pine.

TABLE 9.—*Suitability of the soils for woodland*—Continued

Woodland groups	Estimated ratings for—					Native species priority
	Potential productivity	Plant competition	Equipment limitations	Erosion hazard	Windthrow hazard	
Group 13. Well-drained, medium-textured, acid soils; less than 40 inches to sandstone and shale bedrock.						
35 to 70 percent slopes: Lordstown (LoF).	Poor to fair	Slight	Severe	Severe	Severe	White oak, red oak, black oak, white pine, hemlock.[1]
Group 14. Dominantly poorly drained and very poorly drained, medium-textured to fine-textured, medium acid to neutral soils; subject to overflow or ponding.						
14a—0 to 6 percent slopes: Halsey (Ha); Ilion (IcA, IcB); Kendaia and Lyons (KnA); Madalin (Mn); Wayland and Sloan (Ws).	Poor to fair	Severe	Moderate to severe.	Slight	Moderate to severe.	Ash, basswood, beech, oak, soft maple, hemlock.
14b—Nearly level slopes: Canandaigua and Lamson (Ca); Halsey (Hc); Lyons (Ly); Madalin (Mm).	Poor to fair	Severe	Severe	Slight	Severe	Ash, basswood, beech, oak, soft maple, hemlock.
Group 15. Dominantly poorly drained and very poorly drained, medium-textured, acid to neutral soils. Chippewa, Ellery, Erie, and Volusia soils have a fragipan. Tuller is less than 24 inches to bedrock. Holly and Papakating are subject to flooding.						
0 to 8 percent slopes: Ellery, Chippewa, and Alden (EcA); Erie-Ellery (ErA); Holly and Papakating (Hk); Tuller (TeA); Volusia-Chippewa (VoA).	Poor to fair	Moderate to severe.	Moderate to severe.	Slight	Severe	Oak, hemlock, white pine, basswood, white ash.

[1] Only on the deeper Lordstown soils on north and northeast aspects.

hardwoods, largely of superior form and growth rate, are dominant. A rating of fair indicates that the stand commonly consists of mixed hardwoods and conifers that have good form and moderate growth. A rating of poor indicates that form and growth generally are poor.

Plant competition refers to the rate at which undesirable species are likely to invade a given site. A rating of slight indicates that no special problems are recognized. A rating of moderate indicates that competition will not ordinarily prevent establishment of an adequate stand. A rating of severe indicates that competition is so strong that natural regeneration cannot be relied upon to provide adequate restocking, and that special management and site preparation are probably necessary.

Equipment limitation indicates the degree to which factors such as stoniness, steepness, and wetness restrict the use of equipment commonly used in woods operations. A rating of slight indicates that no special problems are recognized. A rating of moderate indicates that there are seasonal restrictions or that some damage to tree roots can be expected. A rating of severe indicates that there are serious limitations on the use of heavy machinery because of wetness, stoniness, or steepness, and that some damage to tree roots and to soil structure and stability can be expected.

Erosion hazard refers to the relative natural erodibility of the soils, which is a function of soil texture, including coarse fragments, and degree of slope. These ratings refer especially to erosion that may occur during construction of roads and skid trails and during other operations that bare the soil. The ratings are slight, moderate, and severe.

Windthrow hazard represents an evaluation of soil characteristics, principally the depth to bedrock, fragipan, or water table, that control the development of roots and thereby affect wind firmness. These ratings are based on assumptions and on limited field observations of wind damage. A rating of slight indicates no special problem; released trees would be expected to remain standing under normal wind velocities. A rating of moderate indicates that root development is adequate for stability except during periods of excessive wetness and during normal high-velocity winds. A rating of severe indicates that root depth does not give adequate stability; trees are likely to be blown over if released on all sides.

At present, no specific information is available on the disease and insect problems that may arise. It is known that white pine is subject to disease on somewhat poorly drained soils and that the growth of red pine is adversely affected on such soils. Sandy, dry, exposed sites favor the pine-root collar weevil (*Hylobius radicis*) in attacks on

Scotch and Austrian pine, particularly where the trees are widely spaced (*15*).

In table 10 all of the woodland groups except group 16, which consists of land types and undifferentiated units, are rated according to their suitability for specified kinds of trees. Planting suitability differs within some groups, mainly because of differences in the degree of erosion; such groups are divided into subgroups according to the particular limitations.

An "S" rating in this table means that the soils are suitable for the specified tree, that plantations generally develop satisfactorily, and that no serious site hazards are known.

A rating of "L" indicates limited suitability, that is, that the soils are suitable only where drainage and associated factors are favorable. On-site appraisals should be made on such soils. Limitations may result in slow growth or uncertainty as to long-term survival. Additional fertilizer and more intensive cultural practices may be necessary for Christmas trees.

An "N" rating means that the soils are not suitable. Failure, poor growth, or short life are of such frequent occurrence that the species is a poor risk. Moreover, ordinary planting on such soils generally is hazardous.

WOODLAND SUITABILITY GROUP 1

This group consists of nearly level to steep, well-drained, medium-textured and moderately coarse textured soils. These soils formed in gravelly or sandy glacial outwash, in lacustrine sediments, or in waterworked glacial till.

The soils in group 1a are—

Arkport fine sandy loam, 2 to 6 percent slopes.
Arkport fine sandy loam, 6 to 12 percent slopes.
Chenango gravelly loam, 0 to 5 percent slopes.
Chenango gravelly loam, 5 to 15 percent slopes.
Chenango gravelly loam, fan, 0 to 8 percent slopes.
Howard gravelly loam, 0 to 5 percent slopes.
Howard gravelly loam, 5 to 15 percent simple slopes.
Howard gravelly loam, 5 to 15 percent complex slopes.
Howard-Valois gravelly loams, 5 to 15 percent slopes.
Palmyra gravelly loam, 0 to 5 percent slopes.
Palmyra gravelly loam, 5 to 15 percent simple slopes.
Palmyra gravelly loam, 5 to 15 percent complex slopes.

The soils in group 1b are—

Chenango gravelly loam, 15 to 25 percent slopes.
Howard gravelly loam, 15 to 25 percent slopes.
Howard and Palmyra soils, 25 to 35 percent slopes.
Howard-Valois gravelly loams, 15 to 25 percent slopes.
Palmyra gravelly loam, 15 to 25 percent slopes.

All except Palmyra soils are acid in reaction in the surface soil and subsoil but may be calcareous below a depth of 36 to 40 inches. Palmyra soils are slightly acid or neutral in the surface soil and subsoil and calcareous at a depth of 24 to 40 inches.

Valuable hardwoods are native to these soils. Native species that should be favored in management are sugar maple, black cherry, white ash, basswood, and red oak.

The commonly planted conifers are usually suitable for these soils (see tables 9 and 10). If the surface soil is gravelly, it is important to choose drought-resistant species. A reaction above pH 7.0 in the surface soil, which occurs in places on the severely eroded Palmyra soils, restricts the choice of species to Austrian and Scotch pine, European larch, and black locust.

WOODLAND SUITABILITY GROUP 2

This group consists of nearly level to moderately sloping, well drained and moderately well drained, medium-textured soils. These soils formed in high-lime glacial till or gravelly and sandy outwash. They are—

Honeoye gravelly silt loam, 2 to 8 percent slopes.
Honeoye gravelly silt loam, 8 to 15 percent slopes.
Honeoye gravelly silt loam, 8 to 15 percent slopes, eroded.
Lima silt loam, 0 to 3 percent slopes.
Lima silt loam, 3 to 8 percent slopes.
Lima silt loam, 3 to 8 percent slopes, eroded.
Phelps gravelly silt loam, 0 to 3 percent slopes.
Phelps gravelly silt loam, 3 to 8 percent slopes.

These soils are slightly acid or neutral in reaction in the surface soil and subsoil but may become calcareous at a depth of between 16 and 36 inches.

High-quality hardwoods are native to these soils, but few areas remain in natural forest. Native species that should be favored in management are white ash, black cherry, black walnut, tulip-poplar, sugar maple, and red oak.

Competition from weeds and high reaction in the surface soil restrict the choice of conifers (see tables 9 and 10). Red pine should not be planted where the reaction in the surface soil is higher than pH 6.0.

WOODLAND SUITABILITY GROUP 3

The soils in this group are nearly level, well drained and moderately well drained, and medium textured. They formed in acid to high-lime sediments on flood plains. These soils are—

Eel silt loam.
Genesee silt loam.
Middlebury and Tioga silt loams.

Genesee and Eel soils are slightly acid or neutral but may be calcareous within 40 inches of the surface. Middlebury and Tioga silt loams are strongly acid to slightly acid throughout.

These alluvial soils usually are not wooded. They are subject to flooding. Native species that should be favored in management are white ash, basswood, cottonwood, sugar maple, and oaks.

The flooding hazard and heavy weed growth ordinarily restrict planting possibilities (see tables 9 and 10).

WOODLAND SUITABILITY GROUP 4

This group consists of nearly level to moderately sloping, well drained and moderately well drained, medium-textured soils. One of these soils, Williamson very fine sandy loam, 2 to 6 percent slopes, formed in acid, lacustrine silt and very fine sand. The rest formed in medium-lime glacial till. These soils are—

Conesus gravelly silt loam, 0 to 3 percent slopes.
Conesus gravelly silt loam, 3 to 8 percent slopes.
Conesus gravelly silt loam, 3 to 8 percent slopes, eroded.
Lansing gravelly silt loam, 0 to 3 percent slopes.
Lansing gravelly silt loam, 3 to 8 percent slopes.
Lansing gravelly silt loam, 3 to 8 percent slopes, eroded.
Lansing gravelly silt loam, 8 to 15 percent slopes.
Lansing gravelly silt loam, 8 to 15 percent slopes, eroded.
Williamson very fine sandy loam, 2 to 6 percent slopes.

These soils tend to have a somewhat higher base status and higher productivity in the northern part of the county, where they adjoin the soils of woodland suitability group 2.

TABLE 10.—*Suitability of soils*

[Data based on "Planting Sites in the Northeast" (*25*). A rating of "S" indicates that the soils are suitable for the specified tree; "L" Other environmental features, pests, and purpose of

Woodland groups	Forest plantings						
	Pine					Larch	
	Pitch	Jack	Scotch	Red	White	European	Japanese
Group 1. Well-drained, medium-textured and moderately coarse textured, dominantly acid soils.							
1a—0 to 15 percent slopes: Arkport (ArB, ArC); Howard (HdA, HdC, HdCK); Palmyra (PaA, PaC, PaCK); Chenango (CdA, CdC, CnB); Howard-Valois (HrC).	S	S	S	S	S	S	S
1b—15 to 35 percent slopes: Chenango (CdD); Howard (HdD); Howard and Palmyra (HpE); Howard-Valois (HrD); Palmyra (PaD).	S	S	S	S	S	S	S
Group 2. Well drained and moderately well drained, medium-textured, slightly acid or neutral soils, 0 to 15 percent slopes.							
Uneroded soils: Honeoye (HmB, HmC); Lima (LmA, LmB); Phelps (PhA, PhB).	--------	------	L	-------	L	S	S
Eroded soils: Honeoye (HmC3); Lima (LmB3)	N	N	N	N	N	S	S
Group 3. Well drained and moderately well drained, medium-textured, acid or neutral soils on flood plains, nearly level.							
Eel (Em); Genesee (Gn)	--------	------	L	N	L	S	S
Middlebury and Tioga (Mo)	S	S	S	S	S	S	S
Group 4. Well drained and moderately well drained, medium-textured, strongly acid to slightly acid soils.							
0 to 15 percent slopes: Conesus (CfA, CfB, CfB3); Lansing (LbA, LbB, LbB3, LbC, LbC3); Williamson (WrB).	S	L	S	L	S	S	S
Group 5. Well-drained, medium-textured, acid soils that have a fragipan.							
5a—2 to 15 percent slopes: Bath (BaB, BaC, BaC3); Bath and Valois (BgC, BgC3).	S	S	S	S	S	S	S
5b—15 to 35 percent slopes: Bath (BaD); Bath and Valois (BgD, BoE)	S	S	S	S	S	S	S
Group 6. Moderately well drained to well drained, medium-textured and fine-textured, medium acid to neutral soils.							
6a—2 to 12 percent slopes:							
Uneroded soils: Hudson (HsB); Hudson-Cayuga (HuB); Hudson and Collamer (HwB).	--------	N	L	N	L	S	S
Eroded soils: Hudson (HsC3); Hudson-Cayuga (HuB3, HuC3)	N	N	N	N	N	S	S
6b—12 to 20 percent slopes:							
Uneroded soils: Hudson-Cayuga (HuD)	--------	N	L	N	L	S	S
Eroded soils: Hudson (HsD3)	N	N	N	N	N	S	S
6c—20 to 45 percent slopes: Hudson and Dunkirk (HzE)	--------	N	L	N	L	S	S
Group 7. Well-drained, medium-textured and moderately coarse textured, medium acid to slightly acid soils.							
35 to 60 percent slopes: Howard and Palmyra (HpF)	S	S	S	S	S	S	L
Group 8. Moderately well drained, medium-textured, acid soils that have a fragipan.							
8a—2 to 15 percent slopes:							
Uneroded soils: Braceville (BvA); Langford (LaB, LaC); Mardin (MaB, MaC).	S	S	S	L	S	S	S
Eroded soils: Langford (LaB3, LaC3); Mardin (MaC3)	S	L	S	N	S	S	S
8b—15 to 25 percent slopes: Mardin and Langford (MfD)	S	S	S	L	S	S	S
Group 9. Somewhat poorly drained, medium-textured, acid soils that have a fragipan.							
9a—0 to 15 percent slopes: Erie (EbB, EbC); Red Hook (RhA); Volusia (VbB, VbC).	S	L	L	N	L	L	L
9b—3 to 15 percent slopes, eroded: Erie (EbB3, EbC3); Volusia (VbB3, VbC3).	L	------	L	N	L	L	L
9c—15 to 25 percent slopes: Volusia and Erie (VrD)	S	L	L	N	L	L	L
Group 10. Well-drained, medium-textured, medium acid to slightly acid soils. Bath soils have a fragipan.							
35 to 60 percent slopes: Bath, Valois, and Lansing (BtF)	S	S	S	S	S	S	S
Group 11. Somewhat poorly drained and moderately well drained, medium-textured to fine-textured, medium acid to neutral soils.							
11a—0 to 8 percent slopes: Darien (DgB); Fredon (FdB); Kendaia (KaB); Niagara (NaB); Ovid (OaA); Ovid and Rhinebeck (OrA, OrB); Rhinebeck (RkA, RkB).	--------	N	L	N	L	S	S
11b—6 to 12 percent slopes:							
Uneroded soils: Ovid and Rhinebeck (OrC)	--------	N	L	N	L	S	S
Eroded soils: Ovid (OcC3); Rhinebeck (RnC3)	N	N	N	N	N	S	S

for specified kinds of trees

indicates limited suitability; "N" indicates that the soils are not suitable. Dashes in a column indicate that information is insufficient. planting must be considered in choice of species]

Forest plantings—Continued										Christmas trees and cover						
Spruce		Cedar		Hemlock	Hardwood					Pine			Fir		Spruce	
Norway	White	White	Red		Black locust	Sugar maple	Oaks	White ash and black cherry	Black walnut	Scotch	Red	Austrian	Douglas	Balsam	Norway	White
S	S	S	S	L	S	L	S	L	------	S	S	S	S	------	S	S
S	S	S	S	L	S	L	S	L	------	S	S	S	S	------	S	S
S	S	S	S	S	S	S	S	S	S	S	------	S	L	S	S	S
S	S	S	S	S	S	S	S	S	S	S	------	S	L	S	S	S
S	S	S	------	S	L	S	S	S	S	S	------	S	L	S	S	S
S	S	S	S	S	L	L	L	L	------	S	------	S	L	S	S	S
S	S	S	S	S	L	S	S	S	L	S	L	S	S	S	S	S
S	S	L	S	S	L	L	L	L	N	S	S	S	S	L	S	S
S	S	L	S	S	L	L	L	L	N	S	S	S	S	L	S	S
S	S	S	S	S	N	L	L	L	------	L	N	--------	L	S	S	S
S	S	S	S	S	N	L	L	L	N	L	N	--------	L	S	S	S
S	S	S	S	S	N	L	L	L	------	L	N	--------	L	S	S	S
S	S	S	S	S	N	L	L	L	N	L	N	--------	L	S	S	S
S	S	S	S	S	L	L	L	L	N	L	N	--------	L	S	S	S
L	L	L	S	N	S	N	N	N	------	S	S	S	L	N	L	L
S	S	L	S	S	L	L	L	L	N	S	S	S	S	L	S	S
S	S	L	------	S	N	N	L	N	N	S	L	S	N	L	S	S
S	S	L	S	S	L	L	L	L	N	S	S	S	S	L	S	S
S	S	N	------	S	N	L	N	N	N	S	N	L	N	L	S	S
S	S	N	------	S	N	N	N	N	N	L	N	L	N	L	S	S
S	S	N	------	S	N	L	N	N	N	S	N	S	N	L	S	S
L	L	L	S	L	L	L	S	N	N	S	S	S	L	------	L	L
S	S	S	S	S	N	L	L	L	N	L	N	S	L	S	S	S
S	S	S	S	S	N	L	L	L	N	L	N	--------	L	S	S	S
S	S	S	S	S	N	L	L	L	N	L	N	--------	L	S	S	S

TABLE 10.—*Suitability of soils for*

Woodland groups	Forest plantings						
	Pine					Larch	
	Pitch	Jack	Scotch	Red	White	European	Japanese
Group 12. Well-drained, medium-textured, acid soils; 20 to 40 inches to sandstone and shale bedrock.							
12a—5 to 15 percent slopes: Lordstown (LnC, LnC3)	S	S	S	S	L	S	L
12b—15 to 35 percent slopes: Lordstown (LnD, LnE)	S	S	S	S	L	S	L
Group 13. Well-drained, medium-textured, acid soils; less than 40 inches to sandstone and shale bedrock.							
35 to 70 percent slopes: Lordstown (LoF)	L	L	L	L	L	L	N
Group 14. Dominantly poorly drained and very poorly drained, medium-textured to fine-textured, medium acid to neutral soils; subject to overflow or ponding.							
14a—0 to 6 percent slopes: Halsey (Ha); Ilion (IcA, IcB); Kendaia and Lyons (KnA); Madalin (Mn); Wayland and Sloan (Ws).	L	N	N	N	L	N	N
14b—Nearly level slopes: Canandaigua and Lamson (Ca); Halsey (Hc); Lyons (Ly); Madalin (Mm).	L	N	N	N	L	N	N
Group 15. Dominantly poorly drained and very poorly drained, medium-textured, acid to neutral soils. Chippewa, Ellery, Erie, and Volusia soils have a fragipan. Tuller soils are less than 24 inches to bedrock. Holly and Papakating soils are subject to flooding.							
0 to 8 percent slopes: Ellery, Chippewa, and Alden (EcA); Erie-Ellery (ErA); Holly and Papakating (Hk); Tuller (TeA); Volusia-Chippewa (VoA).	L	N	N	N	L	N	N

The surface soil and subsoil are strongly acid to slightly acid in reaction. Lansing and Conesus soils are slightly acid or neutral in the upper substratum but become calcareous at a depth of between 30 and 42 inches. Locally, Williamson soils, although they formed in acid material, may become calcareous at a depth of 42 inches. They have a weakly expressed fragipan at a depth of 16 to 24 inches.

Only a small percentage of the acreage remains in natural forest. The forests have deteriorated as a result of grazing and the removal of desirable species, but they can be managed for production of high-quality hardwoods. Native species that should be favored in management are sugar maple, white ash, black cherry, basswood, and red oak.

There are few restrictions to planting on these soils (see tables 9 and 10), except that red pine is poorly suited to the Conesus and Williamson soils that are in the wetter part of the drainage range.

WOODLAND SUITABILITY GROUP 5

The soils in this group are gently sloping to steep, well drained, and medium textured. They formed in glacial till.

The soils in group 5a are—

- Bath channery silt loam, 2 to 5 percent slopes.
- Bath channery silt loam, 5 to 15 percent slopes.
- Bath channery silt loam, 5 to 15 percent slopes, eroded.
- Bath and Valois gravelly silt loams, 5 to 15 percent slopes.
- Bath and Valois gravelly silt loams, 5 to 15 percent slopes, eroded.

The soils in group 5b are—

- Bath channery silt loam, 15 to 25 percent slopes.
- Bath and Valois gravelly silt loams, 15 to 25 percent slopes.
- Bath and Valois soils, 25 to 35 percent slopes.

Bath soils have a strongly to moderately expressed fragipan at a depth of 18 to 30 inches and are acid throughout. Valois soils have slight or no rooting restrictions. They are acid in the surface soil and subsoil and slightly acid to neutral in the substratum, the pH increasing with depth.

These soils are similar to those in woodland suitability group 10, except that they are less steep and in some places are eroded. The eroded soils are the less productive. Native species that should be favored in management are red oak, sugar maple, white ash, black cherry, and white pine. Almost all of the commonly planted conifers are suitable for these soils (see tables 9 and 10). Growth of the more demanding species, such as spruce, may be slower on the eroded soils.

WOODLAND SUITABILITY GROUP 6

The soils in this group are gently sloping to steep, moderately well drained and well drained, and medium textured and moderately fine textured. They formed in lacustrine silt and clay containing free lime, or in deposits of this material over Honeoye and Lansing glacial till.

The soils in group 6a are—

- Hudson silty clay loam, 2 to 6 percent slopes.
- Hudson silty clay loam, 6 to 12 percent slopes, eroded.
- Hudson-Cayuga silt loams, 2 to 6 percent slopes.
- Hudson-Cayuga silt loams, 2 to 6 percent slopes, eroded.
- Hudson-Cayuga silt loams, 6 to 12 percent slopes, eroded.
- Hudson and Collamer silt loams, 2 to 6 percent slopes.

specified kinds of trees—Continued

Forest plantings—Continued										Christmas trees and cover						
Spruce		Cedar		Hemlock	Hardwood					Pine			Fir		Spruce	
Norway	White	White	Red		Black locust	Sugar maple	Oaks	White ash and black cherry	Black walnut	Scotch	Red	Austrian	Douglas	Balsam	Norway	White
N	N	N	S	N	L	N	L	N	N	S	S	S	N	N	L	L
N	N	N	S	N	L	N	L	N	N	S	S	S	N	N	L	L
N	N	N	L	N	N	N	N	N	N	L	L	L	N	N	N	N
L	L	L	------	--------	N	N	N	N	N	--------	N	N	N	L	------	L
L	L	L	------	--------	N	N	N	N	N	--------	N	N	N	L	------	L
N	------	L	------	--------	N	N	N	N	N	--------	N	N	N	L	------	L

The soils in group 6b are—

Hudson silty clay loam, 12 to 20 percent slopes, eroded.
Hudson-Cayuga silt loams, 12 to 20 percent slopes.

The soils in group 6c are—

Hudson and Dunkirk soils, 20 to 45 percent slopes.

Reaction in the surface soil and subsoil ranges from medium acid to neutral. The lime content increases with depth; these soils may be calcareous at a depth of 24 to 48 inches.

Care is necessary in locating and maintaining roads and landings on these medium-textured and moderately fine textured soils. Erosion control is important in cuts and on fills. Roads and trails with grades of more than 6 percent need water control that prevents gully erosion. Equipment limitation is slight on all soils in group 6a when the soils are dry or frozen, but it is moderate when the soils are wet.

Native species to be favored in management are sugar maple, white ash, basswood, and red oak. These soils are suited to spruce, white pine, and larch (see tables 9 and 10). The original clayey subsurface layer of the eroded soils may be exposed. Heavy weed growth and failure of the planting slit to close completely may reduce survival of planted seedlings.

WOODLAND SUITABILITY GROUP 7

The only unit in this group, Howard and Palmyra soils, 35 to 60 percent slopes, is steep and well drained. These soils are medium textured and moderately coarse textured and formed in gravelly and sandy glacial outwash.

These soils may be medium acid or slightly acid in the surface soil and subsoil. They are calcareous at a depth of between 24 and 60 inches. They are rapidly permeable, have moderate water-holding capacity, and allow deep rooting.

Seedling mortality may be a problem on southern and western exposures. Seedlings that start through natural regeneration may be at a disadvantage in competing for moisture.

Except where these soils are very gravelly or cobbly, they are productive of hardwoods. Native species to be favored in management are red oak, sugar maple, black cherry, and white ash.

Uneroded areas are ordinarily suited to all common conifers and to black locust (see tables 9 and 10). In some locations, a neutral or alkaline surface soil restricts the choice to Austrian and Scotch pine, European larch, and black locust. A very gravelly surface soil or a southern exposure restricts the choice to drought-resistant species.

WOODLAND SUITABILITY GROUP 8

This group consists of nearly level to strongly sloping, moderately well drained, medium-textured soils. One of these soils, Braceville gravelly silt loam, 0 to 5 percent slopes, formed in gravelly and sandy outwash and has a weakly expressed fragipan. The rest formed in glacial till and have a strongly expressed fragipan at a depth of 15 to 24 inches.

The soils in group 8a are—

Braceville gravelly silt loam, 0 to 5 percent slopes.
Langford channery silt loam, 2 to 8 percent slopes.
Langford channery silt loam, 3 to 8 percent slopes, eroded.

Langford channery silt loam, 8 to 15 percent slopes.
Langford channery silt loam, 8 to 15 percent slopes, eroded.
Mardin channery silt loam, 2 to 8 percent slopes.
Mardin channery silt loam, 8 to 15 percent slopes.
Mardin channery silt loam, 8 to 15 percent slopes, eroded.

The soils in group 8b are—

Mardin and Langford soils, 15 to 25 percent slopes.

These soils are acid in the surface soil and upper subsoil. Mardin and Braceville soils are acid throughout. Langford soils are slightly acid or neutral in the upper part of the fragipan, and their lime content increases with depth.

These soils are similar to those in woodland suitability groups 5 and 10, but they are one drainage class wetter and the fragipans are generally closer to the surface.

Native species to be favored in management are sugar maple, white ash, basswood, black cherry, and red oak. Most of the commonly planted conifers are well suited to these soils (see tables 9 and 10). Red pine, however, is not suited to the soils in the wetter part of the drainage range, nor is it suited to the eroded soils.

WOODLAND SUITABILITY GROUP 9

This group consists of nearly level to strongly sloping, somewhat poorly drained, medium-textured soils. One of these soils, Red Hook gravelly silt loam, 0 to 5 percent slopes, formed in gravelly and sandy glacial outwash and has a weakly expressed fragipan. The rest formed in glacial till and have a strongly expressed fragipan at a depth of 10 to 18 inches.

The soils in group 9a are—

Erie channery silt loam, 3 to 8 percent slopes.
Erie channery silt loam, 8 to 15 percent slopes.
Red Hook gravelly silt loam, 0 to 5 percent slopes.
Volusia channery silt loam, 3 to 8 percent slopes.
Volusia channery silt loam, 8 to 15 percent slopes.

The soils in group 9b are—

Erie channery silt loam, 3 to 8 percent slopes, eroded.
Erie channery silt loam, 8 to 15 percent slopes, eroded.
Volusia channery silt loam, 3 to 8 percent slopes, eroded.
Volusia channery silt loam, 8 to 15 percent slopes, eroded.

The soils in group 9c are—

Volusia and Erie soils, 15 to 25 percent slopes.

Volusia and Red Hook soils are acid throughout. Erie soils are acid in the surface layer and upper subsoil but slightly acid or neutral in the pan; their lime content increases with depth.

Extensive forests are found on the soils of this group. Site quality varies somewhat with elevation, depth of friable soil, and slope. Soils on the steeper slopes may have somewhat better drainage than those on the lesser slopes. The eroded soils are poorer sites because of lower organic-matter content and lower moisture-holding capacity. The equipment limitation is moderate in wet weather on all the soils in this group. Trees are likely to be adversely affected by drought.

Native species to be favored in management are sugar maple, oak, and hemlock. Larch, spruce, white pine, and Scotch pine grow moderately well on these soils (see tables 9 and 10), at least in youth. They are of limited suitability for the wetter soils and for the eroded soils, on which poor growth of spruce and of Christmas trees other than Scotch pine is likely.

WOODLAND SUITABILITY GROUP 10

The only unit in this group is Bath, Valois, and Lansing soils, 35 to 60 percent slopes. These soils are very steep, well drained, and medium textured. They formed in acid to medium-lime glacial till.

Bath soils have a moderately expressed fragipan at a depth of 18 to 30 inches and are acid throughout. Valois and Lansing soils have little or no restriction of the root zone and are acid in the surface soil and subsoil. The lime content in the substratum increases with depth. Lansing soils may be calcareous below a depth of 36 inches.

Care in locating roads, trails, and landings, control of surface water, and reseeding of logging roads may be necessary to prevent gully erosion.

Native species that should be favored in management are red oak, sugar maple, white ash, white pine, and black cherry.

All of the commonly planted conifers are suitable for these soils (see tables 9 and 10), but resistant species should be used on very steep, eroded south slopes.

WOODLAND SUITABILITY GROUP 11

This group consists of nearly level and gently sloping, somewhat poorly drained and moderately well drained, medium-textured and moderately fine textured soils. These soils formed in medium- to high-lime till, in medium- to high-lime gravelly and sandy glacial outwash, in lacustrine silt and very fine sand, in lacustrine silt and clay, and in a thin smear of these lacustrine sediments over glacial till.

The soils in group 11a are—

Darien gravelly silt loam, 2 to 8 percent slopes.
Fredon silt loam, 0 to 5 percent slopes.
Kendaia silt loam, 3 to 8 percent slopes.
Niagara silt loam, 2 to 6 percent slopes.
Ovid silt loam, 0 to 6 percent slopes.
Ovid and Rhinebeck silt loams, moderately deep, 0 to 2 percent slopes.
Ovid and Rhinebeck silt loams, moderately deep, 2 to 6 percent slopes.
Rhinebeck silt loam, 0 to 2 percent slopes.
Rhinebeck silt loam, 2 to 6 percent slopes.

The soils in group 11b are—

Ovid silty clay loam, 6 to 12 percent slopes, eroded.
Ovid and Rhinebeck silt loams, moderately deep, 6 to 12 percent slopes.
Rhinebeck silty clay loam, 6 to 12 percent slopes, eroded.

The surface soil is medium acid or slightly acid, and the subsoil is slightly acid or neutral. The substratum may become calcareous at a depth of between 24 and 48 inches.

On the finer textured soils in this group, erosion control measures are usually necessary in connection with any soil-exposing operations on grades of more than 6 percent. The eroded soils are likely to be poor sites for growing wood crops. Using heavy machinery in wet weather is likely to damage roots and break down soil structure.

Native species that should be favored in management are basswood, white ash, red oak, and white oak. The choice of species (see tables 9 and 10) is limited by somewhat poor drainage and by the heavy weed cover often found on these soils. Spruce is suitable. Frost heaving is a hazard. Another hazard is that planting slits may not close completely on the eroded soils of the group.

WOODLAND SUITABILITY GROUP 12

The soils in this group are gently sloping to steep, well drained, and medium textured. They formed in glacial till.

The soils in group 12a are—

Lordstown channery silt loam, 5 to 15 percent slopes.
Lordstown channery silt loam, 5 to 15 percent slopes, eroded.

The soils in group 12b are—

Lordstown channery silt loam, 15 to 25 percent slopes.
Lordstown channery silt loam, 25 to 35 percent slopes.

These soils are acid and are ordinarily 20 to 40 inches deep over sandstone and shale bedrock.

Hemlock and sugar maple are native species to be favored on the deeper soils and on northeast exposures. White, red, and black oaks and white pine are suitable for other exposures. All of the commonly planted conifers are suitable for these soils. Growth of the more demanding trees may be slow. A drought-resistant species should be chosen for the eroded Lordstown soils.

WOODLAND SUITABILITY GROUP 13

Lordstown soils, 35 to 70 percent slopes, the only unit in this group, consists of very steep, well-drained, medium-textured soils formed in glacial till. These soils are acid and are ordinarily less than 40 inches deep over sandstone and shale bedrock. They may be ledgy.

Except for some productive forests on foot slopes, wood crops ordinarily are not profitable on these soils. Drought, resulting from shallowness and steepness, is a limitation on many sites. The depth of soil varies; consequently, each individual site should be investigated. Slope direction also affects composition and growth, for variations in exposure affect moisture demands.

Native species that should be favored in management are, in order of priority, red, white, and black oaks and white pine. Hemlock may be favored on north and northeast slopes. Most of the woodland is native. Plantings should consist of drought-resistant species, such as red and Scotch pine and European larch. Site limitations are less severe where the bedrock is fissured or broken so that roots penetrate extensively.

WOODLAND SUITABILITY GROUP 14

The soils in this group are nearly level and medium textured or moderately fine textured. They are predominantly poorly drained and very poorly drained; some are somewhat poorly drained. These soils formed in medium-to high-lime till, in lacustrine silt and clay, in lacustrine silt and fine sand, in gravelly and sandy outwash, and in flood-plain sediments.

The soils in group 14a are—

Halsey silt loam.
Ilion silty clay loam, 0 to 2 percent slopes.
Ilion silty clay loam, 2 to 6 percent slopes.
Kendaia and Lyons silt loams, 0 to 3 percent slopes.
Madalin silty clay loam.
Wayland and Sloan silt loams.

The soils in group 14b are—

Canandaigua and Lamson soils.
Halsey mucky silt loam.
Lyons silt loam.
Madalin mucky silty clay loam.

These soils contain free lime. Ordinarily they are not suited to wood crops. Surface water limits the choice of valuable species, and competition from undesirable species is severe. Trees are easily windthrown on these soils because their root systems are flat and shallow. The supply of oxygen to tree roots is generally insufficient.

Native species to be favored in management are ash, basswood, beech, oak, soft maple, and hemlock. Wetness and competing vegetation are limitations on forest planting (see tables 9 and 10). Spruce and white cedar offer the best possibilities for establishment of plantations or cover, but vigorous stock and control of vegetation are usually required.

WOODLAND SUITABILITY GROUP 15

This group consists of nearly level or gently sloping, medium-textured soils. These soils are predominantly poorly drained and very poorly drained; some are somewhat poorly drained. Two of these soils, Holly and Papakating, formed in sediments on the flood plain. The rest formed in glacial till. These soils are—

Ellery, Chippewa, and Alden soils, 0 to 8 percent slopes.
Erie-Ellery channery silt loams, 0 to 3 percent slopes.
Holly and Papakating soils.
Tuller channery silt loam, 0 to 6 percent slopes.
Volusia-Chippewa channery silt loams, 0 to 3 percent slopes.

Ellery, Chippewa, Erie, and Volusia soils have a strongly to moderately expressed fragipan at a depth of 10 to 30 inches. Alden soils lack a fragipan. Tuller soils are less than 24 inches deep over siltstone or sandstone bedrock.

For woodland conservation purposes, these soils are like those in woodland suitability group 14, from which they are separated mainly because of lower lime content. The soils in this group are acid to neutral.

Native species that should be favored in management are oak, hemlock, white pine, basswood, and white ash. These soils are not suitable for forest planting unless special practices are used to alter the poor drainage (see tables 9 and 10).

WOODLAND SUITABILITY GROUP 16

This group consists of miscellaneous land types and undifferentiated units in which the soil properties are so variable that estimates of productivity, suggestions for suitable species, and evaluations of hazards cannot be made without critical on-site inspection. The potential for commercial production of timber ranges from good to very poor. These mapping units are—

Alluvial land.
Fresh water marsh.
Lordstown, Tuller, and Ovid soils, shallow and very shallow, 0 to 15 percent slopes.
Lordstown, Tuller, and Ovid soils, shallow and very shallow, 15 to 35 percent slopes.
Made land.
Muck and Peat.
Rock outcrop.

Wildlife [17]

Wildlife is a valuable resource of Tompkins County. The principal game species are ring-necked pheasant, ruffed grouse, woodcock, cottontail rabbit, gray squirrel,

[17] This section prepared by PHILIP F. ALLAN and ROBERT E. MYERS, biologists, Soil Conservation Service.

and white-tailed deer. Bobwhite quail and wild turkey have recently been introduced. They are not as yet numerous enough to support hunting, but public interest in these two species is great. Some hunting of ducks, geese, red and gray fox, and raccoon is done. At one time, such furbearers as muskrat, mink, skunk, weasel, and opossum were harvested on a considerable scale. Few are trapped now, although they are still common. Beaver are not common but are objects of considerable interest to sightseers. They are not generally troublesome as in some other regions. Black bear are seen occasionally.

There is an unusually high degree of local interest in nongame wildlife, both vertebrate and invertebrate. Bird watching and various other sorts of nature study and observation are popular forms of recreation. As a result, the use and management of land for wildlife are highly regarded. Wild plants and animals also provide the basis for important biological research.

Fishing provides sport to a large segment of the population. Cayuga Lake supports good fishing for the skilled fisherman but cannot be classed as a high-quality fishing lake. The principal sports fish in the lake are lake trout, northern pike, and largemouth and smallmouth bass. Landlocked salmon are stocked periodically, and there also are rainbow trout in the lake. Smelt dipped from streams during the spring spawning run provide sport and food. Good fishing for brook, rainbow, and brown trout is enjoyed in several streams. There are numerous small artificial ponds, stocked with brook trout or warm-water species, principally largemouth bass and bluegill sunfish or golden shiner. The fishing in these ponds ranges from poor to excellent.

Land use is rapidly changing in the county and, with a decline in farming land use, vegetation patterns are changing. The natural succession of vegetation affects the habitat of wildlife species. Pheasants were abundant when much of Tompkins County was in crop production. Grassland farming mostly affected nongame species such as the red-winged blackbird and the woodchuck. With the perennial weed and early brush stages following farm abandonment, the habitat for cottontail rabbit, red fox, skunk, and other wildlife improved. Late brush and early tree stages form important habitat for woodcock, ruffed grouse, and deer. The mature woodland stage provides desirable habitat for gray squirrel and wild turkey. At present the trend is toward advancement of all of the successional stages beyond that of grassland.

Present wildlife patterns

Two methods of relating wildlife to soils are recognized. The soil associations shown on the general soil map are related to present land use and types of vegetation and, hence, to certain wildlife species. Specific information also can be given on the suitability of soil types and phases for the creation, improvement, or maintenance of broad types of wildlife habitats (see table *11*).

High-lime and medium-lime soils area.—This area is located on either side of Cayuga Lake in the northwestern part of the county (see figure 7 and General Soil Map). It consists principally of fairly uniform slopes, generally inclined toward the lake, of the Lima-Honeoye, Hudson-Cayuga, Hudson-Rhinebeck, Conesus-Lansing, and Palmyra soil associations. The slopes are abrupt near the lake and are traversed by several deep, rocky gorges, or "hanging valleys."

Figure 17.—Living fences of multiflora rose on the Conesus-Lansing association. These are medium-lime soils in the northwestern part of Tompkins County.

A high percentage of this area is in cultivated crops; somewhat less is in pasture. On the somewhat steeper slopes, pasture is more extensive. To the west of the lake, there are orchards. The very steep slopes are idle or wooded. The principal crops are corn, wheat, and dry beans. Woodlands consist predominantly of hardwoods but include some conifers. Oak and maple are the major hardwood species. White pine, redcedar, and, in the coves, hemlock are the main conifers.

The grainfields, beanfields, grassland, overgrown land, and numerous hedgerows (fig. 17) in these areas provide the best upland pheasant habitats in the county. Pheasants commonly thrive best on soils high in lime. The overgrown valleys of Palmyra soils are important wintering areas.

Bobwhite quail, the supply of which appears to be increasing, thrive in the same habitat as do pheasants.

Grouse are fairly common along the upper edges of the steeper slopes where idle land and woodland meet. Generally, the land is too open to provide first-class grouse habitat.

Woodcock are confined largely to overgrown idle land and poorly drained areas.

Cottontail rabbits, although generally distributed throughout the high-lime and medium-lime soil area, are abundant mainly on idle land and along the edges of woods.

Gray squirrels occupy chiefly the steep wooded slopes of the Hudson-Cayuga soil association. They may be found, however, in other woodland tracts, particularly on poorly drained sites, in any of the five soil associations.

Deer are fairly common throughout the area. The soils, relatively more fertile than those elsewhere in the county, may favorably affect the size and reproductive capacity of deer. There appears to be less evidence of winter food shortage in this part of the county than elsewhere.

Low-lime soils area.—The Howard-Valois, Langford-Erie, and Erie-Langford soil associations form an area that extends roughly in an arc from the west-central boundary of the county southeastward and thence northward to the north-central boundary (see figure 7 and General Soil Map). This is an area of gently sloping to steep land. Significant areas in the Erie-Langford association are somewhat poorly drained.

Farming is principally of the dairy type, and hay and pasture are the main crops. Corn, oats, and beans are grown on the better soils. There is a higher percentage of idle land and woodland in this area than in the area of high-lime and medium-lime soils.

Pheasants are fewer and more scattered in this area than in the area of high-lime and medium-lime soils. Pheasants are likely to be less abundant where there is more grassland and less tilled cropland.

Ruffed grouse tend to be more widely distributed in this area where woodland and brushy idle land are more common than in the more intensively farmed areas.

The best woodcock habitat in the county is probably in this area. Idle land, brushy pasture, swampy spots, and areas of poplar and other early-stage hardwoods provide nesting areas and attract migrating woodcock.

The numerous ponds and small artificial marshes that have been constructed in this area provide nesting places for black ducks, mallards, blue-winged teal, and wood ducks and attract migrating waterfowl and other wetland birds.

This area generally has a large population of cottontail rabbits, for which the distribution of pastures, meadows, hedgerows, and brushy overgrown land is favorable.

Gray squirrels are widely distributed and abundant. An abundance of oak, hickory, walnut, maple, beech, ash, wild apple, hawthorn, and other natural food plants provides good habitat for squirrels.

Deer are fairly numerous throughout the area. Woodland, idle land, and grassland provide an abundance of mast, browse, and herbaceous forage for deer.

Very low-lime soils area.—Across the southern part of the county and extending midway up the east side is an area of rugged, hilly country (see figure 7 and General Soil Map). The soils, which are mainly associations of Volusia and Lordstown or of Lordstown and Mardin soils, are mainly acid and range from poorly drained to well drained.

Once farmed extensively, much of this area is no longer cropped. Poor soils, steep slopes, wetness, climate, and other factors have led to the discontinuance of farming. Some hayland and pasture remain open. Brushy overgrown land and second-growth woodland predominate.

Pheasants are not very significant in this part of the county. A few are to be found here and there near cornfields and grainfields.

This area is a good range for grouse. The large tracts of fairly mature woodland that occur in parts of the area, however, are not good grouse habitats. As the plant succession advances, the quality of the area as a habitat for ruffed grouse will probably decline.

Very poorly drained idle land and tracts of sapling hardwoods provide very good habitats for woodcock. A large proportion of the area is now too heavily wooded to be attractive to woodcock.

Idle land and brushy pasture provide good habitats for cottontail rabbits. The extensive woodland is relatively poor and has scattered populations, which are likely to decrease as plant succession advances.

This area is, and should continue to be, the best range for gray squirrels because it is now heavily wooded and woodland is spreading.

Parts of this area are now heavily populated with deer. Large herds often are seen late in winter foraging on south slopes in pastures and idle fields. Abandonment of cropland presumably has created a habitat favorable to the expansion of the deer population. But the habitat is gradually declining, and the number of deer will probably decrease unless intensive management measures are taken to offset the heavy use of the food supply.

For the past several years a small colony of wild turkeys, transplanted from the range in western New York, has successfully reproduced in the wooded hills of this area. The ability of this area to support this game bird will increase as the plant succession progresses.

Soil interpretations for wildlife habitat

Successful management of wildlife on any tract of land requires that food, cover, and water be available in a suitable combination (*27*). Lack of any one element, or imbalance in elements, may account for the absence of the desired wildlife species.

Most managed wildlife habitats are created, improved, or maintained by planting suitable vegetation; by manipulating existing vegetation so as to bring about natural establishment of desired plants; or by a combination of such measures. The influence of a soil on the growth characteristics of plants can be inferred from knowledge about the properties of the soil. Soil properties are carefully recorded in soil survey reports, and by using this information, it can be determined whether a particular soil mapping unit is suitable for establishing and maintaining various combinations of plants. By evaluating the various combinations of plants that can be produced on a soil, one can get an approximate idea of the suitability of that soil for three general classes of wildlife; namely, openland, woodland, and wetland wildlife.

Such evaluations are shown in table 11 for the soils of Tompkins County. This table contains ratings that indicate the relative suitability of each soil as a producer of grain crops, grasses and legumes, wild plants, and other elements important in wildlife habitats. This table also contains ratings that show the relative value of each soil as a habitat for the three main classes of wildlife.

Present land use and existing vegetation are not considered in the ratings shown in table 11. These factors, though important to the wildlife manager, are subject to change, and there is no practical method of determining them from a soil survey. Also, the soil areas on the soil survey map are rated without regard to their position in relation to adjoining areas. The size, shape, and location of an outlined area is assumed not to affect its rating.

The ability of wildlife to move from place to place is disregarded in the ratings. Movement is not considered, because wildlife species are not directly rated; instead, suitability of soils as habitats is rated.

Another point needs to be clear. Our present knowledge is such that we are not prepared to say that soil "A" will produce more or larger pheasants, for example, than soil "B", nor even that pheasants will occur on either soil. We are, however, prepared to say that soil "A", in general, is better suited than soil "B" if one wants to maintain, establish, or establish and maintain the habitat elements that

TABLE 11.—*Rating of Tompkins County soils for wildlife elements and classes of wildlife*

[A rating of 1 means soil is well suited; 2 means suited; 3 means poorly suited; 4 means unsuited]

Map symbol	Soil name	Wildlife habitat elements								Classes of wildlife		
		Grain crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood woodland plants	Coniferous woodland plants	Wetland food and cover plants	Shallow water developments	Excavated ponds	Openland	Woodland	Wetland
Ab	Alluvial land	4	2	1	3	4	3	4	4	2	4	4
ArB	Arkport fine sandy loam, 2 to 6 percent slopes	2	1	1	1	3	4	4	4	1	1	4
ArC	Arkport fine sandy loam, 6 to 12 percent slopes	2	1	1	1	3	4	4	4	1	1	4
BaB	Bath channery silt loam, 2 to 5 percent slopes	2	2	1	1	3	4	3	4	1	2	4
BaC	Bath channery silt loam, 5 to 15 percent slopes	2	2	1	1	3	4	4	4	1	2	4
BaC3	Bath channery silt loam, 5 to 15 percent slopes, eroded	3	3	2	2	3	4	4	4	3	3	4
BaD	Bath channery silt loam, 15 to 25 percent slopes	3	3	1	1	3	4	4	4	2	2	4
BgC	Bath and Valois gravelly silt loams, 5 to 15 percent slopes	2	2	1	1	3	4	4	4	1	2	4
BgC3	Bath and Valois gravelly silt loams, 5 to 15 percent slopes, eroded	3	2	1	1	3	4	4	4	2	2	4
BgD	Bath and Valois gravelly silt loams, 15 to 25 percent slopes	3	2	1	1	3	4	4	4	2	2	4
BoE	Bath and Valois soils, 25 to 35 percent slopes	4	3	1	1	3	4	4	4	3	2	4
BtF	Bath, Valois, and Lansing soils, 35 to 60 percent slopes	4	4	2	1	3	4	4	4	3	2	4
BvA	Braceville gravelly silt loam, 0 to 5 percent slopes	3	2	1	2	3	2	3	4	2	2	3
Ca	Canandaigua and Lamson soils	3	3	3	2	2	1	1	1	3	3	1
CdA	Chenango gravelly loam, 0 to 5 percent slopes	1	1	1	1	3	4	4	4	1	1	4
CdC	Chenango gravelly loam, 5 to 15 percent slopes	2	1	1	1	3	4	4	4	1	1	4
CdD	Chenango gravelly loam, 15 to 25 percent slopes	3	2	1	1	3	4	4	4	2	2	4
CnB	Chenango gravelly loam, fan, 0 to 8 percent slopes	1	1	1	1	3	4	4	4	1	1	4
CfA	Conesus gravelly silt loam, 0 to 3 percent slopes	2	1	1	1	3	4	3	4	1	1	4
CfB	Conesus gravelly silt loam, 3 to 8 percent slopes	2	1	1	1	3	4	4	4	1	1	4
CfB3	Conesus gravelly silt loam, 3 to 8 percent slopes, eroded	3	2	1	1	3	4	4	4	1	2	4
DgB	Darien gravelly silt loam, 2 to 8 percent slopes	2	2	1	1	3	3	3	4	1	2	3
Em	Eel silt loam	2	2	1	1	3	4	4	4	1	2	4
EcA	Ellery, Chippewa, and Alden soils, 0 to 8 percent slopes	4	3	3	2	2	1	1	1	3	3	1
EbB	Erie channery silt loam, 3 to 8 percent slopes	2	3	2	2	2	3	4	4	2	2	4
EbB3	Erie channery silt loam, 3 to 8 percent slopes, eroded	3	3	2	2	3	3	4	4	3	2	4
EbC	Erie channery silt loam, 8 to 15 percent slopes	2	2	1	2	2	4	4	4	1	2	4
EbC3	Erie channery silt loam, 8 to 15 percent slopes, eroded	3	3	2	2	2	4	4	4	3	2	4
ErA	Erie-Ellery channery silt loams, 0 to 3 percent slopes	3	3	1	2	1	1	1	1	2	2	1
FdB	Fredon silt loam, 0 to 5 percent slopes	2	2	1	2	3	2	2	2	1	2	2
Fm	Fresh water marsh	4	4	4	4	4	1	1	4	4	4	1
Gn	Genesee silt loam	2	1	1	1	3	4	4	4	1	1	4
Ha	Halsey silt loam	4	3	3	2	1	1	1	1	3	2	1
Hc	Halsey mucky silt loam	4	4	3	2	1	1	1	1	4	2	1
Hk	Holly and Papakating soils	4	3	3	2	1	1	3	3	3	2	2
HmB	Honeoye gravelly silt loam, 2 to 8 percent slopes	1	1	1	1	3	4	4	4	1	1	4

TABLE 11.—*Rating of Tompkins County soils for wildlife elements and classes of wildlife*—Continued

[A rating of 1 means soil is well suited; 2 means suited; 3 means poorly suited; 4 means unsuited]

Map symbol	Soil name	Wildlife habitat elements								Classes of wildlife		
		Grain crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood woodland plants	Coniferous woodland plants	Wetland food and cover plants	Shallow water developments	Excavated ponds	Openland	Woodland	Wetland
HmC	Honeoye gravelly silt loam, 8 to 15 percent slopes	2	1	1	1	3	4	4	4	1	1	4
HmC3	Honeoye gravelly silt loam, 8 to 15 percent slopes, eroded	3	2	1	1	3	4	4	4	2	2	4
HdA	Howard gravelly loam, 0 to 5 percent slopes	2	2	1	1	3	4	4	4	1	2	4
HdC	Howard gravelly loam, 5 to 15 percent simple slopes	2	2	1	1	3	4	4	4	1	2	4
HdCK	Howard gravelly loam, 5 to 15 percent complex slopes	2	2	1	1	3	4	4	4	1	2	4
HdD	Howard gravelly loam, 15 to 25 percent slopes	3	2	1	1	3	4	4	4	2	2	4
HpE	Howard and Palmyra soils, 25 to 35 percent slopes	4	3	1	1	2	4	4	4	3	1	4
HpF	Howard and Palmyra soils, 35 to 60 percent slopes	4	4	2	2	2	4	4	4	3	3	4
HrC	Howard-Valois gravelly loams, 5 to 15 percent slopes	2	2	1	1	3	4	4	4	1	2	4
HrD	Howard-Valois gravelly loams, 15 to 25 percent slopes	3	2	1	1	3	4	4	4	2	2	4
HsB	Hudson silty clay loam, 2 to 6 percent slopes	2	2	2	1	1	4	4	4	2	1	4
HsC3	Hudson silty clay loam, 6 to 12 percent slopes, eroded	2	2	2	1	1	4	4	4	2	1	4
HsD3	Hudson silty clay loam, 12 to 20 percent slopes, eroded	3	2	2	1	1	4	4	4	2	1	4
HuB	Hudson-Cayuga silt loams, 2 to 6 percent slopes	2	2	2	1	1	4	4	4	2	1	4
HuB3	Hudson-Cayuga silt loams, 2 to 6 percent slopes, eroded	2	2	2	1	1	4	4	4	2	1	4
HuC3	Hudson-Cayuga silt loams, 6 to 12 percent slopes, eroded	3	2	2	1	1	4	4	4	2	1	4
HuD	Hudson-Cayuga silt loams, 12 to 20 percent slopes	3	2	2	1	1	4	4	4	2	1	4
HwB	Hudson and Collamer silt loams, 2 to 6 percent slopes	2	2	2	1	1	4	4	4	2	1	4
HzE	Hudson and Dunkirk soils, 20 to 45 percent slopes	4	4	2	1	1	4	4	4	3	1	4
IcA	Ilion silty clay loam, 0 to 2 percent slopes	4	3	2	1	1	1	1	1	3	1	1
IcB	Ilion silty clay loam, 2 to 6 percent slopes	4	3	1	1	1	3	3	4	3	1	3
KaB	Kendaia silt loam, 3 to 8 percent slopes	2	2	1	1	3	3	4	4	1	2	4
KnA	Kendaia and Lyons silt loams, 0 to 3 percent slopes	3	2	2	1	2	1	1	1	2	1	1
LaB	Langford channery silt loam, 2 to 8 percent slopes	2	1	1	1	3	4	3	4	1	2	4
LaB3	Langford channery silt loam, 3 to 8 percent slopes, eroded	2	2	1	1	3	4	4	4	1	2	4
LaC	Langford channery silt loam, 8 to 15 percent slopes	2	1	1	1	3	4	4	4	1	1	4
LaC3	Langford channery silt loam, 8 to 15 percent slopes, eroded	3	2	1	1	3	4	4	4	2	2	4
LbA	Lansing gravelly silt loam, 0 to 3 percent slopes	1	1	1	1	3	4	4	4	1	1	4
LbB	Lansing gravelly silt loam, 3 to 8 percent slopes	1	1	1	1	3	4	4	4	1	1	4
LbB3	Lansing gravelly silt loam, 3 to 8 percent slopes, eroded	2	2	1	1	3	4	4	4	1	1	4
LbC	Lansing gravelly silt loam, 8 to 15 percent slopes	2	1	1	1	3	4	4	4	1	1	4
LbC3	Lansing gravelly silt loam, 8 to 15 percent slopes, eroded	3	2	1	1	3	4	4	4	2	2	4

TABLE 11.—*Rating of Tompkins County soils for wildlife elements and classes of wildlife*—Continued

[A rating of 1 means soil is well suited; 2 means suited; 3 means poorly suited; 4 means unsuited]

Map symbol	Soil name	Wildlife habitat elements: Grain crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood woodland plants	Coniferous woodland plants	Wetland food and cover plants	Shallow water developments	Excavated ponds	Classes of wildlife: Openland	Woodland	Wetland
LmA	Lima silt loam, 0 to 3 percent slopes	2	1	1	1	3	3	3	3	1	1	3
LmB	Lima silt loam, 3 to 8 percent slopes	2	1	1	2	3	4	4	4	1	1	4
LmB3	Lima silt loam, 3 to 8 percent slopes, eroded	3	2	1	1	3	4	4	4	2	1	4
LnC	Lordstown channery silt loam, 5 to 15 percent slopes	2	2	1	1	3	4	4	4	1	2	4
LnC3	Lordstown channery silt loam, 5 to 15 percent slopes, eroded	3	2	1	1	3	4	4	4	2	2	4
LnD	Lordstown channery silt loam, 15 to 25 percent slopes	3	2	1	1	3	4	4	4	2	2	4
LnE	Lordstown channery silt loam, 25 to 35 percent slopes	4	3	1	1	3	4	4	4	3	2	4
LoF	Lordstown soils, 35 to 70 percent slopes	4	4	2	1	3	4	4	4	3	2	4
LtB	Lordstown, Tuller, and Ovid soils, shallow and very shallow, 0 to 15 percent slopes	4	4	3	3	2	4	4	4	4	4	4
LtC	Lordstown, Tuller, and Ovid soils, shallow and very shallow, 15 to 35 percent slopes	4	4	3	2	1	4	4	4	4	2	4
Ly	Lyons silt loam	4	3	3	1	1	1	1	1	3	1	1
Mn	Madalin silty clay loam	4	3	2	3	3	1	1	1	3	4	1
Mm	Madalin mucky silty clay loam	4	4	3	3	3	1	1	1	4	4	1
Mc	Made land	(1)	------	------	------	------	------	------	------	------	------	------
MaB	Mardin channery silt loam, 2 to 8 percent slopes	2	1	1	1	3	3	3	4	1	1	3
MaC	Mardin channery silt loam, 8 to 15 percent slopes	2	1	1	1	3	4	4	4	1	1	4
MaC3	Mardin channery silt loam, 8 to 15 percent slopes, eroded	3	2	1	1	3	4	4	4	2	2	4
MfD	Mardin and Langford soils, 15 to 25 percent slopes	3	2	1	1	3	4	4	4	2	2	4
Mo	Middlebury and Tioga silt loams	2	1	1	1	3	4	4	4	1	1	4
Mp	Muck and Peat	4	4	4	4	1	2	1	1	4	4	1
NaB	Niagara silt loam, 2 to 6 percent slopes	2	2	1	1	3	3	3	4	1	2	3
OaA	Ovid silt loam, 0 to 6 percent slopes	2	2	1	1	3	2	2	3	1	2	2
OcC3	Ovid silty clay loam, 6 to 12 percent slopes, eroded	2	2	1	1	3	3	4	4	1	2	4
OrA	Ovid and Rhinebeck silt loams, moderately deep, 0 to 2 percent slopes	2	2	1	2	2	2	2	2	1	1	2
OrB	Ovid and Rhinebeck silt loams, moderately deep, 2 to 6 percent slopes	2	2	1	1	2	4	4	4	1	1	4
OrC	Ovid and Rhinebeck silt loams, moderately deep, 6 to 12 percent slopes	2	2	1	1	2	4	4	4	1	1	4
PaA	Palmyra gravelly loam, 0 to 5 percent slopes	1	1	1	1	3	4	4	4	1	1	4
PaC	Palmyra gravelly loam, 5 to 15 percent simple slopes	2	1	1	1	3	4	4	4	1	1	4
PaCK	Palmyra gravelly loam, 5 to 15 percent complex slopes	2	1	1	1	3	4	4	4	1	1	4
PaD	Palmyra gravelly loam, 15 to 25 percent slopes	3	2	1	1	3	4	4	4	2	2	4
PhA	Phelps gravelly silt loam, 0 to 3 percent slopes	1	1	1	1	3	4	4	3	1	1	4
PhB	Phelps gravelly silt loam, 3 to 8 percent slopes	1	1	1	1	3	4	4	4	1	1	4
RhA	Red Hook gravelly silt loam, 0 to 5 percent slopes	3	3	1	1	2	3	3	3	2	1	3

See footnote at end of table.

TABLE 11.—*Rating of Tompkins County soils for wildlife elements and classes of wildlife*—Continued

[A rating of 1 means soil is well suited; 2 means suited; 3 means poorly suited; 4 means unsuited]

Map symbol	Soil name	Wildlife habitat elements								Classes of wildlife		
		Grain crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood woodland plants	Coniferous woodland plants	Wetland food and cover plants	Shallow water developments	Excavated ponds	Openland	Woodland	Wetland
RkA	Rhinebeck silt loam, 0 to 2 percent slopes	3	3	2	1	1	2	1	1	3	1	1
RkB	Rhinebeck silt loam, 2 to 6 percent slopes	3	2	2	1	1	3	3	4	2	1	3
RnC3	Rhinebeck silty clay loam, 6 to 12 percent slopes, eroded	2	2	1	1	2	4	4	4	1	1	4
Ro	Rock outcrop	4	4	4	4	4	4	4	4	4	4	4
TeA	Tuller channery silt loam, 0 to 6 percent slopes	3	3	3	2	2	4	4	4	3	3	4
VbB	Volusia channery silt loam, 3 to 8 percent slopes	3	3	2	2	1	3	2	2	3	2	2
VbB3	Volusia channery silt loam, 3 to 8 percent slopes, eroded	3	3	2	2	2	4	4	4	3	2	4
VbC	Volusia channery silt loam, 8 to 15 percent slopes	3	3	2	2	2	4	4	4	3	2	4
VbC3	Volusia channery silt loam, 8 to 15 percent slopes, eroded	3	3	2	2	2	4	4	4	3	2	4
VoA	Volusia-Chippewa channery silt loams, 0 to 3 percent slopes	4	3	2	2	2	2	1	1	3	2	1
VrD	Volusia and Erie soils, 15 to 25 percent slopes	3	3	2	2	2	4	4	4	3	2	4
Ws	Wayland and Sloan silt loams	4	3	3	1	1	1	3	4	3	1	2
WrB	Williamson very fine sandy loam, 2 to 6 percent slopes	2	1	1	1	3	4	3	3	1	1	4

[1] Not rated.

are important to pheasants, in a region where pheasants range. This is essentially what is accomplished by the ratings in table 11.

Definitions and use of habitat suitability ratings.—The four numerical ratings that appear in table 11 are defined broadly as follows: 1, well suited; 2, suited; 3, poorly suited; and 4, unsuited. These verbal terms are further defined thus.

1. *Well suited:* Habitats generally are easily created, improved, or maintained on soils rated as *well suited.* There are few or no soil limitations to habitat management, and satisfactory results are well assured.
2. *Suited:* Habitats usually can be created, improved, or maintained on soils rated as *suited*, but there are moderate soil limitations that affect management of habitats. Moderate intensity of management and fairly frequent attention may be required to assure satisfactory results.
3. *Poorly suited:* Habitats usually can be created, improved, or maintained on soils rated as *poorly suited*, but soil limitations are rather severe. Habitat management may be difficult and expensive and require intensive effort. Results are questionable.
4. *Unsuited:* Habitats cannot be created, improved, or maintained on soils rated as *unsuited*, or it is impractical to do so under prevailing soil conditions. Unsatisfactory results are probable.

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The foregoing ratings serve several purposes. They are an aid in selecting the best sites for establishing and managing a habitat. They can be useful in showing why it generally may not be feasible to manage a particular area for a given kind of wildlife.

For broad-scale planning, as for parks, nature areas, or other recreation developments, or for acquiring wildlife land, the ratings can be used to show overall suitability of the areas in question, for each class of wildlife. This can be done by use of colored overlays for each class of wildlife. One can also construct overlays for detailed planning of each habitat element. Also, for explanation by means of tables and charts, the soils of an area can be tabulated according to these ratings, so that all soils with the same ratings for each class of wildlife are in the same wildlife suitability group.

Habitat elements and criteria for rating them.—Eight habitat elements are shown in table 11, and all the soils are rated according to their suitability for each of these. Following are brief descriptions of the eight elements and the criteria for rating them.

GRAIN CROPS: Agricultural grains or seed-producing annuals planted to produce food for wildlife.

Examples: Corn, sorghums, wheat, oats, millet, buckwheat, soybeans, sunflowers.

Rating Criteria:

1. Soil conditions are suitable for repeated annual planting, individually, in combination, or in

rotation, of any or all climatically adapted species; intervening sod crops not needed for soil protection and maintenance.
2. Soil conditions are suitable for planting, individually, in combination, or in rotation, of any or all climatically adapted species; sod crops, however, are required for up to 66 percent of the time to protect and maintain the soil.
3. Soil conditions suitable for planting, individually or in combination, of any or all climatically adapted species; sod crops, however, are required for more than 66 percent of the time to protect and maintain the soil, or sod crops are needed because species selection for grain crops is limited.
4. Prevailing soil conditions not suitable; grain and seed crops cannot be grown, or it is not feasible to plant them.

GRASSES AND LEGUMES: Domestic perennial grasses and herbaceous legumes that are established by planting and that furnish wildlife food and cover.

Examples: Fescue, bromegrass, bluegrass, timothy, redtop, orchardgrass, reed canarygrass, clover, trefoil, alfalfa, panic grasses.

Rating Criteria:
1. Soil conditions suitable for planting a wide variety of climatically adapted species for wildlife cover, or suitable for maintaining adequate stands of such cover; the cover lasts for at least 10 years without renovation or fertilization.
2. Soil conditions suitable for planting of a wide variety of climatically adapted species, but renovation, liming, or fertilization required if wildlife cover is to last for at least 10 years.
3. Soil conditions suitable for a very limited number of species, generally not more than one or two, but natural vigor of stand may be high without renovation, liming, or fertilization.
4. Soil conditions severely limit number of species and vigor of growth; stands very sparse and renovation, liming, and fertilization are impracticable or impossible.

WILD HERBACEOUS UPLAND PLANTS: Native or introduced perennial grasses and forbs (weeds) that provide food and cover principally to upland forms of wildlife, and that are established mainly through natural processes.

Examples: Bluestem, Indiangrass, wheatgrass, wild ryegrass, oatgrass, pokeweed, strawberries, lespedeza, beggarweed, wild beans, nightshade, goldenrod, dandelions.

Rating Criteria:
1. Soil conditions suitable for establishment and vigorous growth of a wide variety of uncultivated species.
2. Soil conditions limit the variety of species, but growth of a few species may be vigorous.
3. Soil conditions suitable for the establishment of very few species, and vigor of growth is limited.
4. Soil conditions allow only restricted variety of adapted species; vigor of growth is poor, and stand is of insignificant value to wildlife.

HARDWOOD WOODLAND PLANTS: Nonconiferous trees, shrubs, and woody vines that produce fruits, nuts, buds, catkins, twigs (browse), or foliage used extensively as food by wildlife, and which commonly are established through natural processes but also may be planted.

Examples: Oak, beech, cherry, hawthorn, dogwood, viburnum, maple, birch, poplar, grapes, honeysuckle, blueberry, briers, greenbriers, autumn olive, multiflora rose.

Rating Criteria:
1. Soil conditions such that there is vigorous growth and dependable food production from a wide variety of climatically adapted species.
2. Soil conditions suitable for most climatically adapted species, but annual dependability of food production is somewhat limited.
3. Soil conditions suitable for a few species important to wildlife, but annual food production is usually low.
4. Soil conditions such that very few or no species important to wildlife will grow, and growth of these is so sparse as to be of little significance to wildlife.

CONIFEROUS WOODLAND PLANTS: Cone-bearing trees and shrubs, important to wildlife mainly as cover, but also may furnish food in the form of browse, seeds, or fruitlike cones; plants commonly are established through natural processes but also may be planted.

Examples: Spruce, pine, white cedar, hemlock, balsam fir, red cedar, juniper, yew.

Rating Criteria:
1. Soil conditions suitable for various climatically adapted species; growth is retarded, and canopy closure is delayed.
2. Soil conditions suitable for a limited number of species; growth rate is slow to moderate.
3. Soil conditions suitable for most, or all, climatically adapted species; growth rate and canopy closure are rapid.
4. Soil conditions suitable for few or no species; stands so sparse as to be insignificant to wildlife.

WETLAND FOOD AND COVER PLANTS: Annual and perennial, wild herbaceous plants in moist to wet sites, exclusive of submerged or floating aquatics, that produce food or cover that is extensively and dominantly used by wetland forms of wildlife.

Examples: Smartweed, wild millet, bulrush, spike rushes, rushes, sedges, burreeds, wild rice, rice cutgrass, mannagrass, cattails.

Rating Criteria:
1. Soil conditions suitable for the growth of a wide variety of climatically adapted species, particularly food-producing annual plants.
2. Soil conditions suitable for a wide variety of species, particularly perennials.
3. Soil conditions that tend to produce dominant stands of a few vigorous perennial species, which generally are of low value as food producers.
4. Soil conditions under which wetland plants do not grow or are so sparse as to be of no significance to wildlife.

SHALLOW WATER DEVELOPMENTS:[18] Impoundments or excavations for control of water generally not exceeding 6 feet in depth.

Examples: Low dikes and levees; shallow dugouts; level ditches; devices for water-level control in marshy drainageways or channels.

Rating Criteria:

1. Soil conditions such that there are few or no limitations to construction of shallow water areas or to control or maintenance of desired water levels.
2. Soil conditions under which there are moderate limitations to construction, limitations to choice of measures, or some difficulties in water-level maintenance.
3. Soil conditions that severely limit choice of measures, present serious construction problems, or bring about major difficulties in water-level maintenance.
4. Soil conditions such that shallow water developments are impossible or not feasible.

EXCAVATED PONDS:[19] Dug-out water areas or combinations of dug-out areas and low dikes (dammed areas) that have water of suitable quality, of suitable depth, and in ample supply for production of fish or wildlife.

Examples: Ponds built on nearly level land, of at least one-fourth acre surface area, having an average depth of 6 feet for at least one-fourth of their area, and having a dependably high water table or other source of water.

Rating Criteria:

1. Soil conditions such that locations for excavated ponds provide adequate supplies of readily available water and present no construction problems.
2. Soil conditions such that location of suitable sites is somewhat difficult; satisfactory supplies of water may be somewhat undependable, or there may be moderate construction difficulties.
3. Soil conditions such that location of suitable sites is difficult; satisfactory supplies of water are undependable, or there may be serious construction difficulties.
4. Soil conditions such that excavated ponds cannot be built or are not feasible.

Classes of wildlife.—As shown in table 11, there are three main classes of wildlife. These classes are defined as follows:

OPENLAND WILDLIFE: Birds and mammals that normally make their homes on croplands, pastures, meadows, lawns, and areas overgrown with grasses, herbs, and shrubby plants.

Examples: Quail, pheasants, meadowlarks, field sparrows, doves, cottontail rabbits, red foxes, woodchucks.

WOODLAND WILDLIFE: Birds and mammals that normally make their homes in areas wooded with hardwood trees and shrubs, coniferous trees and shrubs, or mixtures of such plants.

Examples: Ruffed grouse, woodcock, thrushes, vireos, scarlet tanagers, gray squirrel, red squirrel, gray fox, white-tailed deer, raccoon, wild turkey.

WETLAND WILDLIFE: Birds and mammals that normally make their homes in wet areas such as ponds, marshes, and swamps.

Examples: Ducks, geese, rails, herons, shore birds, mink, muskrat, beaver.

Engineering Applications [20]

This soil survey report for Tompkins County, New York, although made primarily for agricultural purposes, has considerable value for other uses. Some soil properties are of special interest to engineers because they affect the design, construction, and maintenance of roads, airports, pipelines, building foundations, and sewage disposal systems. The properties most important to the engineer are permeability to water, shear strength, grain size, compaction characteristics, soil drainage, plasticity, and pH. Topography, depth to water table, and depth to and kind of bedrock are important as well.

Information in the report can be used to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils in the planning of agricultural drainage systems, farm ponds, irrigation systems, and diversion terraces.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting highway, airport, pipeline, and cable locations and in planning detailed investigations of the selected locations.
4. Locate probable sources of gravel and other construction material.
5. Correlate performance of engineering structures with soil mapping units, and thus develop information that will be useful in designing and maintaining the structures.
6. Determine the suitability of soil units for cross-country movements of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

The mapping and the descriptive report are somewhat generalized and should be used only in planning more detailed field surveys that will, in turn, be used to determine the in-place condition of the soil at the site of the proposed engineering construction. It is not intended that this report will eliminate the need for sampling and testing for design and construction of specific engineering works.

[18] On-site investigation is necessary to determine whether a water development is feasible. Limitations of soils when used for reservoir areas and embankments for farm ponds are contained in "Interpretations of Engineering Properties of Soils," table 14, p. 92.

[19] See footnote 18.

[20] By JOHN FLECKENSTEIN, senior agronomist, and AUSTIN H. EMERY, associate soils engineer, New York State Department of Public Works, Bureau of Soil Mechanics; and WALTER S. ATKINSON, State conservation engineer, Soil Conservation Service.

Some engineering information can be obtained from the soil map and from the tables included in this section of the report. For many details, however, it will be necessary to refer to other parts of the report, particularly to the sections "Descriptions of the Soils," "Formation, Morphology, and Classification of the Soils," and "Bedrock Geology."

Terminology

Some of the terms used by soil scientists may be unfamiliar to engineers, and some words—for example, soil, clay, silt, sand, aggregate, and granular—may have a special meaning to soil scientists. These and other special terms used in the soil survey report are defined in the glossary in the back of the report. Following are definitions of several terms that may be unfamiliar.

Plastic limit.—The moisture content at which the soil material passes from a semisolid to a plastic state.

Liquid limit.—The moisture content at which the soil material passes from a plastic to a viscous, semiliquid state.

Plasticity index.—The numerical difference between the liquid limit and the plastic limit. The plasticity index indicates the range of moisture content within which a soil material is plastic.

Permeability.—The estimated amount of water that passes through the soil as it occurs in place, in inches per hour. "Very slowly permeable" is less than 0.2 inch per hour; "slowly permeable," 0.2 to 0.63; "moderately permeable," 0.63 to 2.0; "rapidly permeable," 2.0 to 6.3; and "very rapidly permeable," more than 6.3.

Shrink-swell potential.—An indication of the volume change to be expected of the soil material with changes in moisture content.

Available moisture.—The approximate amount of capillary water in the soil when wet to field capacity, in inches per inch of soil depth. When the soil is "air dry" this amount of moisture will wet the soil material described to a depth of 1 inch without deeper percolation.

Moisture content.—Moisture content is the ratio of the weight of water contained in the soil to the dry weight of the soil. It is usually expressed as a percentage.

Moisture-density relations.—If a soil material is compacted at successively higher moisture contents, assuming that the compactive effort remains constant, the density of the compacted material will increase until the optimum moisture content is reached. After that, the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is termed maximum dry density. The moisture-density relationship is important in earthwork, for, as a rule, optimum stability is obtained for any given compactive effort if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

Classification systems

Engineers commonly use two classification systems that express, by means of symbols, the relative suitability of the soil material for engineering uses. These classification systems are explained as follows:

AASHO System.—Most highway engineers classify soil material in accordance with the system approved by the American Association of State Highway Officials (*1*). In this system, soil material is classified in seven principal groups. The groups range from A–1, consisting of gravelly soils of high bearing capacity, to A–7, consisting of clayey soils having low strength when wet. The soils of Tompkins County have been classified under this system in table 12.

Unified System.—Some engineers prefer to use the Unified Soil Classification System (*26*). In this system, soil material is identified as coarse grained (8 classes), fine grained (6 classes), and highly organic (1 class). The soils of Tompkins County have been classified under this system in table 12.

Soil data and interpretation

The engineering interpretations in this section are based on the results of analysis of 17 soils tested in the Bureau of Soil Mechanics, New York State Department of Public Works, in cooperation with the U.S. Department of Commerce, Bureau of Public Roads (see table 12). Samples were taken from six soil types that are extensive in the county. Each of the six types was sampled in two or three different places. The soils from which the samples were taken were formed in highly variable glacial till or from water-deposited material. The range in texture (grain size) of some of this material is considerable; therefore, the engineering soil classification given in table 12 may not apply to all parts of the mapped soil unit. Also, in establishing the engineering soil classification, the particles larger than 3 inches were not considered. All of the samples were obtained from depths of less than 6 feet; consequently, the test data given in table 12 may not be a suitable basis for estimating the characteristics of soils at greater depths.

Table 13 lists estimated physical properties that are significant to engineers and gives brief descriptions of the soils. The test data shown in table 12, the information given in the section "Descriptions of the Soils" and elsewhere in the report, and the knowledge obtained through past experience in using the soils for engineering construction were used in preparing this table.

Because samples were taken from only six soil types, it was necessary to estimate the AASHO and Unified classifications for the rest of the soils mapped and to estimate the permeability and moisture-holding capacity, as shown in table 13.

Table 14 lists some appraisals of the suitability of soils of Tompkins County for use in highways, embankments, and building foundations, and as a source of topsoil, sand, and gravel. Also listed in table 14 are characteristics that affect the suitability of soils for installation of conservation engineering practices.

The intent of the engineering interpretatons in table 14 is to provide a set of guides and indicators of potential hazards or characteristics that require unusual or special precautions in planning, designing, or constructing engineering structures.

Significance of geologic deposits and bedrock

Table 16, in the section "Formation, Morphology, and Classification of the Soils," shows the geologic origin of the soils of Tompkins County. It will be noted that the following geologic deposits occur: glacial till, glacial outwash, lacustrine sediments, alluvium, muck and peat, and rock outcrop. In addition, part of the county is undifferentiated urban land, made land, and fresh water marsh.

Each geologic unit has engineering significance that differs from that of other geologic units. Each unit is described in the following paragraphs, and the broad engineering significance is given. Where reference is made to the utility of any deposit, except for topsoil purposes, it is assumed that the reference is to the material that underlies the solum. In general, the A and B horizons would be removed at the site of light fills. Where the utility for topsoil purposes is indicated, it is assumed generally that only the surface soil is considered.

DEEP GLACIAL TILL

The soil and rock materials that make up these deposits were picked up, transported, abraded, mixed, and deposited by glaciers. The action of the ice mixed soil and rock from various sources, and the resulting deposits are highly variable assortments of soil material. The particles range in size from boulders to clay. The deposits generally are unstratified, but in places some local sorting has resulted in the formation of pockets of sand, gravel, or silt within the soil mass.

Deep glacial till occurs in the uplands, mostly on sloping and hilly topography. The deposits are ordinarily 4 feet thick or more over bedrock, but in some places they are less than 4 feet thick. They may occur in some places over other unconsolidated deposits, such as glacial outwash or lacustrine sediments. Compactness varies, depending on whether the material was overridden by ice or left in place when the ice melted.

Soils of the following series formed dominantly on deep glacial till: Alden, Bath, Darien, Cayuga, Conesus, Chippewa, Ellery, Erie, Honeoye, Kendaia, Lansing, Langford, Lima, Lyons, Mardin, Ovid, Ilion, Valois, and Volusia.

A larger acreage of the soils of Tompkins County formed on deep glacial till than on any other geologic deposit. The properties of these soils therefore determine normal criteria for design and construction of engineering structures involving the use of earth material, either in place or transported. Generally, these soils provide stable subgrades, good embankment foundations, and, with proper treatment, stable cut slopes for highways. Generally, they also furnish good foundation support for buildings. If properly compacted, material excavated from these deposits, either from highway cuts or from outside borrow areas, may be used to form excellent fills and embankment, but some till deposits that contain many boulders present a problem of excavation and placement in embankments.

SHALLOW GLACIAL TILL

This material is similar to deep glacial till, but the depth to bedrock is generally less than 4 feet; even in light grading operations, bedrock generally will be encountered in cuts. The content of channery and flaggy fragments also may be higher. Some local areas of deep glacial till occur in these areas that are predominantly shallow.

Soils of the Lordstown and Tuller series and fairly shallow soils of the Ovid series formed on shallow glacial till.

If excavation is required, the design of grade elevations is critical for engineering structures on shallow till areas. Unless a moderately high gradeline is maintained, it is necessary to blast ditches in the bedrock. Highway cut slopes may require special design, depending on the structure and the weathering characteristics of the rock.

Infiltration of water between the pavement and the underlying rock in cuts is a common cause of differential frost heaving, and highways must be designed to control this seepage. Particular attention must be given to the use of transition sections between cut and fill.

GLACIAL OUTWASH

These deposits consist of sorted sand and gravel deposited by meltwater from a glacier. They include outwash terraces, deltas, valley trains, kames, kame moraines, lake beaches, and eskers. Rarely is any outwash deposit uniform in texture throughout. A high degree of sorting and stratification is ordinarily evident in deltas, outwash terraces, and eskers. Kames, kame moraines, and beach ridges may contain excessive fines and may be poorly sorted, and contiguous strata may vary considerably in texture. All outwash may include localized silt strata and silt lenses, which impede drainage. In places deltas and other outwash deposits are underlain by fine-grained lacustrine material. Old lake beach gravel is generally underlain by glacial till. If outwash is underlain by less pervious material, intermittent or continuous wetness is likely at the line of contact. Lime cementing may occur in some outwash deposits.

Valley trains, outwash terraces, and deltas generally have level to gently sloping topography. Kames, kame moraines, and eskers have irregular to steep topography. Beach ridges have gently sloping faces and generally follow a constant elevation.

The soils that developed in deposits of glacial outwash are those of the Chenango, Braceville, Fredon, Halsey, Howard, Palmyra, Phelps, and Red Hook series.

Depending on gradation, soundness, and plasticity, outwash may be used for such purposes as (1) fill material for underwater placement; (2) ordinary fill; (3) material to strengthen unstable subgrade soils; (4) subbase for pavements; (5) wearing surfaces for driveways, parking lots, and some low-class roads; (6) material for highway shoulders; (7) free-draining, granular backfill for structures and pipes; (8) outside shells of impounding dams; and (9) abrasives for ice control on highways. Granular soils derived from outwash are suitable for many uses. Their utility and the relative ease with which they can be handled make these soils excellent material for highway embankments. They may be too permeable, however, for embankments intended to hold water. Side slopes of sandy cuts and fills and ditch inverts require positive erosion control measures.

There are extensive flat terraces and deltas, which, if well drained, furnish excellent locations for highways and other developments. Granular material may be underlain by wet, soft silt and clay. This possibility must always be considered on all sites of proposed heavy fills and structures. Kames, kame moraines, and eskers require considerable grading for highways and other facilities. These steep-sided granular deposits have excellent surface drainage, but silt strata, which retard internal drainage, are to be found within all types of outwash deposits. If these silt strata are intercepted by a highway gradeline or are near the top of the subgrade in cuts, differential frost

TABLE 12.—*Engineering*

[Tests performed by the New York State Department of Public Works, Bureau of Soil Mechanics, in cooperation with the U.S. Department Officials

Soil name and location of sample	Parent material	SCS report No. 59NY55	Depth	Horizon	Moisture-density [1]		Lineal shrinkage	Specific gravity [2]	Reaction
					Maximum dry density	Optimum moisture			
			In.		*Lb. per cu. ft.*	*Pct.*	*Pct.*		*pH*
Conesus gravelly silt loam:									
4.5 miles NW. of Ithaca (modal profile).	Glacial till (sandstone, shale, and limestone).	4–1	0 to 8	Ap	107	17	6. 2	2. 59	4. 8
		4–4	18 to 34	B22	118	14	8. 0	2. 73	5. 8
		4–5	34 to 40	C	125	12	6. 4	2. 73	7. 9
6.5 miles NW. of Ithaca (intergrading to Kendaia soils).	Glacial till (sandstone, shale, and limestone).	10–1	0 to 12	Ap	105	17	6. 0	2. 62	5. 9
		10–3	20 to 26	B2g	123	10	3. 0	2. 70	6. 3
		10–4	26 to 36	C	126	10	4. 4	2. 71	7. 8
7.5 miles NW. of Ithaca (intergrading to Langford soils).	Glacial till (sandstone, shale, and limestone).	11–1	0 to 8	Ap	99	22	6. 0	2. 61	5. 9
		11–4	18 to 26	B2	122	11	5. 0	2. 68	5. 9
		11–5	26 to 40	C	125	11	5. 6	2. 72	7. 1
Erie channery silt loam:									
5 miles SE. of Ithaca, 2.5 miles NE. of Danby (modal profile).	Glacial till (shale, sandstone, and limestone).	13–1	0 to 9	Ap	84	30	8. 4	2. 59	4. 3
		13–4	28 to 42	B22g	124	11	7. 0	2. 73	7. 1
		13–6	42 to 60	C	123	12	6. 0	2. 76	6. 9
5.75 miles E. of Ithaca (intergrading to Ellery soils).	Glacial till (shale, sandstone, and limestone).	6–1	0 to 8	Ap	98	21	8. 4	2. 65	6. 5
		6–3	12 to 23	B	127	11	5. 0	2. 71	6. 2
		6–4	28 to 42	C2g	128	11	5. 6	2. 72	6. 4
Howard gravelly loam:									
1 mile W. of Dryden, 100 yards N. of Route 38 (modal profile).	Glacial outwash.	[5] 2–3	11 to 14	A22	103	18	3. 8	2. 67	4. 7
		2–5	23 to 36	B22	128	10	8. 0	2. 68	6. 3
		2–6	36 to 60	C	138	6	5. 0	2. 70	7. 5
0.5 mile S. of Brooktondale, 1 mile E. of Caroline Depot (no A2 and B1 horizon).	Glacial outwash.	[5] 3–2	8 to 19	A2	121	11	5. 0	2. 66	5. 2
		3–4	27 to 60	B22	132	10	4. 0	2. 69	7. 4
		3–5	60 to 80	C	128	11	4. 2	2. 70	7. 5
4 miles S. of Ithaca, 50 feet S. of Route 13 (intergrading to Chenango soils).	Glacial outwash.	7–2	7 to 14	A2	133	8	4. 0	2. 68	4. 9
		7–4	27 to 43	B22	135	8	2. 0	2. 69	5. 6
		7–5	43 to 60	C	134	8	5. 8	2. 70	7. 2
Langford channery silt loam:									
0.5 mile S. of Ellis, 1.75 mile N. of Slaterville Springs (modal profile).	Glacial till (shale, limestone, and sandstone).	16–1	0 to 7	Ap	94	24	7.6	2.57	4.8
		16–5	28 to 48	B22	126	10	5.4	2.73	5.3
		16–6	48 to 60	C	123	11	5.2	2.72	5.5
8 miles W. of Ithaca, 1 mile E. of county line, 0.25 mile S. of Mecklenburg Road (intergrading to Erie soils).	Glacial till (shale, limestone, and sandstone).	18–1	0 to 7	Ap	98	23	7.4	2.65	4.0
		18–5	25 to 35	B22	122	12	6.0	2.73	6.7
		18–6	35 to 45	C	126	12	5.6	2.74	7.7
1 mile N. of Varna and 4 miles NE. of Ithaca (intergrading to Valois soils).	Glacial till (shale, limestone, and sandstone).	17–1	0 to 7	Ap	85	29	7.6	2.53	4.2
		17–5	30 to 50	B22	123	12	5.6	2.73	5.3
		17–6	56 to 64	C	120	12	7.2	2.73	6.0
Lima silt loam:									
1 mile E. of Lake Ridge and 225 yards N. of Fenner Road on E. bank of Davis Road (modal profile).	Glacial till (shale, limestone, and sandstone).	5–1	0 to 7	Ap	96	22	8.0	2.60	6.5
		5–3	12 to 20	B21	127	11	3.8	2.74	7.6
		5–5	24 to 36	Cg	114	15	6.2	2.71	6.5

See footnotes at end of table.

test data

of Commerce, Bureau of Public Roads (BPR), in accordance with standard procedures of the American Association of State Highway (AASHO)]

Mechanical analysis [3]															Liquid limit	Plasticity index	Classification	
Percentage passing sieve—											Percentage smaller than—							
3-in.	2-in.	1½-in.	1-in.	¾-in.	⅜-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO	Unified
-----	100	98	94	92	87	84	80	70	66	53	43	33	18	10	33	8	A-4(4)	[4] ML-CL.
-----	-----	-----	-----	100	98	96	89	79	74	60	42	34	23	19	26	10	A-4(5)	CL.
100	99	95	91	89	84	80	72	61	57	46	31	25	16	12	23	7	A-4(2)	SM-SC.
-----	100	99	97	95	90	86	80	74	71	63	34	29	13	8	32	8	A-4(6)	ML-CL.
-----	100	97	94	90	81	75	66	56	53	42	24	19	10	7	18	5	A-4(1)	SM-SC.
95	86	83	79	76	70	66	59	52	49	40	30	23	12	9	20	2	A-4(1)	SM.
-----	100	98	96	95	93	91	89	81	77	63	38	25	12	8	36	5	A-4(6)	ML.
-----	100	99	95	94	88	83	74	65	62	52	29	23	12	9	23	7	A-4(3)	ML-CL.
-----	100	98	95	92	84	79	70	60	56	44	30	23	14	10	21	5	A-4(2)	SM-SC.
-----	-----	-----	100	99	86	80	79	75	72	65	28	24	12	7	47	8	A-5(7)	[4] ML.
-----	100	99	93	90	82	77	69	59	56	50	40	34	21	15	25	9	A-4(3)	SC.
100	98	98	96	93	87	82	71	60	58	52	43	34	21	14	25	10	A-4(3)	CL.
-----	100	99	98	96	90	86	79	72	70	65	53	39	20	12	40	14	A-6(8)	ML-CL.
-----	-----	100	95	89	79	71	63	51	49	42	34	27	14	10	22	5	A-4(1)	SM-SC.
-----	100	98	96	93	83	77	70	58	55	47	38	28	16	12	21	7	A-4(2)	SM-SC.
-----	-----	100	98	97	92	88	83	73	70	61	43	27	10	5	30	8	A-4(5)	ML-CL.
-----	100	98	94	88	70	56	41	29	28	25	19	15	9	7	30	9	A-2-4(0)	GM-GC.
-----	-----	-----	100	99	90	77	55	22	20	17	14	10	6	4	21	6	A-2-4(0)	SM-SC.
100	98	97	90	86	73	65	53	41	37	30	23	16	7	4	28	4	A-2-4(0)	GM-GC.
-----	100	96	85	78	56	39	21	4	4	3	2	2	1	1	28	5	A-1-a(0)	GW.
-----	100	99	95	91	75	60	38	7	6	5	3	2	1	1	20	3	A-1-a(0)	GP-GM.
-----	-----	100	96	92	79	64	46	16	13	12	9	7	4	2	21	3	A-1-a(0)	SW-SM.
-----	100	97	88	81	68	59	50	26	17	9	6	5	3	2	(6)	(6)	A-1-a(0)	SW-SM.
-----	100	97	86	79	61	52	33	12	8	5	4	3	2	2	21	7	A-2-4(0)	GW-GC.
100	98	98	97	94	88	84	78	67	64	56	26	22	9	6	40	4	A-4(4)	ML.
-----	-----	100	95	92	88	84	75	64	60	49	39	32	16	12	21	6	A-4(3)	SM-SC.
100	98	97	96	94	90	87	81	72	68	56	43	32	18	14	22	6	A-4(4)	ML-CL.
-----	100	98	98	97	92	89	85	80	78	68	53	38	18	12	34	11	A-6(7)	ML-CL.
-----	-----	100	98	96	91	86	78	68	65	53	43	33	19	15	27	9	A-4(4)	CL.
-----	100	96	93	89	83	77	70	59	56	46	38	29	16	12	22	7	A-4(2)	SM-SC.
-----	-----	-----	100	99	95	92	89	82	79	71	56	39	17	11	55	10	A-5(7)	MH.
-----	100	93	89	86	83	78	72	61	58	48	38	29	18	14	20	7	A-4(3)	SM-SC.
-----	-----	-----	-----	100	95	90	81	69	65	54	41	31	20	15	23	7	A-4(4)	ML-CL.
-----	-----	100	97	96	93	91	88	84	79	64	46	34	17	10	41	14	A-7-5(7)	ML-CL.
100	96	89	82	78	71	68	64	56	52	41	34	26	15	9	21	6	A-4(1)	GM-GC.
-----	100	99	97	95	91	88	84	75	71	58	44	36	23	19	25	8	A-4(5)	CL.

TABLE 12.—*Engineering*

Soil name and location of sample	Parent material	SCS report No. 59NY55	Depth	Horizon	Moisture-density [1]		Lineal shrinkage	Specific gravity [2]	Reaction
					Maximum dry density	Optimum moisture			
			In.		*Lb. per cu. ft.*	*Pct.*	*Pct.*		*pH*
Lima silt loam—Continued									
0.75 mile W. of North Lansing and 20 feet S. of DeCamp Road (shallow).	Glacial till (shale, limestone, and sandstone).	15–1	0 to 7	Ap	106	19	6.2	2.63	5.6
		15–3	9 to 16	B2	115	15	8.2	2.69	6.5
		15–4	16 to 36	C	128	10	4.4	2.70	5.6
3 miles NE. of Lake Ridge and 300 yards N. of Snushall Road (intergrading to Honeoye soils).	Glacial till (shale, limestone, and sandstone).	14–1	0 to 7	Ap	104	18	5.0	2.63	6.7
		14–4	15 to 25	B22g	114	16	7.4	2.71	7.5
		14–5	25 to 36	C	130	10	4.4	2.73	7.4
Rhinebeck silt loam:									
0.5 mile E. of Ithaca town line (modal profile).	Lake-deposited clay.	1–1	0 to 10	Alp	101	22	6.4	2.68	7.0
		1–3	12 to 23	B2g	108	18	10.0	2.75	7.1
		1–5	27 to 50	C2	109	17	8.0	2.77	7.0
1 mile SE. of Freeville (grayer and deeper to carbonates).	Lake-deposited clay.	9–1	0 to 7	Ap	94	24	8.0	2.64	5.4
		9–4	30 to 36	B22g	113	15	8.0	2.69	6.9
		9–5	36 to 70	C	108	19	9.0	2.71	7.1
0.25 mile N. of White School Road junction on E. side of Jacksonville Road.	Lake-deposited clay.	8–1	0 to 8	Ap	88	27	10.0	2.55	6.2
		8–4	15 to 24	B22g	103	21	10.3	2.76	6.7
		8–5	24 to 36	C	109	12	10.0	2.76	7.6

[1] Based on AASHO Designation: T 99–57, Method C (*1*).
[2] Specific gravity test performed on fraction passing 3/4-inch sieve.
[3] Mechanical analysis according to AASHO Designation: T 88–57 (*1*). 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

test data—Continued

Mechanical analysis[3]															Liquid limit	Plasticity index	Classification	
Percentage passing sieve—											Percentage smaller than—						AASHO	Unified
3-in.	2-in.	1½-in	1-in.	¾ in.	⅜ in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
-----	100	96	95	94	90	86	81	76	72	60	49	34	16	9	27	8	A-4(5)	CL.
-----	100	99	97	96	90	87	83	78	75	63	46	32	21	17	26	11	A-6(6)	CL.
100	99	98	96	93	86	81	73	63	58	41	30	21	12	9	19	5	A-4(1)	SM-SC.
-----	-----	100	98	97	95	94	92	88	84	69	52	38	15	9	30	8	A=4(7)	ML-CL.
-----	100	98	98	96	94	93	91	87	83	66	50	38	24	17	25	8	A-4(6)	CL.
-----	100	98	94	92	87	83	77	68	64	50	39	27	14	10	17	4	A-4(3)	SM-SC.
-----	-----	-----	----	----	----	-----	100	98	97	91	78	66	33	16	37	11	A-6(8)	ML-CL.
-----	-----	-----	----	----	100	99	99	98	97	92	74	65	41	30	33	13	A-6(9)	CL.
-----	-----	-----	----	----	----	-----	-----	-----	100	99	89	77	40	29	30	10	A-4(8)	CL.
-----	100	99	98	97	95	94	93	90	88	84	66	54	27	15	41	11	A-7-5(8)	ML.
-----	-----	100	95	90	86	85	83	81	80	78	67	60	37	27	33	12	A-6(9)	CL.
-----	-----	-----	----	100	99	98	96	94	92	90	80	72	43	31	30	9	A-4(8)	ML-CL.
-----	-----	-----	----	----	----	-----	100	96	95	92	83	73	40	22	54	20	A-7-5(15)	MH.
-----	-----	100	99	99	99	98	98	96	95	92	81	76	55	42	41	17	A-7-6(11)	CL.
-----	-----	-----	----	100	99	98	95	92	91	86	71	66	46	36	35	14	A-6(10)	CL.

the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

[4] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points from A-line are to be given a borderline classification. Examples of borderline classifications obtained by this use are ML-CL and SM-SC.

[5] These samples obtained in 1958; all others in 1959.

[6] Nonplastic.

733-022—65——6

TABLE 13—*Brief descriptions of soils*

[Physical properties given are those of a modal profile; ranges given are those normal for the soils of each

Symbol on map	Soil name	Description of soil and site	Depth to seasonal high water table	Depth from surface	Classification
					USDA texture
			In.	In.	
Ab	Alluvial land.[1]	Soil material in very recent alluvium adjacent to streams; nearly well drained to very poorly drained. Textures vary greatly within short distances; they may be sandy, silty, or clayey, with or without gravel or stones.			
ArB ArC	Arkport fine sandy loam, 2 to 6 percent slopes. Arkport fine sandy loam, 6 to 12 percent slopes.	3 to 5 feet of well-drained very fine sandy loam, fine sandy loam, or loamy very fine sand; underlain by alternating layers of fine and very fine sand; formed in sandy lake deposits; on nearly level, undulating, and rolling slopes. Locally, may be underlain by clayey or gravelly deposits.	36	0 to 22 22 to 36	Fine sandy loam Very fine sandy loam and loamy fine sand.
BaB BaC BaC3 BaD BgC BgC3 BgD BoE BtF	Bath channery silt loam, 2 to 5 percent slopes. Bath channery silt loam, 5 to 15 percent slopes. Bath channery silt loam, 5 to 15 percent slopes, eroded. Bath channery silt loam, 15 to 25 percent slopes. Bath and Valois gravelly silt loams, 5 to 15 percent slopes. Bath and Valois gravelly silt loams, 5 to 15 percent slopes, eroded. Bath and Valois gravelly silt loams, 15 to 25 percent slopes. Bath and Valois soils, 25 to 35 percent slopes. Bath, Valois, and Lansing soils, 35 to 60 percent slopes.	Bath soils: 1½ to 2½ feet of moderately permeable channery silt loam; underlain by a slowly permeable, very dense, hard, very channery silt loam fragipan that rests on compact, dense, very channery silt loam till dominated by siltstone, sandstone, and shale; well drained; on gentle to steep slopes in the uplands. Depth to bedrock is generally more than 6 feet but is only 4 feet in a few places.	25	0 to 30 30 to 48	Channery silt loam Channery silt loam
		Valois soils: 1½ to 2 feet of moderately permeable gravelly or channery loam or silt loam; underlain by moderately to slowly permeable, slightly firm to friable gravelly or channery silt loam or loam that is slightly sticky, contains more clay than the upper or lower layers, and extends to a depth of 3 to 3½ feet. This is underlain by firm to friable, gravelly or channery loam glacial till that is predominantly siltstone and sandstone but contains some limestone, and that commonly has been waterworked and provides poorly sorted granular material. Well drained; on gentle to steep slopes of glacial moraines and on lower slopes of valley sides.	25	0 to 24 24 to 49 49+	Gravelly silt loam Gravelly silt loam Gravelly loam with thin layers of water-sorted material.
		Lansing soils: 2 to 3 feet of permeable gravelly silt loam to silty clay loam; underlain by very firm, dense, slowly permeable, gravelly silt loam or loam glacial till dominated by shale, siltstone, and limestone; well drained; on steep areas in the uplands.	20	0 to 17 17 to 32 32 to 48+	Gravelly silt loam Gravelly silt loam to silty clay loam. Gravelly silt loam
BvA	Braceville gravelly silt loam, 0 to 5 percent slopes.	1½ to 2 feet of moderately permeable gravelly silt loam or silt loam over firm, fragipan-like gravelly silt loam that is slowly permeable. At a depth of 3 to 4 feet are intermingled layers of gravel, sand, and silt derived from glacial outwash. Moderately well drained; on nearly level slopes or in depressions of outwash terraces; may be underlain by clay or by firm till. Pan may be absent.	6 to 20	0 to 24 24 to 36	Gravelly silt loam Loam or gravelly silt loam.

See footnotes at end of table.

and their estimated physical properties

series. Ranges in some characteristics are described in the column headed "Description of soil and site"]

Classification—Con.		Percentage passing sieve—			Permeability		Shrink-swell potential	Reaction	Available moisture
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Class*	*In. per hr.*		*pH*	*In. per in. of depth*
SM	A-4	100	85 to 95	40 to 50	Moderate to rapid.	0.63 to 6.3	Low	5.5 to 6.5	0.13 to 0.17
SM	A-4	100	80 to 90	40 to 50	Rapid to very rapid.	2.0 to >6.3	Low	6.5 to 7.5	0.13 to 0.17
ML	A-4	60 to 80	55 to 75	50 to 65	Moderate	0.63 to 2.0	Moderate	5.0 to 5.2	0.13 to 0.17
ML, CL, or GM.	A-4	50 to 65	50 to 65	45 to 55	Slow	0.20 to 0.63	Moderate	5.4 to 5.8	0.10 to 0.17
ML	A-4	60 to 70	60 to 65	55 to 60	Moderate	0.63 to 2.0	Moderate	5.0 to 5.5	0.18 to 0.21
ML or ML-CL.	A-4 or A-6.	60 to 70	60 to 65	55 to 65	Moderate to slow.	0.20 to 2.0	Moderate	5.5 to 6.0	0.10 to 0.13
ML or GM-GC.	A-4 or A-2.	50 to 70	40 to 60	20 to 60	Moderate to rapid.	0.63 to 6.3	Moderate	6.0 to 7.5	0.13 to 0.17
ML-CL	A-4	80 to 90	80 to 90	55 to 65	Moderate	0.63 to 2.0	Moderate	5.6 to 6.0	0.13 to 0.15
ML-CL or SM-SC.	A-4	75 to 95	65 to 90	40 to 60	Moderate	0.63 to 2.0	Moderate	6.5 to 7.0	0.15 to 0.21
ML-CL or SM-SC.	A-4	65 to 80	60 to 70	40 to 60	Slow	0.20 to 0.63	Moderate	6.8 to 7.5	0.15 to 0.17
GM or SM.	A-2 or A-4.	65 to 75	50 to 60	35 to 45	Moderate	0.63 to 2.0	Low to moderate.	5.0 to 5.5	0.15 to 0.17
GM	A-2	50 to 60	40 to 50	25 to 35	Slow	0.2 to 0.63	Low to moderate.	5.5 to 6.5	0.13 to 0.17

TABLE 13.—*Brief descriptions of soils and*

Symbol on map	Soil name	Description of soil and site	Depth to seasonal high water table	Depth from surface	Classification
					USDA texture
			In.	*In.*	
Ca	Canandaigua and Lamson soils.	Canandaigua soils: 1½ to 3½ feet of moderately permeable silt loam or very fine sandy loam; surface layer is very high in organic matter; formed in lake deposits that consist mainly of layers of silt and very fine sand but include thin layers of clay; poorly drained and very poorly drained; on nearly level areas or in depressions in basins formerly occupied by lakes.	0 to 6	0 to 8	Silt loam
				8 to 16	Silt loam or very fine sandy loam.
				16 to 24	Silt loam or silty clay loam.
		Lamson soils: 2 to 4 feet of fine or very fine sandy loam over lake-laid fine sand, very fine sand, or loamy fine sand; may have lenses of silt and clay; poorly drained and very poorly drained because of high water table; surface is high or very high in organic matter; on nearly level and ponded sections of glacial lake areas.	0 to 6	0 to 30	Fine or very fine sandy loam.
				30 to 40+	Fine sand
CdA CdC CdD CnB	Chenango gravelly loam, 0 to 5 percent slopes. Chenango gravelly loam, 5 to 15 percent slopes. Chenango gravelly loam, 15 to 25 percent slopes. Chenango gravelly loam, fan, 0 to 8 percent slopes.	1 to 1½ feet of gravelly silt loam or gravelly loam over 1½ to 4 feet of gravelly loam or gravelly sandy loam; underlain by glacial outwash deposits of stratified sand, gravel, and cobblestones; well drained; on nearly level to steep slopes on glacial outwash terraces and kames. Chenango gravelly loam, fan, 0 to 8 percent slopes, occurs on old alluvial fans and has a predominance of flat stone fragments; it also has more fine material in the substratum than is typical of the Chenango soils on glacial outwash terraces.	36	0 to 26	Gravelly loam or gravelly silt loam.
				26 to 34	Stratified sand and gravel.
CfA CfB CfB3	Conesus gravelly silt loam, 0 to 3 percent slopes. Conesus gravelly silt loam, 3 to 8 percent slopes. Conesus gravelly silt loam, 3 to 8 percent slopes, eroded.	1 to 1½ feet of moderately permeable gravelly silt loam over 1 to 2½ feet of slowly permeable gravelly silty clay loam; underlain by very firm, dense, gravelly silt loam or silty clay loam glacial till dominated by shale and limestone; moderately well drained; on nearly level and gentle slopes in the uplands.	6 to 30	0 to 15	Gravelly silt loam
				15 to 22	Gravelly silty clay loam.
				22 to 42	Gravelly silty clay loam.
DgB	Darien gravelly silt loam, 2 to 8 percent slopes.	1 to 1½ feet of moderately permeable gravelly silt loam over slowly permeable gravelly silty clay loam; somewhat poorly drained to moderately well drained; formed in gravelly silty clay loam glacial till that is influenced by lacustrine clay or clay shale; on gently sloping and undulating areas near the margins of glacial lakes.	6 to 15	0 to 13	Gravelly silt loam
				13 to 36	Gravelly silty clay loam.
Em	Eel silt loam.	2½ to 3½ feet of moderately permeable silt loam or fine sandy loam over moderately to rapidly permeable, stratified gravel, sand, and silt; moderately well drained; formed in alluvial sediments on flood plains; textures variable within short distances. Subject to flooding.	6 to 18	0 to 10	Silt loam
				10 to 27	Fine sandy loam

their estimated physical properties—Continued

Classification—Con.		Percentage passing sieve—			Permeability		Shrink-swell potential	Reaction	Available moisture
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Class*	*In. per hr.*		*pH*	*In. per in. of depth*
ML or OL	A-4	100	95 to 100	90 to 95	Moderate	0.63 to 2.0	Moderate	6.0 to 6.5	0.15 to 0.17
ML-CL	A-4	100	95 to 100	90 to 95	Moderate	0.63 to 2.0	Moderate	6.5 to 7.0	0.15 to 0.17
ML-CL	A-4	100	95 to 100	90 to 95	Moderate to slow.	0.2 to 2.0	Moderate	7.0 to 7.5	0.15 to 0.17
SP or SM	A-2 or A-4	80 to 100	75 to 85	10 to 25	Moderate to rapid.	0.63 to 6.3	Low	7.0 to 7.5	0.15 to 0.17
SP or SM	A-2	80 to 100	80 to 90	15 to 30	Moderate to rapid.	0.63 to 6.3	Low	7.0 to 7.5	0.13 to 0.15
GM	A-1-a, A-1-b, or A-2-4.	25 to 40	20 to 35	15 to 30	Rapid	2.0 to 6.3	Low	5.0 to 5.4	0.13 to 0.17
GM or SM.	A-1-a, A-1-b, or A-2-4.	45 to 70	40 to 55	15 to 30	Rapid	2.0 to 6.3	Low	5.5 to 6.0	0.07 to 0.10
ML	A-4	75 to 95	65 to 80	50 to 65	Moderate	0.63 to 2.0	Moderate	6.0 to 6.5	0.17 to 0.19
ML-CL	A-4	80 to 95	75 to 85	50 to 60	Slow	0.2 to 0.63	Moderate	6.5 to 7.0	0.17 to 0.21
GM-GC or SM-SC.	A-4	65 to 80	60 to 75	40 to 45	Slow	0.2 to 0.63	Moderate	6.5 to 7.5	0.17 to 0.21
ML	A-4	75 to 85	65 to 75	60 to 70	Moderate	0.63 to 2.0	Moderate	5.2 to 6.0	0.17 to 0.19
ML-CL	A-4	70 to 80	60 to 70	55 to 70	Slow	0.20 to 0.63	Moderate	6.0 to 7.4	0.17 to 0.19
ML	A-4	65 to 85	60 to 80	50 to 60	Moderate	0.63 to 2.0	Moderate	6.5 to 7.0	0.15 to 0.17
SM-SC	A-2 or A-4.	70 to 90	45 to 60	35 to 45	Moderate to rapid.	0.63 to 6.3	Moderate	5.5 to 6.5	0.15 to 0.17

TABLE 13.—*Brief descriptions of soils and*

Symbol on map	Soil name	Description of soil and site	Depth to seasonal high water table	Depth from surface	Classification
					USDA texture
			In.	*In.*	
EcA	Ellery, Chippewa, and Alden soils, 0 to 8 percent slopes.	Ellery soils: 1 to 1½ feet of moderately permeable silt loam, high in organic matter; underlain by a very firm, dense, slowly permeable, channery silt loam fragipan that is 1½ to 3 feet thick and rests on slowly permeable, dense, firm, channery loam glacial till that is predominantly sandstone, siltstone, and shale but contains some limestone; poorly drained; as depressions, flats, or seeps in the uplands.	0 to 10	0 to 12 12 to 36	Channery silt loam Channery heavy silt loam.
		Chippewa soils: 1 to 1½ feet of moderately permeable silt loam or channery silt loam, high in organic matter; underlain by a firm, dense, very slowly permeable, channery silt loam fragipan. Firm, channery loam or silt loam glacial till at a depth of 3½ to 4 feet. Poorly drained; on nearly flat areas or as seeps in the uplands.	0 to 8	0 to 11 11 to 72	Channery silt loam Channery silt loam
		Alden soils: 1 to 3 feet of silt loam or very fine sandy loam over firm, weakly calcareous glacial till or channery silt loam; very poorly drained; upper 1 to 1½ feet is very high in organic matter; along drainageways, in depressions, or as seeps in the uplands.	0	0 to 24 24 to 40	Silt loam Channery silt loam
EbB EbB3 EbC EbC3	Erie channery silt loam, 3 to 8 percent slopes. Erie channery silt loam, 3 to 8 percent slopes, eroded. Erie channery silt loam, 8 to 15 percent slopes. Erie channery silt loam, 8 to 15 percent slopes, eroded.	Erie soils: 1 to 1½ feet of moderately permeable channery silt loam; underlain by a very dense, firm, slowly permeable, channery loam to clay loam fragipan that is 2 to 4 feet thick and rests on firm, dense, slowly permeable, channery silt loam or loam glacial till that is predominantly siltstone, sandstone, and shale but contains some limestone; somewhat poorly drained; gentle to moderate slopes in the uplands.	4 to 15	0 to 15 15 to 42 42 to 60	Channery silt loam Channery silt loam Channery silt loam
ErA	Erie-Ellery channery silt loams, 0 to 3 percent slopes.	Ellery soils: 1 to 1½ feet of moderately permeable silt loam or channery silt loam, high in organic matter; underlain by a very firm, dense, slowly permeable, channery silt loam fragipan that is 1½ to 3 feet thick and rests on slowly permeable, dense, firm, channery loam glacial till that is predominantly sandstone, siltstone, and shale but contains some limestone; poorly drained; in the uplands as depressions, flats, or seeps.	0 to 10	0 to 12 12 to 36	Channery silt loam Channery heavy silt loam.
FdB	Fredon silt loam, 0 to 5 percent slopes.	1½ to 3½ feet of moderately permeable silt loam or loam over stratified glacial outwash deposits of gravel, sand, and silt dominated by siltstone, shale, and limestone; somewhat poorly drained; on nearly level to slightly concave slopes on outwash plains and stream terraces.	4 to 15	0 to 15 15 to 25	Silt loam or loam Gravelly silt loam or stratified gravel and sand.
Fm	Fresh water marsh.[1]	Areas around ponds or lakes; covered by water most of the year.	----------	----------	----------

See footnotes at end of table.

their estimated physical properties—Continued

Classification—Con.		Percentage passing sieve—			Permeability		Shrink-swell potential	Reaction	Available moisture
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
					Class	*In. per hr.*		*pH*	*In. per in. of depth*
ML-CL	A-4	80 to 85	75 to 85	60 to 70	Moderate	0.63 to 2.0	Moderate	5.5 to 6.5	0.15 to 0.17
SM-SC	A-4	70 to 80	60 to 70	40 to 50	Slow	0.20 to 0.63	Moderate	6.5 to 7.5	0.07 to 0.13
ML-CL	A-4	75 to 90	70 to 80	60 to 70	Moderate	0.63 to 2.0	Moderate	5.0 to 5.5	0.17 to 0.19
ML-CL	A-4	70 to 85	60 to 75	50 to 60	Very slow	<0.2	Moderate	5.5 to 6.5	0.07 to 0.13
ML-CL	A-4	85 to 95	75 to 85	60 to 70	Moderate	0.63 to 2.0	Moderate	5.5 to 7.0	0.20 to 0.25
ML-CL	A-4	75 to 90	70 to 80	65 to 75	Slow	<0.2 to 0.63	Moderate	7.0 to 7.5	0.10 to 0.17
ML-CL	A-4	80 to 85	75 to 85	60 to 70	Moderate	0. 63 to 0. 2	Moderate	5. 5 to 6. 5	0. 15 to 0. 17
SM-SC	A-4	75 to 85	60 to 70	40 to 50	Slow	0. 2 to 0. 63	Moderate	6. 5 to 7. 0	0. 10 to 0. 13
SM-SC	A-4	75 to 85	60 to 70	40 to 50	Slow	0. 2 to 0. 63	Moderate	6. 5 to 7. 5	0. 10 to 0. 13
ML-CL	A-4	80 to 85	75 to 85	60 to 70	Moderate	0. 63 to 2. 0	Moderate	5. 5 to 6. 5	0. 15 to 0. 17
SM-SC	A-4	70 to 80	60 to 70	40 to 50	Slow	0. 2 to 0. 63	Moderate	6. 5 to 7. 5	0. 07 to 0. 13
ML-CL	A-4	65 to 80	60 to 75	55 to 65	Moderate	0. 63 to 2. 0	Moderate	6. 5 to 7. 0	0. 15 to 0. 17
GM-GC or SM-SC.	A-1-a or A-1-b.	40 to 60	25 to 30	15 to 25	Moderate to rapid.	0. 63 to <6. 3	Moderate to low.	6. 5 to 7. 5	0. 10 to 0. 17

TABLE 13.—*Brief descriptions of soils and*

Symbol on map	Soil name	Description of soil and site	Depth to seasonal high water table	Depth from surface	Classification
					USDA texture
			In.	*In.*	
Gn	Genesee silt loam.	2 to 3½ feet of moderately permeable silt loam or very fine sandy loam; underlain by rapidly permeable, stratified alluvial sediments consisting of silt loam, fine sandy loam, gravel, and sand; well drained; on nearly level flood plains. Frequency of flooding varies with height above stream.	30	0 to 38	Silt loam or very fine sandy loam.
				38+	Stratified gravel and sand.
Ha Hc	Halsey silt loam. Halsey mucky silt loam.	2 to 3½ feet of moderately permeable silt loam, loam, or fine sandy loam, with or without gravel; underlain by stratified glacial outwash deposits of gravel, sand, and silt dominated by shale, sandstone, and limestone; surface soil is very high in organic matter. Poorly drained and very poorly drained; in level areas or in depressions on glacial outwash or stream terraces.	0 to 6	0 to 15	Silt loam or mucky silt loam.
				15 to 28	Sandy loam or gravelly sandy loam.
Hk	Holly and Papakating soils.	Holly soils: 2 to 3½ feet of moderately permeable, silt loam material over sandy or silty alluvial sediments; textures vary greatly within short distances; surface soil is high in organic matter. Poorly drained; on low-lying areas of flood plains. Subject to frequent flooding.	0 to 6	0 to 34	Silt loam
				34 to 44	Stratified sand and silt.
		Papakating soils: ½ foot to 1⅓ feet of mucky silt loam; underlain by slowly permeable heavy silt loam or silty clay loam that extends to a depth of 2½ to 3½ feet and rests on extremely variable alluvial sediments consisting of layers of sand, silt, clay, and gravel; poorly drained. In undisturbed areas a thin surface layer of muck and peat may be present. Soils occupy the lowest levels of flood plains and are subject to frequent flooding.	0	0 to 10	Mucky silt loam
				10 to 30	Silty clay loam
				30 to 40+	Stratified gravel, sand, silt, and clay.
HmB HmC HmC3	Honeoye gravelly silt loam, 2 to 8 percent slopes. Honeoye gravelly silt loam, 8 to 15 percent slopes. Honeoye gravelly silt loam, 8 to 15 percent slopes, eroded.	1 foot of gravelly silt loam or loam over ½ foot to 1½ feet of moderately permeable gravelly heavy silt loam or light silty clay loam; underlain by slowly permeable, dense, firm, gravelly silt loam or loam glacial till dominated by limestone, sandstone, and shale; well drained; on gentle to moderate slopes in the uplands; contains some boulders.	20	0 to 13	Gravelly silt loam
				13 to 30	Gravelly heavy silt loam or silty clay loam.
				30+	Gravelly loam
HdA HdC HdCK HdD HpE HpF HrC	Howard gravelly loam, 0 to 5 percent slopes. Howard gravelly loam, 5 to 15 percent simple slopes. Howard gravelly loam, 5 to 15 percent complex slopes. Howard gravelly loam, 15 to 25 percent slopes. Howard and Palmyra soils, 25 to 35 percent slopes. Howard and Palmyra soils, 35 to 60 percent slopes. Howard-Valois gravelly loams, 5 to 15 percent slopes.	Howard soils: 1½ to 2 feet of moderately to rapidly permeable gravelly loam; underlain by ½ to 1 foot of moderately to rapidly permeable gravelly silt loam or gravelly clay loam that tongues into very rapidly permeable, stratified gravelly and sandy glacial outwash dominated by sandstone, shale, and limestone; well drained; on nearly level and hilly areas of glacial outwash terraces and kames.	36	0 to 25	Gravelly loam
				25 to 47	Gravelly sandy clay loam.
				47 to 57	Stratified sand and gravel.
		Palmyra soils: 1 foot to 1½ feet of moderately to rapidly permeable gravelly loam; underlain by a zone of moderately permeable gravelly clay loam that extends	36	0 to 16	Gravelly loam

their estimated physical properties—Continued

Classification—Con.		Percentage passing sieve—			Permeability		Shrink-swell potential	Reaction	Available moisture
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Class*	*In. per hr.*		*pH*	*In. per in. of depth*
ML	A-4	65 to 85	60 to 80	55 to 70	Moderate	0.63 to 2.0	Moderate	6.5 to 7.2	0.17 to 0.19
GM-GC	A-2 or A-4.	45 to 65	40 to 50	35 to 45	Rapid	2.0 to 6.3	Moderate to low.	7.2 to 7.5	0.10 to 0.13
ML or OL.	A-4	65 to 80	60 to 75	55 to 65	Moderate	0.63 to 2.0	Moderate	6.5 to 7.0	0.15 to 0.17
SM-SC or GM-GC.	A-1-a, A-1-b, or A-2.	40 to 60	25 to 35	15 to 25	Rapid	2.0 to 6.3	Low	7.0 to 7.5	0.13 to 0.17
ML	A-4	65 to 85	60 to 80	55 to 70	Moderate	0.63 to 2.0	Moderate	5.5 to 6.5	0.17 to 0.19
GM or SM.	A-4	65 to 80	45 to 50	35 to 45	Moderate to rapid.	0.63 to 6.3	Moderate to low.	6.5 to 7.0	0.13 to 0.17
OL	A-4	80 to 95	70 to 80	60 to 75	Moderate	0.63 to 2.0	Moderate	5.5 to 6.0	0.17 to 0.19
ML-CL	A-4	75 to 90	60 to 80	55 to 70	Slow	0.20 to 0.63	Moderate	5.5 to 6.0	0.17 to 0.19
GM	A-4	45 to 60	45 to 50	35 to 45	Moderate to rapid.	0.63 to 6.3	Moderate to low.	6.0 to 7.0	0.13 to 0.17
ML	A-4	65 to 95	65 to 90	55 to 65	Moderate	0.63 to 2.0	Moderate	6.5 to 7.0	0.15 to 0.19
ML-CL	A-4	65 to 95	65 to 90	55 to 70	Moderate	0.63 to 2.0	Moderate	6.5 to 7.2	0.15 to 0.19
ML or SM-SC.	A-4	80 to 90	75 to 85	40 to 55	Slow	0.20 to 0.63	Moderate	7.2 to 7.5	0.13 to 0.17
SM-SP	A-1-a or A-1-b.	65 to 90	45 to 80	10 to 60	Moderate to rapid.	0.63 to 6.3	Low	5.5 to 5.8	0.13 to 0.17
GW, GC-GP, or SC-SP.	A-1 or A-2.	40 to 60	20 to 50	3 to 25	Moderate to rapid.	0.63 to 6.3	Low	5.8 to 6.2	0.13 to 0.17
SM-SC, SW, SP, or GM.	A-1-a or A-1-b.	50 to 75	30 to 55	5 to 20	Very rapid	>6.3	Low	6.2 to 7.5	0.07 to 0.10
GM, ML, or GM-GC.	A-1-b or A-2-4.	65 to 85	40 to 60	20 to 60	Moderate to rapid.	0.63 to 6.3	Low to moderate.	6.5 to 7.0	0.17 to 0.19

TABLE 13.—*Brief descriptions of soils and*

Symbol on map	Soil name	Description of soil and site	Depth to seasonal high water table	Depth from surface	Classification: USDA texture
			In.	*In.*	
HrD	Howard-Valois gravelly loams, 15 to 25 percent slopes.	to a depth of 1¼ to 2½ feet and tongues downward into very rapidly permeable, stratified gravelly and sandy glacial outwash dominated by limestone, sandstone, and shale; on steep slopes on glacial terraces and kames.		16 to 21 21+	Gravelly clay loam Stratified sand and gravel.
		Valois soils: 1½ to 2 feet of moderately permeable gravelly or channery loam or slit loam; underlain by slowly permeable, slightly firm to friable gravelly or channery silt loam or loam that is slightly sticky, and contains more clay than the upper or lower layers, and extends to a depth of 3 to 3½ feet. This is underlain by firm to friable, gravelly or channery loam glacial till that is predominantly siltstone and sandstone but contains some limestone and that commonly has been waterworked and provides poorly sorted granular material. Well drained; on gentle to steep slopes of glacial moraines and on lower slopes of valley sides.	25	0 to 24 24 to 49 49+	Gravelly silt loam Gravelly silt loam Gravelly loam with thin layers of water-sorted material.
HsB HsC3 HsD3 HuB HuB3 HuC3 HuD HwB HzE	Hudson silty clay loam, 2 to 6 percent slopes. Hudson silty clay loam, 6 to 12 percent slopes, eroded. Hudson silty clay loam, 12 to 20 percent slopes, eroded. Hudson-Cayuga silt loams, 2 to 6 percent slopes. Hudson-Cayuga silt loams, 2 to 6 percent slopes, eroded. Hudson-Cayuga silt loams, 6 to 12 percent slopes, eroded. Hudson-Cayuga silt loams, 12 to 20 percent slopes. Hudson and Collamer silt loams, 2 to 6 percent slopes. Hudson and Dunkirk soils, 20 to to 45 percent slopes.	Hudson soils: 1 foot to 2 feet of silt loam or silty clay loam over slowly permeable silty clay to 3½ feet; underlain by slowly permeable, lake-laid deposits consisting of layers of silty clay or clay separated by thinner layers of silt. Moderately well drained to well drained; on gentle to rolling convex slopes in the lake plains.	10 to 24	0 to 9 9 to 36	Silt loam Silty clay
		Cayuga soils: 1 foot of moderately permeable silt loam over 8 inches to 2 feet of slowly permeable silty clay loam; may be some gravel where deposits are thin. This lake-laid material is underlain by firm, dense, very gravelly loam glacial till dominated by limestone and shale. Well drained or moderately well drained; on gentle to moderately steep slopes on the sides of valleys; bedrock may be at 3 to 4 feet.	10 to 30	0 to 9 9 to 30 30 to 60	Silt loam Silty clay loam Silt loam or gravelly loam.
		Collamer soils: 1 foot of moderately permeable silt loam over 1 to 2½ feet of heavy silt loam or light silty clay loam that is moderately to slowly permeable and is underlain by layers of lake-laid silt with lenses of very fine sand and clay; moderately well drained; on gentle and undulating slopes in glacial lake areas.	6 to 30	0 to 12 12 to 25 25+	Silt loam or very fine sandy loam. Silt loam or silty clay loam. Stratified silt and very fine sand.
		Dunkirk soils: ½ to 1 foot of moderately permeable silt loam over 2 to 3 feet of moderately to slowly permeable heavy silt loam or light silty clay loam; underlain by stratified lake-laid silty material with thin lenses of slowly permeable clay; well drained; on steep slopes where streams have cut into glacial lake deposits.	24	0 to 4 4 to 36 36 to 50	Silt loam Silt loam or silty clay loam. Stratified silt with thin lenses of clay.
IcA	Ilion silty clay loam, 0 to 2 percent slopes.	1½ to 3 feet of slowly permeable silty clay loam or silty clay over firm, dense.	0 to 8	0 to 15	Silty clay loam

their estimated physical properties—Continued

Classification—Con.		Percentage passing sieve—			Permeability		Shrink-swell potential	Reaction	Available moisture
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
					Class	*In. per hr.*		*pH*	*In. per in. of depth*
GM-GC	A-1-b or A-2-4.	40 to 60	30 to 50	20 to 40	Moderate	0. 63 to 2. 0	Moderate	7. 0 to 7. 5	0. 17 to 0. 21
GM-GC or GC.	A-1-b or A-2-4.	50 to 75	30 to 50	20 to 30	Very rapid	>6. 3	Low	7. 5	0. 10 to 0. 13
ML	A-4	60 to 70	60 to 65	55 to 60	Moderate	0. 63 to 2. 0	Moderate	5. 0 to 5. 5	0. 18 to 0. 21
ML or ML-CL.	A-4, A-6	60 to 70	60 to 65	55 to 65	Slow	0. 20 to 0. 63	Moderate	5. 5 to 6. 0	0. 10 to 0. 13
ML or GM-GC.	A-4, A-2	50 to 70	40 to 60	20 to 60	Moderate to rapid.	0. 63 to 6. 3	Moderate	6. 0 to 7. 5	0. 13 to 0. 17
ML-CL	A-4 or A-6.	----------	100	85 to 95	Moderate	0. 63 to 2. 0	Moderate	6. 8 to 7. 0	0. 17 to 0. 19
CL	A-6	----------	100	85 to 95	Slow	0. 20 to 0. 63	Moderate to high.	7. 0 to 7. 5	0. 17 to 0. 19
ML-CL	A-6	90 to 100	80 to 100	85 to 95	Moderate	0. 63 to 2. 0	Moderate	6. 8 to 7. 0	0. 17 to 0. 19
ML-CL	A-6	90 to 100	80 to 100	80 to 95	Slow	0. 20 to 0. 63	Moderate to high.	6. 8 to 7. 0	0. 17 to 0. 19
ML-CL, SM-SC.	A-4	70 to 80	60 to 70	45 to 55	Slow	0. 20 to 0. 63	Moderate	7. 0 to 7. 5	0. 13 to 0. 15
ML	A-6	90 to 100	90 to 100	85 to 95	Moderate	0. 63 to 2. 0	Moderate	5. 5 to 6. 5	0. 15 to 0. 17
ML-CL, CH.	A-6 or A-7.	85 to 100	85 to 100	75 to 90	Slow	0. 20 to 0. 63	Moderate to high.	6. 5 to 7. 0	0. 17 to 0. 19
ML-CL	A-4 or A-6.	90 to 100	90 to 100	85 to 95	Slow to moderate.	0. 20 to 2. 0	Moderate	7. 0 to 7. 5	0. 17 to 0. 19
ML	A-4	90 to 100	90 to 100	85 to 95	Moderate	0. 63 to 2. 0	Moderate	5. 5 to 6. 5	0. 15 to 0. 17
ML-CL	A-6	85 to 100	85 to 100	75 to 90	Moderate to slow.	0. 20 to 2. 0	Moderate to high.	5. 5 to 6. 5	0. 15 to 0. 17
ML-CL	A-6	90 to 100	90 to 100	75 to 90	Slow	0. 20 to 0. 63	Moderate to high.	7. 0 to 7. 5	0. 15 to 0. 17
ML-CL	A-6	80 to 90	75 to 85	70 to 80	Slow	0. 20 to 0. 63	Moderate to high.	6. 8 to 7. 0	0. 17 to 0. 21

TABLE 13.—*Brief descriptions of soils and*

Symbol on map	Soil name	Description of soil and site	Depth to seasonal high water table	Depth from surface	Classification: USDA texture
			In.	*In.*	
IcB	Ilion silty clay loam, 2 to 6 percent slopes.	slowly permeable, loam to silty clay loam glacial till. Soil material is a mixture of lake-laid silty clay and loamy glacial till; in some places the two have been mixed and in other places a thin layer of clay was deposited over the till. Surface soil is high in organic matter. Quantity of stone fragments in the subsoil ranges widely from area to area. Poorly drained; on level areas and in depressions in the uplands near the margins of glacial lakes.		15 to 26 26 to 36+	Silty clay loam or silty clay. Silt loam
KaB KnA	Kendaia silt loam, 3 to 8 percent slopes. Kendaia and Lyons silt loams, 0 to 3 percent slopes.	Kendaia soils: 1 foot to 1½ feet of moderately permeable silt loam over 1 foot to 1½ feet of heavy silt loam to light silty clay loam; underlain by firm, dense, slowly permeable, gravelly silt loam glacial till dominated by limestone, siltstone, and shale. Surface soil is high in organic matter. Somewhat poorly drained; on nearly level to gently sloping upland areas on which water from adjacent areas accumulates.	4 to 15	0 to 17 17 to 24 24 to 33+	Silt loam Silt loam to silty clay loam. Gravelly silt loam
		Lyons soils: 1½ to 2½ feet of moderately permeable silt loam over slowly permeable silt loam; underlain by dense, very firm, slowly permeable, gravelly silt loam glacial till dominated by limestone, siltstone, and shale. The upper 8 to 18 inches is very high in organic matter and may be mucky. Poorly drained and very poorly drained; in level and depressed areas and as seeps in the uplands.	0 to 6	0 to 12 12 to 30 30 to 42+	Mucky silt loam Silt loam Gravelly silt loam
LaB LaB3 LaC LaC3	Langford channery silt loam, 2 to 8 percent slopes. Langford channery silt loam, 3 to 8 percent slopes, eroded. Langford channery silt loam, 8 to 15 percent slopes. Langford channery silt loam, 8 to 15 percent slopes, eroded.	1½ to 2 feet of moderately permeable channery silt loam; underlain by a very dense, firm, slowly permeable, channery silt loam fragipan that is 2 to 3 feet thick and rests on firm, dense, channery loam or channery silt loam glacial till derived mainly from siltstone and shale but containing some limestone; moderately well drained; on undulating to moderately steep slopes in the uplands.	6 to 30	0 to 22 22 to 52 52 to 60+	Channery silt loam Channery silt loam Channery silt loam
LbA LbB LbB3 LbC LbC3	Lansing gravelly silt loam, 0 to 3 percent slopes. Lansing gravelly silt loam, 3 to 8 percent slopes. Lansing gravelly silt loam, 3 to 8 percent slopes, eroded. Lansing gravelly silt loam, 8 to 15 percent slopes. Lansing gravelly silt loam, 8 to 15 percent slopes, eroded.	1 to 1½ feet of moderately permeable gravelly silt loam over 1 foot to 2½ feet of moderately permeable gravelly silt loam to silty clay loam; underlain by very firm, dense, slowly permeable, gravelly silt loam or loam glacial till dominated by shale, siltstone, and limestone; well drained; on convex, gentle to moderately steep slopes in the uplands.	20+	0 to 17 17 to 32 32 to 48+	Gravelly silt loam Gravelly silt loam to silty clay loam. Gravelly silt loam
LmA LmB LmB3	Lima silt loam, 0 to 3 percent slopes. Lima silt loam, 3 to 8 percent slopes. Lima silt loam, 3 to 8 percent slopes, eroded.	1 foot to 1½ feet of moderately permeable silt loam over permeable heavy silt loam to silty clay loam that extends to a depth of 2 to 2½ feet; underlain by very firm, dense, slowly permeable, gravelly silt loam glacial till dominated by limestone but including some siltstone and shale; moderately well drained; on nearly level and convex slopes in the uplands.	6 to 24	0 to 12 12 to 24 24 to 36	Silt loam Silt loam to silty clay loam. Silt loam or gravelly silt loam.

their estimated physical properties—Continued

Classification—Con.		Percentage passing sieve—			Permeability		Shrink-swell potential	Reaction	Available moisture
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Class*	*In. per hr.*		*pH*	*In. per in. of depth*
ML-CL	A-6	80 to 90	75 to 85	70 to 80	Slow	0. 20 to 0. 63	Moderate to high.	6. 6 to 7. 0	0. 13 to 0. 17
ML	A-4	60 to 75	60 to 70	50 to 70	Slow	0. 20 to 0. 63	Moderate	7. 0 to 7. 5	0. 13 to 0. 17
ML-CL	A-4	80 to 90	70 to 80	60 to 70	Moderate	0. 63 to 2. 0	Moderate	6. 0 to 6. 5	0. 17 to 0. 21
ML-CL	A-4	80 to 90	65 to 70	55 to 65	Moderate	0. 63 to 2. 0	Moderate	6. 5 to 7. 0	0. 17 to 0. 21
ML-CL	A-4	60 to 70	55 to 75	50 to 60	Slow	0. 20 to 0. 63	Moderate	7. 0 to 7. 5	0. 13 to 0. 17
ML-CL	A-6	95 to 100	90 to 100	85 to 95	Moderate	0. 63 to 2. 0	Moderate	6. 8 to 7. 0	0. 17 to 0. 21
ML	A-4	65 to 85	60 to 85	50 to 65	Slow to moderate.	0. 20 to 2. 0	Moderate	7. 0 to 7. 5	0. 17 to 0. 19
ML-CL	A-4	60 to 70	55 to 75	50 to 60	Slow	0. 20 to 0. 63	Moderate	7. 0 to 7. 5	0. 13 to 0. 17
ML-CL	A-4	85 to 95	75 to 90	55 to 70	Moderate	0. 63 to 2. 0	Moderate	5. 2 to 5. 7	0. 15 to 0. 21
SM, SC, or ML-CL.	A-4	75 to 85	70 to 80	45 to 55	Slow	0. 20 to 0. 63	Moderate	6. 0 to 7. 0	0. 05 to 0. 07
SM, SC, or ML-CL.	A-4	85 to 90	70 to 80	45 to 55	Slow	0. 20 to 0. 63	Moderate	7. 0 to 7. 5	0. 07 to 0. 10
ML-CL	A-4	80 to 90	80 to 90	55 to 65	Moderate	0. 63 to 2. 0	Moderate	5. 6 to 6. 0	0. 13 to 0. 17
ML-CL or SM-SC.	A-4	75 to 95	65 to 90	40 to 60	Moderate	0. 63 to 2. 0	Moderate	6. 5 to 7. 0	0. 13 to 0. 17
ML-CL or SM-SC.	A-4	65 to 80	60 to 70	40 to 60	Slow	0. 20 to 0. 63	Moderate	6. 8 to 7. 5	0. 13 to 0. 15
ML-CL	A-4	85 to 95	80 to 95	60 to 70	Moderate	0.63 to 2.0	Moderate	7.0 to 7.2	0.13 to 0.15
ML-CL, GM-GC, or SM-SC.	A-4	65 to 95	65 to 90	40 to 65	Moderate	0.63 to 2.0	Moderate	7.0 to 7.5	0.15 to 0.21
CL, SM-SC.	A-4	80 to 90	70 to 85	40 to 60	Slow	0.20 to 0.63	Moderate	7.5	0.15 to 0.17

TABLE 13.—*Brief descriptions of soils and*

Symbol on map	Soil name	Description of soil and site	Depth to seasonal high water table	Depth from surface	Classification: USDA texture
			In.	*In.*	
LnC	Lordstown channery silt loam, 5 to 15 percent slopes.	Lordstown soils: 1½ to 2½ feet of moderately permeable channery silt loam over interbedded siltstone, sandstone, and shale; formed from till dominated by siltstone, sandstone, and shale; well drained; on moderately sloping to steep areas in the uplands. Shallower inclusions and occasional rock outcrops may occur.	20+	0 to 26	Channery silt loam
LnC3	Lordstown channery silt loam, 5 to 15 percent slopes, eroded.			26+	Fractured bedrock
LnD	Lordstown channery silt loam, 15 to 25 percent slopes.				
LnE	Lordstown channery silt loam, 25 to 35 percent slopes.				
LoF	Lordstown soils, 35 to 70 percent slopes.				
LtB	Lordstown, Tuller, and Ovid soils, shallow and very shallow, 0 to 15 percent slopes.	Tuller soils: 1¼ to 2 feet of moderately permeable channery silt loam over siltstone or sandstone. The bedrock is generally fractured 2 to 3 inches over the hard rock surface and contains some firm soil material; locally, the bedrock may be shale. Formed from glacial till dominated by siltstone; poorly drained to somewhat poorly drained; on nearly level to moderately sloping, bedrock-controlled slopes in the uplands.	0 to 15	0 to 24	Channery silt loam
LtC	Lordstown, Tuller, and Ovid soils, shallow and very shallow, 15 to 35 percent slopes.			24+	Siltstone or sandstone bedrock.
		Ovid soils: 1 foot of moderately permeable silt loam that may contain some gravel, over slowly permeable gravelly silty clay loam that extends to a depth of 14 to 20 inches; underlain by siltstone, shale, or sandstone; the bedrock is generally fractured 2 to 3 inches over the hard rock surface and contains some firm soil material; locally the bedrock may be shale. Formed from thin deposits of clayey lake sediments; somewhat poorly drained to moderately well drained; on nearly level to moderate bedrock-controlled slopes in the uplands.	4 to 15	0 to 12	Silt loam
				12 to 20	Gravelly silty clay loam.
				20+	Siltstone or sandstone bedrock.
Ly	Lyons silt loam.	1½ to 2½ feet of moderately permeable silt loam over slowly permeable silt loam; underlain by slowly permeable, dense, very firm, gravelly silt loam glacial till dominated by limestone, siltstone, and shale; the upper 8 to 18 inches is very high in organic matter and may be mucky; poorly drained and very poorly drained; on level or depressed areas and as seeps in the uplands.	0 to 6	0 to 12	Mucky silt loam
				12 to 30	Silt loam
				30 to 42+	Gravelly silt loam
Mn	Madalin silty clay loam.	1 foot to 2 feet of slowly permeable silty clay loam over very slowly permeable silty clay or clay; upper 6 to 18 inches is very high in organic matter and may be mucky; found in lake-laid deposits of silty clay or clay; poorly drained and very poorly drained; on flat or slightly depressed areas formerly occupied by glacial lakes.	0 to 8	0 to 15	Silty clay loam or mucky silty clay loam.
Mm	Madalin mucky silty clay loam.			15 to 38+	Silty clay or clay
Mc	Made land.[1]	Areas that have been filled with a variety of material including soil, rubble, and trash.	---	---	---
MaB	Mardin channery silt loam, 2 to 8 percent slopes.	Mardin soils: 1¼ to 2 feet of moderately permeable channery silt loam; underlain by a very dense, firm, very slowly permeable, channery silt loam fragipan that extends to a depth of 4 to 5 feet and rests on an equally firm, dense, slowly permeable, channery silt loam or loam glacial till dominated by siltstone, sandstone, and shale; moderately well drained; on gentle to moderately steep convex slopes in the uplands.	10 to 30	0 to 16	Channery silt loam
MaC	Mardin channery silt loam, 8 to 15 percent slopes.			16 to 42	Channery silt loam
MaC3	Mardin channery silt loam, 8 to 15 percent slopes, eroded.			42 to 80	Channery loam

See footnotes at end of table.

their estimated physical properties—Continued

Classification—Con.		Percentage passing sieve—			Permeability		Shrink-swell potential	Reaction	Available moisture
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
					Class	*In. per hr.*		*pH*	*In. per in. of depth*
ML	A-4	70 to 80	65 to 80	55 to 70	Moderate	0.63 to 2.0	Moderate	5.4 to 6.0	0.15 to 0.18
ML-CL	A-4	75 to 85	65 to 80	55 to 65	Moderate	0.63 to 2.0	Moderate	5.0 to 5.5	0.13 to 0.17
ML	A-4	85 to 95	80 to 90	60 to 90	Moderate	0.63 to 2.0	Moderate	6.0 to 6.2	0.17 to 0.19
ML-CL	A-6	65 to 95	60 to 90	50 to 85	Slow	0.20 to 0.63	Moderate to high.	6.2 to 7.0	0.17 to 0.19
ML or OL	A-6	95 to 100	90 to 100	85 to 95	Moderate	0. 63 to 2. 0	Moderate	6. 8 to 7. 0	0. 17 to 0. 21
ML	A-4	65 to 85	60 to 85	50 to 65	Slow to moderate.	0. 20 to 2. 0	Moderate	7. 0 to 7. 5	0. 17 to 0. 19
ML-CL	A-4	60 to 70	55 to 75	50 to 60	Slow	0. 20 to 0. 63	Moderate	7. 0 to 7. 5	0. 13 to 0. 17
OH, CH, or OH-CH.	A-7	100	95 to 100	85 to 90	Slow	0. 20 to 0. 63	High	6. 0 to 6. 5	0. 17 to 0. 19
CL or CH	A-7	100	95 to 100	90 to 95	Very slow	<0. 2	High	6. 5 to 7. 5	0. 13 to 0. 17
ML-CL	A-4	65 to 80	60 to 70	50 to 60	Moderate	0.20 to 0.63	Moderate	4.5 to 5.5	0.17 to 0.25
ML-CL or GM-GC.	A-4	65 to 75	55 to 65	40 to 55	Very slow	<0.2	Moderate	4.5 to 6.0	0.05 to 0.07
ML-CL or GM-GC.	A-4	65 to 75	55 to 65	40 to 55	Very slow	<0.2	Moderate	6.0 to 7.4	0.07 to 0.10

TABLE 13.—*Brief descriptions of soils and*

Symbol on map	Soil name	Description of soil and site	Depth to seasonal high water table	Depth from surface	Classification
					USDA texture
			In.	*In.*	
MfD	Mardin and Langford soils, 15 to 25 percent slopes.[2]	Langford soils: 1½ to 2 feet of moderately permeable channery silt loam over a very dense, firm, slowly permeable, channery silt loam fragipan that is 2 to 3 feet thick and rests on firm, dense, channery loam or silt loam glacial till that is predominantly siltstone and shale but contains a little lime; moderately well drained; on undulating to moderately steep slopes in the uplands.	6 to 30	0 to 22 22 to 52 52 to 60+	Channery silt loam Channery silt loam Channery silt loam
Mo	Middlebury and Tioga silt loams	Middlebury soils: 2 to 3 feet of moderately permeable silt loam over stratified alluvial sediments consisting of silt loam, loam, sand, and gravel. Layers of sand and gravel are not uncommon in the upper 2 to 3 feet. Near streams that flood frequently; moderately well drained; on level areas of flood plains.	6 to 18	0 to 30 30+	Silt loam Stratified silt, sand, and gravel.
		Tioga soils: 2 to 3 feet of moderately permeable silt loam; underlain by stratified gravelly, sandy, and silty alluvial sediments that vary widely from area to area; well drained. There may be gravelly and sandy layers in the upper 2 to 3 feet on better drained areas of flood plains. Subject to flooding.	30	0 to 36 36+	Silt loam Stratified gravel, sand, and silt.
Mp	Muck and Peat.[2]	Undifferentiated organic soils 18 inches or more thick over mineral soils; includes well-decomposed muck as well as almost undecomposed peat that occurs in small closed depressions.			
NaB	Niagara silt loam, 2 to 6 percent slopes.	1 foot of silt loam or very fine sandy loam over moderately permeable silt loam or very fine sandy loam that contains more clay than the surface layer and extends to a depth of 2 to 3½ feet; underlain by stratified, slowly permeable lake-laid silt and very fine sand with thin lenses of clay; somewhat poorly drained; on gentle slopes in glacial lake areas.	4 to 15	0 to 12 12 to 30 30+	Silt loam Heavy silt loam Stratified silt and very fine sand with lenses of clay.
OaA OcC3 OrA OrB OrC	Ovid silt loam, 0 to 6 percent slopes. Ovid silty clay loam, 6 to 12 percent slopes, eroded. Ovid and Rhinebeck silt loams, moderately deep, 0 to 2 percent slopes. Ovid and Rhinebeck silt loams, moderately deep, 2 to 6 percent slopes. Ovid and Rhinebeck silt loams, moderately deep, 6 to 12 percent slopes.	Ovid soils: 1 foot to 1¼ feet of moderately permeable silt loam that may contain some gravel over slowly permeable gravelly silty clay loam that extends to a depth of 2 to 3 feet; underlain by very firm, dense, very slowly permeable, gravelly loam glacial till dominated by limestone, siltstone, and shale; formed from thin clayey deposits of lake sediments over glacial till; somewhat poorly drained to moderately well drained; on nearly level to moderate slopes along the margins of glacial lakes. Bedrock is generally at a depth of 20 to 40 inches in areas of Ovid and Rhinebeck silt loams, moderately deep.	4 to 15	0 to 12 12 to 30 30+	Silt loam Gravelly silty clay loam. Gravelly loam

See footnotes at end of table.

their estimated physical properties—Continued

Classification—Con.		Percentage passing sieve—			Permeability		Shrink-swell potential	Reaction	Available moisture
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)					
					Class	*In. per hr.*		*pH*	*In. per in. of depth*
ML–CL	A–4	85 to 95	75 to 90	55 to 70	Moderate	0.63 to 2.0	Moderate	5.2 to 5.7	0.15 to 0.21
SM, SC, or ML–CL.	A–4	75 to 85	70 to 80	45 to 55	Slow	0.20 to 0.63	Moderate	6.0 to 7.0	0.05 to 0.07
SM, SC, or ML–CL.	A–4	85 to 90	70 to 80	45 to 55	Slow	0.20 to 0.63	Moderate	7.0 to 7.5	0.07 to 0.10
ML	A–4	65 to 85	60 to 80	50 to 70	Moderate	0.63 to 2.0	Moderate	5.0 to 5.5	0.17 to 0.19
GM–GC	A–2 or A–4.	50 to 65	45 to 50	35 to 45	Rapid to very rapid.	>2.0	Moderate to low.	5.0 to 5.8	0.10 to 0.13
ML	A–4	65 to 85	60 to 80	50 to 70	Moderate to rapid.	0.63 to 6.3	Moderate	5.0 to 5.5	0.17 to 0.19
GM–GC	A–2 or A–4.	50 to 65	45 to 50	35 to 45	Rapid	0.20 to 6.3	Low to moderate.	5.5 to 6.5	0.10 to 0.13
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ML–CL	A–4	90 to 100	90 to 100	80 to 90	Moderate	0.63 to 2.0	Moderate	6.4 to 7.0	0.17 to 0.21
ML–CL	A–6	90 to 100	90 to 100	75 to 90	Moderate	0.63 to 2.0	Moderate	6.4 to 7.0	0.17 to 0.21
ML	A–4	100	90 to 100	70 to 85	Slow	0.2 to 0.63	Moderate	7.0 to 7.5	0.13 to 0.17
ML	A–4	85 to 95	80 to 90	60 to 90	Moderate	0.63 to 2.0	Moderate	6.0 to 6.2	0.17 to 0.19
ML–CL	A–6	65 to 95	60 to 90	50 to 85	Slow	0.20 to 0.63	Moderate to high.	6.2 to 7.0	0.17 to 0.19
SM or ML.	A–4	80 to 90	75 to 85	40 to 55	Very slow	<0.20	Moderate	7.0 to 7.5	0.13 to 0.17

TABLE 13.—*Brief descriptions of soils and*

Symbol on map	Soil name	Description of soil and site	Depth to seasonal high water table	Depth from surface	Classification: USDA texture
			In.	*In.*	
OrC—Con.	Ovid and Rhinebeck silt loams—Continued	Rhinebeck soils: 1 foot of moderately permeable heavy silt loam over slowly permeable silty clay loam or silty clay that extends to a depth of 2 to 3 feet; underlain by layers of lake-laid silty clay separated by thin layers of silt; somewhat poorly drained; on nearly level to moderate slopes in glacial lake areas. Bedrock is generally at a depth of 20 to 40 inches in areas of Ovid and Rhinebeck silt loams, moderately deep.	0 to 15	0 to 12	Silt loam
				12 to 27	Silty clay loam
				27 to 50	Varved silty clay and silt.
PaA PaC PaCK PaD	Palmyra gravelly loam, 0 to 5 percent slopes. Palmyra gravelly loam, 5 to 15 percent simple slopes. Palmyra gravelly loam, 5 to 15 percent complex slopes. Palmyra gravelly loam, 15 to 25 percent slopes.	1 foot to 1½ feet of moderately to rapidly permeable gravelly loam over a moderately permeable zone of gravelly clay loam that extends to a depth of 1¼ to 2½ feet and tongues downward into very rapidly permeable, stratified gravelly and sandy glacial outwash dominated by limestone, sandstone, and shale; on nearly level to steep slopes on glacial outwash terraces and kames.	36	0 to 16	Gravelly loam
				16 to 21	Gravelly clay loam
				21+	Stratified sand and gravel.
PhA PhB	Phelps gravelly silt loam, 0 to 3 percent slopes. Phelps gravelly silt loam, 3 to 8 percent slopes.	1 foot to 2 feet of moderately permeable gravelly silt loam or loam over a slowly permeable layer that ranges widely in texture and extends to a depth of 2 to 3½ feet. Texture may be almost pure silt, or a gravelly loam, or silt loam that is dense in place. This layer is underlain by stratified gravel, sand, and silt of glacial outwash dominated by limestone, sandstone, and shale. Moderately well drained; on nearly level to gently sloping areas of glacial outwash terraces.	6 to 20	0 to 15	Gravelly loam
				15 to 25	Heavy silt loam
				25 to 40	Stratified gravel, sand, and silt.
RhA	Red Hook gravelly silt loam, 0 to 5 percent slopes.	1 foot to 1⅓ feet of moderately permeable silt loam or gravelly silt loam over firm, dense, slowly permeable gravelly silt loam or silt loam that extends to a depth of 2 to 3 feet; underlain by stratified gravel, sand, and silt of glacial outwash dominated by sandstone and shale; somewhat poorly drained; low-lying positions on glacial outwash terraces.	4 to 15	0 to 12	Gravelly silt loam
				12 to 26	Silt loam
				26+	Stratified gravel, sand, and silt.
RkA RkB RnC3	Rhinebeck silt loam, 0 to 2 percent slopes. Rhinebeck silt loam, 2 to 6 percent slopes. Rhinebeck silty clay loam, 6 to 12 percent slopes, eroded.	1 foot of moderately to slowly permeable heavy silt loam over slowly permeable silty clay loam or silty clay that extends to a depth of 2 to 3 feet; underlain by layers of lake-laid silty clay separated by thin layers of silt; somewhat poorly drained; on nearly level to moderate slopes in glacial lake areas.	0 to 15	0 to 12	Silt loam
				12 to 27	Silty clay loam
				27 to 50	Varved silty clay and silt.
Ro	Rock outcrop.[1]	Rock ledges and gorges of siltstone, shale, sandstone, and limestone; unweathered bedrock with little or no soil in the steeply sloping areas.			
TeA	Tuller channery silt loam, 0 to 6 percent slopes.	1¼ to 2 feet of permeable channery silt loam over siltstone or sandstone. The bedrock is generally fractured 2 to 3 inches over the hard rock surface and contains some firm soil material; locally, the bedrock may be shale. Formed from glacial till dominated by siltstone, shale, and sandstone; poorly to somewhat poorly drained; on nearly level to gently sloping, bedrock-controlled slopes in the uplands.	0 to 15	0 to 24	Channery silt loam
				24+	Siltstone or sandstone bedrock.

their estimated physical properties—Continued

Classification—Con.		Percentage passing sieve—			Permeability		Shrink-swell potential	Reaction	Available moisture
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Class*	*In. per hr.*		*pH*	*In. per in. of depth*
ML-CL	A-6 or A-7.	90 to 100	90 to 100	85 to 95	Moderate to slow.	0. 20 to 2. 0	Moderate to high.	6. 5 to 7. 0	0. 17 to 0. 21
CL	A-6	85 to 100	80 to 95	85 to 95	Slow	0. 20 to 0. 63	Moderate to high.	6. 5 to 7. 0	0. 13 to 0. 17
CL	A-6	90 to 100	90 to 100	85 to 95	Slow	0. 20 to 0. 63	Moderate to high.	7. 0 to 7. 5	0. 13 to 0. 17
ML, GM, or GM-GC.	A-4 or A-2-4.	65 to 85	40 to 60	35 to 60	Moderate to rapid.	0.63 to 6.3	Low to moderate.	6.5 to 7.0	0.17 to 0.19
GM-GC	A-1-b or A-2-4.	40 to 60	30 to 50	20 to 40	Moderate	0.63 to 2.0	Moderate	7.0 to 7.5	0.17 to 0.21
GM-GC or GC.	A-1-b or A-2-4.	50 to 75	30 to 50	20 to 30	Very rapid	>0.63	Low	7.5	0.07 to 0.10
GM, GM-GC, or SM-SC.	A-2 or A-4.	65 to 75	50 to 60	35 to 45	Moderate	0.63 to 2.0	Moderate	6.0 to 6.2	0.15 to 0.18
ML-CL or GM-GC.	A-4	65 to 75	50 to 60	45 to 55	Slow	0.20 to 0.63	Moderate	6.2 to 6.6	0.17 to 0.13
GM-GC	A-1-b or A-2-4.	50 to 60	40 to 50	25 to 35	Rapid	2.0 to 6.3	Moderate	6.5 to 7.7	0.10 to 0.13
ML-CL, GM-GC.	A-4	65 to 85	50 to 75	45 to 65	Moderate	0.63 to 2.0	Moderate	5.2 to 5.6	0.15 to 0.18
ML-CL	A-4	70 to 80	60 to 75	50 to 60	Slow	0.20 to 0.63	Moderate	5.4 to 5.8	0.17 to 0.18
GM-GC	A-1-b or A-2-4.	50 to 60	40 to 50	20 to 35	Rapid	2.0 to 6.3	Low	5.8 to 6.0	0.10 to 0.13
ML-CL	A-6 or A-7.	90 to 100	90 to 100	85 to 95	Moderate to slow.	0. 20 to 2. 0	Moderate to high.	6. 5 to 7. 0	0. 17 to 0. 21
CL	A-6	85 to 100	80 to 95	85 to 95	Slow	0. 20 to 0. 63	Moderate to high.	6. 5 to 7. 0	0. 13 to 0. 17
CL	A-6.	90 to 100	90 to 100	85 to 95	Very slow	<0. 20	Moderate to high.	7. 0 to 7. 5	0. 13 to 0. 17
ML-CL	A-4	75 to 85	65 to 80	55 to 65	Moderate	0. 63 to 2. 0	Moderate	5. 0 to 5. 5	0. 13 to 0. 17

TABLE 13.—*Brief descriptions of soils and*

Symbol on map	Soil name	Description of soil and site	Depth to seasonal high water table	Depth from surface	Classification
					USDA texture
			In.	*In.*	
VbB	Volusia channery silt loam, 3 to 8 percent slopes.	Volusia soils: ½ to a little more than 1 foot of moderately permeable channery silt loam; underlain by a very firm, dense, very slowly permeable, channery silt loam fragipan that extends to a depth of 4 to 5 feet and rests on firm, dense, channery silt loam glacial till dominated by siltstone, sandstone, and shale; somewhat poorly drained; on nearly level to moderately steep areas on the uplands.	0 to 15	0 to 14	Channery silt loam
VbB3	Volusia channery silt loam, 3 to 8 percent slopes, eroded.			14 to 48	Channery silt loam fragipan.
VbC	Volusia channery silt loam, 8 to 15 percent slopes.			48+	Channery silt loam till.
VbC3	Volusia channery silt loam, 8 to 15 percent slopes, eroded.				
VoA	Volusia-Chippewa channery silt loams, 0 to 3 percent slopes.				
VrD	Volusia and Erie soils, 15 to 25 percent slopes.	Chippewa soils: 1 foot to 1½ feet of moderately permeable silt loam or channery silt loam, high in organic matter over a firm, dense, very slowly permeable, channery silt loam fragipan; firm, channery loam or silt loam glacial till at a depth of 3½ to 4 feet; poorly drained; occurs as nearly level areas or seeps in the uplands.	0 to 8	0 to 11	Channery silt loam
				11 to 72	Channery silt loam
		Erie soils: 1 foot to 1½ feet of moderately permeable channery silt loam over a very dense, firm, slowly permeable, channery loam to clay loam fragipan 2 to 4 feet thick; underlain by firm, dense, slowly permeable, channery silt loam or loam glacial till that is predominantly siltstone, sandstone, and shale but contains some lime; somewhat poorly drained; on gentle to moderate slopes in the uplands.	4 to 15	0 to 15	Channery silt loam
				15 to 42	Channery silt loam
				42 to 60	Channery silt loam
Ws	Wayland and Sloan silt loams.	Wayland soils: 1 foot to 3 feet of moderately permeable silt loam over stratified alluvial sediments consisting of layers of sand, silt, clay, and gravel; poorly drained to somewhat poorly drained; in low-lying positions on flood plains; subject to frequent floods. Surface soil is high in organic matter.	0 to 6	0 to 14	Silt loam
				14 to 30+	Stratified sand, silt, and gravel.
		Sloan soils: ½ foot to 1½ feet of mucky silt loam over a moderately permeable to slowly permeable heavy silt loam or silty clay loam that extends to a depth of 2½ to 4 feet; underlain by stratified alluvial deposits of gravel, silt, sand, and clay; very poorly drained; undisturbed areas may have a thin surface layer of muck or peat; on lowest areas of flood plains. Subject to frequent floods.	0	0 to 10	Mucky silt loam
				10 to 36	Heavy silt loam or silty clay loam.
				36+	Stratified gravel, sand, silt, and clay.
WrB	Williamson very fine sandy loam, 2 to 6 percent slopes.	1½ to 2 feet of moderately permeable very fine sandy loam over a slowly permeable, fairly dense, silt loam fragipan that extends to a depth of 2 to 2½ feet; underlain by stratified lake-laid deposits of silt and very fine sand with thin lenses of clay; moderately well drained; on gentle slopes in glacial lake areas.	6 to 30	0 to 16	Very fine sandy loam.
				16 to 26	Very fine sandy loam.
				26+	Stratified silt and very fine sand.

[1] Miscellaneous land type. No estimates of the physical properties have been made because soil material is variable.

their estimated physical properties—Continued

Classification—Con.		Percentage passing sieve—			Permeability		Shrink-swell potential	Reaction	Available moisture
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Class*	*In. per hr.*		*pH*	*In. per in. of depth*
MH	A-7-5	65 to 80	60 to 75	50 to 65	Moderate	0.63 to 2.0	Moderate	5.0 to 5.5	0.19 to 0.21
ML-CL or GM-GC.	A-4	60 to 70	55 to 65	45 to 55	Very slow	<0.20	Moderate	5.4 to 5.8	0.05 to 0.07
ML-CL or GM-GC.	A-4	50 to 75	50 to 75	45 to 55	Very slow	<0.20	Moderate	5.5 to 6.0	0.13 to 0.17
MH	A-7	75 to 90	70 to 80	60 to 70	Moderate	0.63 to 2.0	Moderate	5.0 to 5.5	0.17 to 0.19
ML-CL	A-4	70 to 85	60 to 75	50 to 60	Very slow	<0.2	Moderate	5.5 to 6.5	0.07 to 0.13
ML-CL	A-4 or A-6.	80 to 85	75 to 85	60 to 70	Moderate	0.63 to 2.0	Moderate	5.5 to 6.5	0.15 to 0.17
SM-SC	A-4	75 to 85	60 to 70	40 to 50	Slow	<0.20	Moderate	6.5 to 7.0	0.10 to 0.13
SM-SC	A-4	75 to 85	60 to 70	40 to 50	Slow	<0.20	Moderate	6.5 to 7.5	0.10 to 0.13
CL	A-6	70 to 95	65 to 80	60 to 70	Moderate	0.63 to 2.0	Moderate	6.0 to 7.0	0.15 to 0.19
GM	A-2 or A-4.	50 to 65	45 to 60	35 to 45	Rapid	2.0 to 6.3	Moderate to low.	7.0 to 7.5	0.13 to 0.15
CH or MH	A-7-6	80 to 95	70 to 80	60 to 75	Moderate	0.63 to 2.0	Moderate	6.5 to 7.0	0.15 to 0.17
CH	A-7-6	75 to 90	60 to 80	55 to 70	Slow	0.20 to 0.63	Moderate	6.5 to 7.0	0.15 to 0.17
GM	A-4	45 to 60	45 to 50	35 to 45	Moderate to rapid.	0.63 to 6.3	Moderate to low.	7.0 to 7.5	0.13 to 0.15
ML-CL	A-6 or A-7-6.	100	95 to 100	85 to 100	Moderate	0.63 to 2.0	Moderate	5.0 to 5.5	0.15 to 0.17
ML-CL	A-6 or A-7-6.	100	95 to 100	85 to 100	Slow	0.20 to 0.63	Moderate	5.0 to 6.0	0.10 to 0.13
ML-CL	A-6 or A-7-6.	100	95 to 100	85 to 100	Moderate	0.63 to 2.0	Moderate	5.5 to 7.5	0.13 to 0.17

[2] Each site needs investigation to determine its physical properties.

TABLE 14.—*Interpretations of*

[Dashes in columns indicate soils are so variable that no interpretation of engineering

Soil name [1] and symbol	Suitability as source of—			Soil features that affect engineering			
	Topsoil	Granular material	Fill material	Highway location	Highway cut conditions	Embankment foundations	Building foundations
Alluvial land (Ab)	Variable [2]	Possible [2]	Variable; wet in natural state.	Generally adverse soil conditions in cuts; subject to flooding; high water table; seasonally poor trafficability.	Subject to flooding; high water table; wet subgrade; unstable slopes.	Variable strength; subject to flooding.[3]	Subject to flooding.[4]
Arkport fine sandy loam (ArB, ArC).	Fair; sandy.[2]	Generally unsuitable.[2]	Good; highly erodible.	Water table may be encountered in deep cuts.	Subgrades subject to differential frost heaving; slopes subject to seepage and highly erodible.[5]	Generally adequate strength for moderately high embankments.[3]	Generally low bearing capacity; large settlements possible under heavy or vibratory loads.[3 6]
Bath channery silt loam (BaB, BaC, BaC3, BaD).	Unsuitable	Unsuitable	Good	Generally good soil conditions; fragipan at a depth of 14 to 30 inches.	Slopes subject to seepage above pan.	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility.[7]
Bath and Valois gravelly silt loam (BgC, BgC3, BgD). Bath and Valois soils (BoE). Bath, Valois, and Lansing soils (BtF).	Unsuitable	Bath: unsuitable. Valois: generally unsuitable; may be granular in places.[2] Lansing: unsuitable.	Good	Generally good soil conditions; fragipan at a depth of 14 to 42 inches in Bath and Valois soils.	Slopes subject to seepage above pan in Bath and Valois. Valois subgrades may be wet.	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility.[7]
Braceville gravelly silt loam (BvA).	Unsuitable	Good [2]	Good; highly erodible if sandy.	Weak fragipan at depth of 24 to 36 inches; silt layers in subsoil.	Subgrades subject to differential frost heaving; slopes subject to seepage; highly erodible if sandy.[5]	Generally adequate strength for moderately high embankments.[3]	Generally moderately low bearing capacity; low compressibility.[3 6]

See footnotes at end of table.

engineering properties of soils

properties is possible without adequate on-site or subsurface investigation]

Soil features that affect engineering—Continued							
Infiltration systems	Dikes and levees	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
		Reservoir areas	Embankments				
Prolonged high water table; subject to frequent flooding.[4]	Very poor stability.	May be permeable; subject to flooding.	Very poor stability.	Subject to flooding; cut slopes unstable; natural outlets inadequate.	Subject to flooding.[4]	Subject to flooding.[4]	Subject to flooding.[4]
Small void space in very fine sands and silt may become plugged with use.	Fair to poor stability; subject to piping.	Rapid permeability with depth; excessive seepage during dry periods.	Fair to poor stability; subject to piping.	Cut slopes subject to seepage and sloughing.	Good water-intake rate; fair water-holding capacity.	Moderate to rapid permeability.	Erodible.
Seasonally high water table; slow permeability. BaD: steep slopes.	Good stability; slow permeability. BaD: steep slopes.	Slow permeability.	Good stability; slow permeability.	Slowly permeable layer at depth of 14 to 30 inches; moderate to slow internal drainage.	Fair-water intake rate and water-holding capacity to a depth of 14 to 30 inches. BaD: steep slopes.	Slowly permeable layer at depth of 14 to 30 inches. BaD: steep slopes.	Channery, gravelly, or stony.
Seasonally high water table. Lansing: slow permeability. Valois: good permeability below 40 inches. BgD: steep slopes. BoE, BrF: very steep slopes.[4]	Good stability. Valois and Lansing: slow permeability when compacted. BgD: steep slopes. BoE, BtF: very steep slopes.[4]	Valois: rapid permeability with depth. Lansing: moderate to slow permeability.	Good stability; slow permeability when compacted.	Slowly permeable layer at depth of 14 to 30 inches; moderate to slow internal drainage. BoE, BtF: very steep slopes.	Fair water-intake rate and water-holding capacity to a depth of 14 to 30 inches. BgD: steep slopes. BoE, BtF: very steep slopes.[4]	Slowly permeable layer at depth of 14 to 30 inches. BgD: steep slopes. BoE, BtF: very steep slopes.[4]	Channery, gravelly, or stony. BoE, BtF: very steep slopes.
Seasonally high water table; silt layers impede internal drainage.	Poor stability if silt layers are saturated; subject to piping.	Subject to excess seepage during dry periods; stratified fine sand and gravel.	Good stability if mixed and compacted; silt layers unstable for foundation if saturated.	Cut slopes subject to seepage and sloughing; silt layers impede internal drainage.	Fair to good water-intake rate; fair water-holding capa - ity to a depth of 24 inches.	Seasonally high water table; slow permeability in layers at variable depths.	Subject to prolonged flow.

TABLE 14.—*Interpretations of engineering*

Soil name[1] and symbol	Suitability as source of—			Soil features that affect engineering			
	Topsoil	Granular material	Fill material	Highway location	Highway cut conditions	Embankment foundations	Building foundations
Canandaigua and Lamson soils (Ca).	Fair: may be wet.[2]	Unsuitable	Fair to good when dry; may be wet in natural state.	Long periods of poor trafficability; soil below oxidized layer too wet for use in compacted fill.	Unstable wet subgrades and slopes; subgrade subject to differential frost heaving.	Generally adequate strength for low embankments; moderately high compressibility.[3]	Generally low bearing capacity; moderately high compressibility.[6 3]
Chenango gravelly loam (CdA, CdC, CdD).	Unsuitable	Good[2]	Good; highly erodible if sandy.	Well-drained surface soil; water table may be encountered in deep cuts.	Subgrades subject to differential frost heaving; slopes subject to seepage; highly erodible if sandy.[5]	Generally adequate strength for the high embankments.[3]	Generally moderately high bearing capacity; low compressibility.[3 6]
Chenango gravelly loam, fan (CnB).	Unsuitable	Good[2]	Good	Subject to flash flooding.	Subgrades subject to differential frost heaving.[5]	Generally adequate strength for high embankments.[3]	Generally moderately low bearing capacity; low compressibility.[3 6]
Conesus gravelly silt loam (CfA, CfB, CfB3).	Unsuitable	Unsuitable	Good	Generally good soil conditions.	Variable soils below 1,000-foot elevation; irregular subgrade support; subgrades and slopes subject to seepage.	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility; bearing capacity and compressibility variable below 1,000-foot elevation.
Darien gravelly silt loam (DgB).	Unsuitable	Unsuitable	Good	Generally adverse soil conditions in cuts; long periods of poor trafficability.	Seasonally high water table; subgrades nonuniform and subject to differential heaving; slopes subject to seepage and sloughing.[5]	Generally adequate strength for moderately high embankments; in places till is intermixed with bottom sediments.[3]	Generally moderately low bearing capacity; variable compressibility.[6 3]
Eel silt loam (Em)	Good; may be wet in natural state.[2]	Unsuitable	Good when dry; wet in natural state.	Subject to flooding; high water table; seasonally poor trafficability.	Subject to flooding; high water table; variable soils; slope may be subject to seepage and sloughing.[5]	Subject to flooding; variable soil material; generally adequate strength for low embankments; moderately high compressibility.[3]	Subject to flooding; high water table.[4]

properties of soils—Continued

Soil features that affect engineering—Continued							
Infiltration systems	Dikes and levees	Farm ponds: Reservoir areas	Farm ponds: Embankments	Agricultural drainage	Irrigation	Terraces and diversions	Waterways
Prolonged high water table; subject to ponding.[4]	Poor stability; subject to piping.	Prolonged high water table; permeability varies between slow and rapid.	Poor stability..	Cut slopes unstable; inadequate surface outlets.	Prolonged high water table; subject to ponding.[4]	Prolonged high water table.	Very erodible.
Rapid permeability. CdD: steep slopes.	Good stability for outside shell; rapid permeability. CdD; steep slopes	Rapid permeability; subject to excess seepage.	Good stability for outside shell; rapid permeability.	Cut slopes subject to erosion if sandy.	Good water-intake rate; fair to low water-holding capacity. CdD: steep slopes.	Rapid permeability; gravelly and cobbly. CdD: steep slopes.	Rapid permeability; gravelly and cobbly.
Rapid permeability.	Good stability for outside shell; rapid permeability.	Rapid permeability; subject to excess seepage.	Good stability for outside shell; rapid permeability.	Cut slopes subject to erosion if sandy.	Good water-intake rate; fair to low water-holding capacity.	Rapid permeability; gravelly and cobbly.	Rapid permeability; gravelly and cobbly.
Seasonally high water table; slowly permeable layer at a depth of 18 to 30 inches.	Very good stability; slow permeability if compacted.	Moderate to slow permeability; seasonally high water table.	Good shear strength and stability; slow permeability if compacted.	Permeability slow in layers at depth of 18 to 30 inches; moderate to slow internal drainage.	Fair to good water-intake rate and water-holding capacity to a depth of 18 to 20 inches.	Compact layer at depth of 18 to 30 inches; contains areas that are subject to seepage.	Erodibility on steeper slopes; subject to seepage.
Seasonally high water table; clay layers impede internal drainage.	Good stability; slow permeability.	Slow permeability.	Good stability if material is mixed and compacted; slow permeability.	Cut slopes subject to seepage and sloughing; slow internal drainage.	Fair water-intake rate; fair to good water-holding capacity.	Seasonally high water table; subject to seepage.	Subject to prolonged flow.
High water table; subject to flooding; good permeability if water table is absent.	Fair stability when compacted; may be permeable.	High water table; permeable if water table is absent.	Fair stability if material is mixed and compacted; may be permeable.	Subject to annual flooding; cut slopes unstable; natural outlets inadequate.	Subject to flooding; good water-intake rate; good water-holding capacity.	Subject to flooding; nearly level.	Subject to flooding; seldom needed.

733-022—65——7

TABLE 14.—*Interpretations of engineering*

Soil name [1] and symbol	Suitability as source of—			Soil features that affect engineering			
	Topsoil	Granular material	Fill material	Highway location	Highway cut conditions	Embankment foundations	Building foundations
Ellery, Chippewa, and Alden soils (EcA).	Ellery: Good to poor.[2] Chippewa: Poor; channery.[2] Alden: Good to depth of 20 inches; may be wet in natural state.[2]	Unsuitable	Good when dry; may be wet in natural state.	Fragipan at shallow depth. Alden: mucky surface soils; long periods of poor trafficability.	Subgrade generally wet; slopes subject to seepage and sloughing.[5]	Alden: mucky surface materials; generally adequate strength for high embankments.	Generally moderately high bearing capacity; wet for long periods of time; negligible compressibility.[6 7]
Erie channery silt (loam EbB, EbB3, EbC, EbC3).	Unsuitable	Unsuitable	Good	Fragipan at depth of 12 to 18 inches; long periods of poor trafficability.	Subgrade may be wet; slopes subject to seepage and sloughing.	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility.[6 7]
Erie-Ellery channery silt loams (ErA).	Erie: unsuitable. Ellery: variable.[2]	Unsuitable	Good	Fragipan at shallow depths. Ellery: unsuitable surface material; long periods of poor trafficability.	Ellery: subgrade very wet. Erie: seasonally wet; slopes subject to seepage and sloughing.	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility.[67]
Fredon silt loam (FdB).	Fair, except where gravelly.[2]	Good [2]	Good; may be wet in natural state; highly erodible if sandy.	High water table; poor trafficability.	High water table; subgrade subject to differential frost heaving; slopes subject to seepage; unstable below water table.	Generally adequate strength for moderately high embankments; may be underlain by bottom sediments.[3]	Generally moderately low bearing capacity; low compressibility.[3 6]
Fresh water marsh (Fm).	Unsuitable	Unsuitable	([2])	Permanently wet; probably unsuitable for foundations.	([4])	([8])	([4])

See footnotes at end of table.

properties of soils—Continued

Soil features that affect engineering—Continued							
Infiltration systems	Dikes and levees	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
		Reservoir areas	Embankments				
Prolonged high water table; slow to very slow permeability.[4]	Stability of material below 24 inches; good when material is mixed and compacted; slow permeability.	May contain sand lenses subject to seepage; prolonged high water table; slow permeability.	Stability of material below 24 inches good when mixed and compacted; slow permeability.	Slowly permeable layer at depth of 12 to 24 inches; slow internal drainage; subject to piping in cut slopes.	Fair water-intake rate and water-holding capacity; limited rooting depth; prolonged high water table.[4]	Slowly permeable layer at depth of 12 to 24 inches; subject to seepage.	Subject to seepage and prolonged flow.
Seasonally high water table; slow permeability.	Good stability; slow permeability.	May contain sand lenses subject to seepage; seasonally high water table; slow permeability.	Good stability; slow permeability if material is compacted.	Slowly permeable layer at depth of 18 to 24 inches; slow internal drainage; may contain sand lenses subject to piping.	Fair water-intake rate and water-holding capacity; limited rooting depth.	Slowly permeable layer at depth of 18 to 24 inches; subject to seepage.	Erodibility on steep slopes.
Seasonally high water table; slow permeability.	Good stability; slow permeability.	May contain sand lenses subject to seepage; seasonally high water table; slow permeability.	Good stability; slow permeability if material is compacted.	Slowly permeable layer at depth of 18 to 24 inches; slow internal drainage; may contain sand lenses subject to piping.	Fair water-intake rate and water-holding capacity; limited rooting depth.	Slowly permeable layer at depth of 18 to 24 inches; subject to seepage.	Erodibility on steep slopes.
High water table; moderate to rapid permeability in absence of water table.	Good stability; subject to seepage.	High water table; rapid permeability if water table is absent; stratified sand and gravel.	Good stability for outside shell; permeable.	Cut slopes unstable; may contain pockets of sand subject to piping; natural outlets inadequate.	Fair water-intake rate and water-holding capacity.	High water table.	High water table.
([4])	([4])	([4])	([4])	([4])	([4])	([4])	([4]).

TABLE 14.—*Interpretations of engineering*

Soil name [1] and symbol	Suitability as source of—			Soil features that affect engineering			
	Topsoil	Granular material	Fill material	Highway location	Highway cut conditions	Embankment foundations	Building foundations
Genesee silt loam (Gn).	Good; may be too stony on fans.[2]	Unsuitable	Generally good if dry; may be wet in natural state.	On first bottoms, high water table and flooding. On second bottoms, possible high water table. On fans, flash flooding.	On first bottoms, flooding and high water table. On second bottoms, possibly high water table, probably wet subgrade. On second bottoms and fans, slope seepage and sloughing.[5]	Variable soil material; generally adequate strength for low embankments.[3]	Generally low bearing capacity; moderately high compressibility; some areas subject to flooding.[3 6]
Halsey silt loam (Ha). Halsey mucky silt loam (Hc).	Ha: fair, except where gravelly. Hc: good.[2]	Good [2]	Good; may be wet in natural state; highly erodible if sandy.	High water table. Hc: highly organic surface soil; poor trafficability.	High water table; subgrade subject to differential frost heaving; slopes unstable below water table. Hc: highly organic surface soil.	Generally adequate strength for low fills.[3 7]	Generally moderately low bearing capacity; low compressibility. Hc: highly organic surface material; permanently high water table.[3 6]
Holly and Papakating soils (Hk).	Good; may be wet in natural state.[2]	Unsuitable	Generally unsuitable; wet in natural state.	Subject to flooding; high water table; seasonally poor trafficability.	Subject to flooding; high water table.	Variable soil material; generally adequate strength for low embankments; subject to flooding.[3]	Subject to flooding; high water table.[4]
Honeoye gravelly silt loam (HmB, HmC, HmC3).	Unsuitable	Unsuitable	Good; bouldery in places	Generally good soil conditions.	Generally good soil conditions.	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility.[7]
Howard gravelly loam (HdA, HdC, HdCK, HdD). Howard and Palmyra soils (HpE, HpF).	Unsuitable	Good [2]	Good; highly erodible if sandy.	Water table may be encountered in deep cuts.	Subgrade subject to differential frost heaving; slopes subject to seepage; highly erodible if sandy.[5]	Generally adequate strength for high embankments.[8]	Generally moderately high bearing capacity; low compressibility.[3 6]

See footnotes at end of table.

properties of soils—Continued

Soil features that affect engineering—Continued							
Infiltration systems	Dikes and levees	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
		Reservoir areas	Embankments				
Variable water table; subject to flooding; rapid permeability in absence of water table.	Good stability; permeable.	Permeable	Good stability for outside shell; permeable.	Subject to flooding; stratified sand may be subject to piping.	Good water-intake rate; good water-holding capacity; subject to flooding.	Nearly level; subject to flooding.	Seldom needed; subject to flooding; variable water table.
High water table; moderate to rapid permeability if water table is absent.	Good stability below depth of 36 inches; permeable; high water table.	Permeable if high water table is absent; stratified sand and gravel.	Good stability for outside shell below depth of 36 inches; permeable.	High water table; may contain sand lenses subject to piping; natural outlets inadequate.	Fair water-holding capacity; good water-intake rate; high water table.	High water table.	High water table.
High water table; subject to flooding.[4]	Poor stability	Subject to flooding; high water table.	Poor stability	High water table; may contain sand lenses subject to piping; cut banks unstable; outlets generally inadequate.	Subject to flooding; high water table; generally not irrigated.	Nearly level; prolonged high water table.	Subject to flooding and prolonged flow.
Moderate permeability.	Good stability; moderate permeability.	Moderate permeability.	Good stability; slow permeability if compacted.	Gravel; cut slopes subject to erosion.	Good water-intake rate and water-holding capacity.	Moderate permeability; gravelly.	Moderate permeability; gravelly.
Rapid to very rapid permeability. HdD: steep slopes. HpE, HpF: very steep slopes.	Good stability; rapid permeability. HdD: steep slopes. HpE, HpF: very steep slopes.[4]	Permeability rapid to very rapid. HpE, HpF: very steep slopes.	Good stability for outside shell; permeable.	Sand layers may be subject to piping; rapid permeability.	Good water-intake rate; fair to low water-holding capacity. HdD: steep slopes. HpE, HpF: very steep slopes.[4]	Undulating topography; gravelly; steep in many places. HdD: steep slopes. HpE, HpF: very steep slopes.[4]	Erodible on steep slopes; gravelly.

TABLE 14.—*Interpretations of engineering*

Soil name [1] and symbol	Suitability as source of—			Soil features that affect engineering			
	Topsoil	Granular material	Fill material	Highway location	Highway cut conditions	Embankment foundations	Building foundations
Howard-Valois gravelly loams (HrC, HrD).	Unsuitable	Howard: good. Valois: generally unsuitable; may be granular in places.[2]	Good	Valois: fragipan at depth of 18 to 36 inches.	Howard: subgrade subject to differential frost heaving; slopes subject to seepage; highly erodible if sandy.[5]	Generally adequate strength for high embankments.[3]	Generally moderately high bearing capacity; low compressibility.[3 6]
Hudson silty clay loam (HsB, HsC3, HsD3).	Poor; may be clayey.[2]	Unsuitable	Good when dry; poor when wet.	Soil below oxidized layers probably too wet for use in compacted fill; poor trafficability.	Usually unstable as subgrade and in cut slopes.[5]	Generally adequate strength for low fills; low to moderately high compressibility.[3]	Generally low to moderately low bearing capacity, depending upon degree to which soil has been desiccated; low to moderately high compressibility.[3 6]
Hudson-Cayuga silt loams (HuB, HuB3, HuC3, HuD).	Hudson: poor. Cayuga: may be too stony.[2]	Unsuitable	Hudson: good when dry; poor when wet. Cayuga: good.	Hudson: soil below oxidized layers probably too wet for use in compacted fill. Cayuga: irregular thickness of water-laid material; poor trafficability.	Hudson: usually unstable subgrade and cut slopes.[5] Cayuga: nonuniform subgrades; slopes subject to seepage and sloughing.	Generally adequate strength for low fills. Hudson: low to moderately high compressibility.[3]	Generally low to moderately low bearing capacity. Hudson: low to moderately high compressibility.[3 6]
Hudson and Collamer silt loams (HwB).	Hudson: poor.[2] Collamer: fair.[2]	Unsuitable	Hudson: good when dry; poor when wet. Collamer: good to fair; may be silty in places.	Soil below oxidized layers probably too wet for use in compacted fill; poor trafficability.	Usually unstable subgrade and slopes.[5]	Generally adequate strength for low fills; low to moderately high compressibility.[3]	Generally low to moderately low bearing capacity; low to moderately high compressibility.[3 6]
Hudson and Dunkirk soils (HzE).	Unsuitable	Unsuitable	Good when dry; poor when wet.	Very unstable natural slopes; steep topography.[4]	Very unstable natural slopes; steep topography.[5]	Unstable [4]	Unstable [4]
Ilion silty clay loam (IcA, IcB).	Poor; either too clayey or too gravelly.[2]	Unsuitable	Good when dry; may be seasonally wet.	Extremely variable soil material; long periods of poor trafficability.	Subgrade extremely variable in short distances and wet for long periods; slopes subject to seepage and sloughing.[5]	Generally adequate strength for low fills.[3 7]	Generally moderately low bearing capacity; variable strength and compressibility.[7]

See footnotes at end of table.

properties of soils—Continued

Soil features that affect engineering—Continued							
Infiltration systems	Dikes and levees	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
		Reservoir areas	Embankments				
Valois: slowly permeable layer at 24 to 48 inches; rapid permeability below this layer. HrD: steep slopes.	Good stability; slow permeability if materials are mixed and compacted. HrD: steep slopes.	Rapid permeability below depth of 24 to 48 inches.	Good stability; slow permeability if material is mixed and compacted.	Slowly permeable layer at depth of 24 to 48 inches; sand layers may be subject to piping.	Good water-intake rate and water-holding capacity. HrD: steep slopes.	Slowly permeable layer at depth of 24 to 48 inches. HrD: steep slopes.	Subject to prolonged seepage.
Seasonally high water table; slow permeability. HsD3: steep slopes.	Very poor stability. HsD3: steep slopes.	Seasonally high water table; slow permeability.	Very poor stability.	Seasonally high water table; cut slopes unstable; slow internal drainage.	Poor water-intake rate; good water-holding capacity. HsD3: steep slopes.	Seasonally high water table; irregular topography. HsD3: steep slopes.	Very erodible on steep slopes.
Seasonally high water table; slow permeability. HuD: steep slopes.	Hudson: very poor stability. Cayuga: good stability below depth of 30 inches. HuD: steep slopes.	Seasonally high water table; slow permeability.	Hudson: very poor stability. Cayuga: stability good below depth of 30 inches.	Seasonally high water table; cut slopes unstable; slow internal drainage.	Poor water-intake rate; good water-holding capacity. HuD: steep slopes.	Seasonally high water table. HuD: steep slopes.	Very erodible on steep slopes.
Seasonally high water table; slow permeability.	Very poor stability.	May have sand lenses; subject to seepage.	Very poor stability; may be used for inside core of dam.	Seasonally high water table; sand lenses subject to piping; cut slopes unstable.	Poor water-intake rate; good water-holding capacity.	Seasonally high water table; irregular topography.	Very erodible on steep slopes.
Very steep slopes.[4]	([4])	([4])	([4])	([4])	([4])	([4])	([4]).
High water table; slow permeability.	Good stability below depth of 24 inches when compacted.	Slow permeability.	Good stability below depth of 24 inches when compacted; slow permaability.	High water table; cut slopes subject to seepage and sloughing.	Poor water-intake rate; good water-holding capacity.	High water table.	High water table; subject to prolonged flow.

TABLE 14.—*Interpretations of engineering*

Soil name [1] and symbol	Suitability as source of—			Soil features that affect engineering			
	Topsoil	Granular material	Fill material	Highway location	Highway cut conditions	Embankment foundations	Building foundations
Kendaia silt loam (KaB). Kendaia and Lyons silt loams (KnA).	Kendaia: unsuitable. Lyons: fair; may be stony and wet in natural state.[2]	Unsuitable	Kendaia: good. Lyons: good when dry; may be seasonally wet. Surface material may be unsuitable.	Generally good soil conditions; seasonally poor trafficability.	Seasonally high water table; slopes subject to seepage and sloughing; where associated with Erie soils, a fragipan may be present.	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility.[7] KnA: high water table.[5]
Langford channery silt loam (LaB, LaB3, LaC, LaC3).	Unsuitable	Unsuitable	Good	Generally good soil conditions; fragipan at depth of 12 to 18 inches; seasonally poor trafficability.	Subgrade may be wet; slopes subject to seepage above fragipan.	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility.[7]
Lansing gravelly silt loam (LbA, LbB, LbB3, LbC, LbC3).	Unsuitable	Unsuitable	Good	Generally good soil conditions. LbC3: relatively shallow over bedrock.	Variable soil material in small areas; some shallow cuts may encounter bedrock.[5]	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility.[7]
Lima silt loam (LmA, LmB, LmB3).	Unsuitable	Unsuitable	Good; bouldery in places.	Generally good soil conditions.	Generally good soil conditions.	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility.[7]
Lordstown channery silt loam (LnC, LnC3, LnD, LnE).	Unsuitable	Unsuitable	Good; shallow over bedrock.	Shallow over bedrock.	Shallow over bedrock; seepage just above rock.	Adequate strength for high embankments.	High bearing capacity; bedrock encountered in most excavations; negligible compressibility.[7]
Lordstown soils (LoF). Lordstown, Tuller, and Ovid soils, shallow and very shallow (LtB, LtC).	Unsuitable	Unsuitable	Good; shallow over bedrock.	Shallow over bedrock.	Shallow over bedrock; seepage just above rock.	Adequate strength for high embankments.	High bearing capacity; bedrock encountered in most excavations; negligible compressibility.[7]
Lyons silt loam (Ly)	Fair; may be stony and wet in natural state.[2]	Unsuitable	Good when dry; may be seasonally wet; surface material may be unsuitable.	May have highly organic surface soil; poor trafficability.	High water table; slopes subject to seepage and sloughing.[5]	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; low compressibility.[6 7]

See footnotes at end of table.

properties of soils—Continued

Soil features that affect engineering—Continued							
Infiltration systems	Dikes and levees	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
		Reservoir areas	Embankments				
High water table. Kendaia: moderate to slow permeability. Lyons: slow to very slow permeability.	Good stability below depth of 24 inches; slow permeability.	High water table; may contain sand or gravel lenses subject to seepage.	Good stability below depth of 24 inches; slow permeability when compacted.	High water table. Lyons: ponding of surface runoff; may contain sand lenses subject to piping.	Fair water-intake rate; good water-holding capacity.	High water table. Lyons: subject to ponding of surface runoff.	Prolonged flow.
Seasonally high water table; slow permeability in layers at depth of 18 to 24 inches and below.	Good stability; slow permeability.	Seasonally high water table; sand lenses in substratum may be subject to seepage in dry periods.	Good stability; slow permeability when compacted.	Compact layer at a depth of 18 to 24 inches and below; moderate to slow internal drainage; sand lenses subject to piping.	Limited rooting depth; poor water-intake rate; fair to good water-holding capacity above depth of 18 inches but poor below.	Compact layer at depth of 18 to 24 inches; sand lenses subject to seepage.	Erodible on steeper slopes; subject to seepage.
Slow permeability below depth of 36 inches.	Good stability; moderate permeability.	Moderate permeability.	Good stability; slow permeability when compacted.	Drainage not generally needed; cut slopes will erode.	Fair to good water-intake rate; good water-holding capacity.	Irregular topography; gravelly.	Erodible on steeper slopes; gravelly.
Seasonally high water table; moderate to slow permeability.	Good stability; moderate permeability.	Moderate permeability.	Good stability; slow permeability when compacted.	Cut slopes subject to erosion; sand layers may be subject to piping; seasonally high water table.	Fair water-intake rate and water-holding capacity.	Moderate permeability; gravelly in places.	Erodible on steeper slopes; gravelly in places.
Bedrock at depth of 20 to 40 inches. LnD: steep slopes. LnE: very steep slopes.[4]	Bedrock at depth of 20 to 40 inches. LnD: steep slopes. LnE: very steep slopes.[4]	Bedrock at depth of 20 to 40 inches.	Bedrock at depth of 20 to 40 inches.	Well drained; bedrock at depth of 20 to 40 inches.	Moderately deep root zone and depth for storing moisture.	Bedrock at depth of 20 to 40 inches. LnD: steep slopes. LnE: very steep slopes.[4]	Erodible; bedrock at depth of 20 to 40 inches.
Very steep; shallow over bedrock.	([4])	([4])	([4])	([4])	([4])	([4])	([4]).
High water table; slow to very slow permeability.[4]	Good stability below depth of 18 to 24 inches; slow permeability.	High water table; slow permeability.	Good stability below depth of 18 to 24 inches; slow permeability.	High water table; slow to very slow internal drainage.	Fair water-intake rate; good water-holding capacity.	Annual high water table.	Subject to prolonged flow.

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TABLE 14.—*Interpretations of engineering*

Soil name [1] and symbol	Suitability as source of—			Soil features that affect engineering			
	Topsoil	Granular material	Fill material	Highway location	Highway cut conditions	Embankment foundations	Building foundations
Madalin mucky silty clay loam (Mm). Madalin silty clay loam (Mn).	Mm: fair; wet in natural state.[2] Mn: poor; too clayey; wet in natural state.[2]	Unsuitable	Good when dry; wet in natural state.	Too wet for use in compacted fills; very poor trafficability.	High water table; unstable subgrade and cut slopes.[5]	Very low strength; moderately high compressibility.[3]	Generally low bearing capacity; moderately high compressibility.[3] [6]
Made land (Mc)	Variable [2]	([8])	([8])	([8])	([8])	([8])	([8])
Mardin channery silt loam (MaB, MaC, MaC3). Mardin and Langford soils (MfD).	Unsuitable	Unsuitable	Good	Generally good soil conditions; fragipan at depth of 15 to 24 inches.	Generally good conditions; slopes subject to seepage above pan.	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility.[7]
Middlebury and Tioga silt loams (Mo).	Good; may be wet in natural state.[2]	Poor; may be granular in places.[2]	Fair; may be wet in natural state.	Subject to flooding; high water table; seasonally poor trafficability.	Variable; subject to flooding; high water table; slopes subject to seepage and sloughing.	Variable; subject to flooding; generally adequate strength for low embankments.[3]	Subject to flooding; high water table.[4]
Muck and Peat (Mp).	Possible use as amendment for mineral soils.[2]	Unsuitable	Unsuitable	Unsuitable for embankment foundations; high water table.	High water table; soft organic material not suitable for cut subgrade.	Very low strength; generally not suitable for embankment foundations; high water table; high compressibility; severe settlement conditions.[3] [7]	([4])
Niagara silt loam (NaB).	Fair; may may be wet in natural state.[2]	Unsuitable	Generally good; in places may be too silty and too wet; may be highly erodible.	Seasonally poor trafficability.	Seasonally high water table; subgrade may be unstable and subject to differential frost heaving; slopes may be unstable.[5]	Generally adequate strength for low embankments.[3]	Generally low to moderately low bearing capacity; moderately high compressibility.[6] [7]

See footnotes at end of table.

properties of soils—Continued

Soil features that affect engineering—Continued							
Infiltration systems	Dikes and levees	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
		Reservoir areas	Embankments				
High water table; subject to occasional flooding; slow permeability.	Poor stability	High water table; subject to occasional flooding; high organic-matter content in surface soil.	Poor stability; high in organic-matter content.	High water table; subject to occasional flooding; cut slopes unstable; slow internal drainage.	Generally not irrigated; occasional flooding; high water table.	High water table; subject to occasional flooding; nearly level.	Subject to occasional flooding; nearly level.
(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8).
Seasonally high water table; slow to very slow permeability below about 15 inches. MfD: steep slopes.	Good stability; slow permeability. MfD: steep slopes.	Slow to very slow permeability at 15 to 24 inches; channery. MfD: steep slopes.	Good stability; coarse material is mixed with fine material and compacted; slow permeability.	Compact layer below depth of 15 to 24 inches; may contain small wet areas; subject to prolonged seepage. MfD: steep slopes.	Limited rooting depth; fair water-intake rate; fair to poor water-holding capacity. MfD: steep slopes.	Compact layer at depth of 15 to 24 inches; wet areas; subject to prolonged seepage. MfD: steep slopes.	Erodible on steeper slopes; subject to seepage.
Subject to flooding; moderate to rapid permeability if water table is lowered.[4]	Fair stability if compacted; permeable below depth of 2½ feet.	Annual flooding; permeable below depth of 2½ feet. Middlebury: high water table.	Poor shear strength and stability.	Subject to flooding; cut slopes subject to seepage and erosion. Middlebury: high water table.	Subject to annual flooding; good water-intake rate; fair to poor water-holding capacity.	Permeable; nearly level. Middlebury: high water table.	Subject to flooding.
(4)	Very poor stability; high compressibility.	(4)	(4)	Very high shrinkage when first drained; underlying material may be at variable depths.	Good water-intake rate and water-holding capacity.	(4)	(4).
Seasonally high water table; slow to very slow permeability.	Fair stability; slow permeability when compacted.	High water table; stratified sand; may be subject to excess seepage in dry periods.	Fair to poor stability.	High water table; cut slopes unstable; very fine sand subject to piping.	Good water-intake rate and water-holding capacity.	High water table.	Subject to prolonged flow.

TABLE 14.—*Interpretations of engineering*

Soil name [1] and symbol	Suitability as source of—			Soil features that affect engineering			
	Topsoil	Granular material	Fill material	Highway location	Highway cut conditions	Embankment foundations	Building foundations
Ovid silt loam (OaA). Ovid silty clay loam (OcC3).	Unsuitable	Unsuitable	Good when dry; may be wet in natural state.	Extremely variable; wet for long periods; seasonally poor trafficability.	Subgrade extremely variable within very short distances and subject to differential frost heaving; slopes subject to seepage and sloughing.	Generally adequate strength for low embankments.[3 7]	Generally moderately low bearing capacity; variable compressibility.[3 6]
Ovid and Rhinebeck silt loams, moderately deep (OrA, OrB, OrC).	Ovid: unsuitable. Rhinebeck: poor; too clayey.[2]	Unsuitable	Shallow over bedrock. Ovid: good when dry; may be wet in natural state. Rhinebeck: good when dry; poor when wet.	Shallow over bedrock; seasonally poor trafficability.	Subgrade conditions variable; shallow over bedrock; seepage just above rock.	Shallow over bedrock; adequate strength for high embankments, except on steep side slopes.	High bearing capacity on rock; generally moderately low bearing capacity on soil; bedrock encountered in most excavations; negligible to low compressibility.[7]
Palmyra gravelly loam (PaA, PaC, PaCK, PaD).	Unsuitable	Good [2]	Good; highly erodible if sandy.	Generally good soil conditions; surface soil well drained; water table may be encountered in deep cuts.	Subgrades subject to differential frost heaving; slopes subject to seepage; highly erodible if sandy.	Generally adequate strength for high embankments.[3]	Generally moderately high bearing capacity; low compressibility; large settlements possible under heavy or vibratory loads.[3 6]
Phelps gravelly silt loam (PhA, PhB).	Unsuitable	Good [2]	Good; highly erodible if sandy.	Generally good soil conditions; surface soil well drained; water table may be encountered in deep cuts.	Subgrade subject to differential frost heaving; slopes subject to seepage; highly erodible if sandy.	Generally adequate strength for high embankments.[3]	Generally moderately high bearing capacity; low compressibility; large settlements possible under heavy or vibratory loads.[3 6]

See footnotes at end of table.

properties of soils—Continued

Soil features that affect engineering—Continued							
Infiltration systems	Dikes and levees	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
		Reservoir areas	Embankments				
Seasonally high water table; slow to very slow permeability.	Fair stability; moderate to very slow permeability.	Moderate to very slow permeability.	Good stability below depth of 24 to 30 inches when compacted; slow permeability.	Seasonally high water table; moderate to slow permeability.	Fair to poor water-intake rate; fair to good water-holding capacity.	Substratum gravelly.	Subject to prolonged flow.
Bedrock at depth of 20 to 40 inches; seasonally high water table; slow to very slow permeability.	Good to fair stability; moderate to slow permeability.	Moderate to slow permeability; seasonally high water table; may contain sand lenses subject to seepage; bedrock at depth of 20 to 40 inches.	Good to fair stability; slow permeability if compacted.	Bedrock at depth of 20 to 40 inches; seasonally high water table; moderate to slow permeability.	Fair to poor water-intake rate; fair to good water-holding capacity.	Seasonally high water table; erodible; bedrock at depth of 20 to 40 inches.	High water table; erodible.
Seasonally high water table; moderate to very rapid permeability. PaD: steep slopes.	Good stability; permeable. PaD: steep slopes.	Very rapid permeability.	Good stability for outside shells; permeable.	Generally not needed; rapid to very rapid permeability; sandy material may be subject to piping.	Good water-intake rate; fair water-holding capacity above depth of 24 inches, but poor below. PaD: steep slopes.	Irregular topography; permeable; gravelly. PaD: steep slopes.	Moderately erodible on steep slopes; gravelly.
Seasonally high water table; very rapid permeability below depth of 18 to 24 inches.	Good stability if material is mixed and compacted; may become permeable with depth.	Rapid permeability below depth of 24 inches; stratified sand and gravel.	Good stability if material is mixed and compacted; slow permeability if compacted.	Seasonally high water table; cut slopes unstable; stratified sand subject to piping.	Fair to poor water-intake rate; water-holding capacity good above depth of 24 inches.	Subject to prolonged flow of runoff from surrounding areas.	Subject to prolonged flow of runoff from surrounding areas.

TABLE 14.—*Interpretations of engineering*

Soil name [1] and symbol	Suitability as source of—			Soil features that affect engineering			
	Topsoil	Granular material	Fill material	Highway location	Highway cut conditions	Embankment foundations	Building foundations
Red Hook gravelly silt loam (RhA).	Fair, except where gravelly.[2]	Good [2]	Good; may be wet in natural state. Highly erodible if sandy.	High water table; poor trafficability.	High water table; subgrade wet and subject to differential frost heaving; slopes subject to seepage; unstable below water table.	Generally adequate strength for high embankments.[3]	Generally moderately low bearing capacity; low compressibility. High water table.[3 6]
Rhinebeck silt loam (RkA, RkB). Rhinebeck silty clay loam (RnC3).	RkA, RkB: fair.[2] RnC3: poor, clayey.	Unsuitable	Good when dry; poor when wet.	Soil below oxidized layer probably too wet for use in compacted fills; poor trafficability.	Usually unstable subgrade and slopes.[5]	Generally adequate strength for low embankments; low to moderately high compressibility.[3]	Generally low bearing capacity; low to moderately high compressibility.[3 6]
Rock outcrop (Ro)	Unsuitable	All rock, but Tully limestone is relatively soft.	Good	Steep rock slopes and gorges.	Subgrade in bedrock; cut slope design depends on physical characteristics of bedrock.	Adequate strength for high embankments.	High bearing capacity; negligible compressibility; rock excavation required for most structures; irregular topography.
Tuller channery silt loam (TeA).	Unsuitable	Unsuitable	Shallow over bedrock.	Shallow over bedrock.	Seepage just above rock.	Adequate strength for high embankments.	High bearing capacity; bedrock encountered in most excavations; low compressibility.[7]
Volusia channery silt loam (VbB, VbB3, VbC, VbC3). Volusia-Chippewa channery silt loams (VoA). Volusia and Erie soils (VrD).	Unsuitable	Unsuitable	Good when dry; may be seasonally wet in natural state. Chippewa: may have unsuitable surface material.	Fragipan occurs at a depth of 6 to 18 inches; poor trafficability for long periods of time.	Subgrade may be wet; slopes subject to seepage and sloughing.	Generally adequate strength for high embankments.	Generally moderately high bearing capacity; negligible compressibility.[6 7]
Wayland and Sloan silt loams (Ws).	Good; may be wet in natural state.[2]	Unsuitable	Generally unsuitable; wet in natural state.	Seasonally poor trafficability; subject to flooding; high water table.	Subject to flooding; high water table.	Variable; subject to flooding; generally adequate strength for low embankments.[3]	Subject to flooding; high water table.[4]

See footnotes at end of table.

properties of soils—Continued

Soil features that affect engineering—Continued							
Infiltration systems	Dikes and levees	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
		Reservoir areas	Embankments				
Seasonally high water table; rapid permeability below depth of 18 to 24 inches.	Good stability; permeable below depth of 24 inches.	Stratified sand and gravel below depth of 2 to 3 feet.	Good stability; slow permeability if compacted.	Seasonally high water table; stratified sand susceptible to piping; cut slopes unstable.	Fair to poor water-intake rate; water-holding capacity good above depth of 24 inches.	High water table; gravelly.	Subject to prolonged flow of runoff from surrounding areas; gravelly.
High water table; slow to very slow permeability.	Poor stability; may be subject to seepage.	High water table; may contain sand lenses subject to seepage.	Poor stability; slow permeability if compacted.	Cut slopes very unstable; may contain lenses of very fine sand subject to piping.	Poor water-intake rate; good water-holding capacity.	High water table; erodible.	High water table; erodible.
([4])	([4])	([4])	([4])	([4])	([4])	([4])	([4]).
Bedrock at depth of 12 to 24 inches.	Bedrock at depth of 12 to 24 inches.	Bedrock at depth of 12 to 24 inches; seasonally high water table.	Bedrock at depth of 12 to 24 inches; low yield of soil material.	Seasonally high water table; bedrock at depth of 12 to 24 inches.	Seasonally high water table; bedrock at depth of 12 to 24 inches.	Seasonally high water table; bedrock at depth of 12 to 24 inches.	Bedrock at depth of 12 to 24 inches; channery.
Seasonally high water table; slow to very slow permeability. VrD: steep slopes.	Slow permeability; good stability, except in surface layer of Chippewa. VrD: steep slopes.	Slow permeability; prolonged high water table.	Good stability; slow permeability if compacted.	Slowly permeable layer beginning at depth of 10 to 18 inches; prolonged seepage along top of this layer.	Limited rooting depth; slow water-intake rate; fair to good water-holding capacity. VrD: steep slopes.	Subject to prolonged flow; channery. VrD: steep slopes.	Subject to prolonged flow; channery.
Subject to flooding; prolonged high water table.[4]	High water table. Sloan: poor stability; highly organic surface soil.	Subject to flooding; sand lenses may be subject to seepage.	Wayland: good stability if material is mixed and compacted. Sloan: poor stability; highly organic surface soil.	Subject to flooding; natural outlets inadequate; prolonged high water table.	Generally not irrigated; prolonged high water table.	Nearly level; subject to flooding.	Subject to flooding.

TABLE 14.—*Interpretations of engineering*

Soil name [1] and symbol	Suitability as source of—			Soil features that affect engineering			
	Topsoil	Granular material	Fill material	Highway location	Highway cut conditions	Embankment foundations	Building foundations
Williamson very fine sandy loam (WrB).	Good [2]	Unsuitable	Generally good; in places may be too silty and too wet; highly erodible.	Fragipan at depth of 16 to 24 inches; seasonally poor trafficability.	Subgrades may be wet and subject to differential frost heaving; slopes unstable below water table; slopes subject to seepage and sloughing.	Generally adequate strength for low embankments.[3]	Generally low bearing capacity; moderately high compressibility; large settlements possible under heavy or vibratory loads.[3 6]

[1] If two or more soil names appear in the name of a mapping unit and are separated by "and" or a comma, the named soils may occur separately, or all may occur in a given mapped area. If soil names are separated by a hyphen, both soils occur within each mapped area.

[2] Each source must be investigated by adequate exploration, sampling, and testing.

[3] Some areas consist of or are underlain by wet, soft, plastic material. If structures or high embankments are contemplated, the site should be thoroughly investigated, with adequate subsurface exploration. Detailed soil testing and foundation analysis is necessary for sites where soil conditions are adverse.

[4] Not recommended for this purpose.

heaving will occur. Undercutting may be necessary to prevent frost heaving and to provide uniform support for the subgrade. Cuts may be dry during construction seasons, and it is difficult to foresee the potentially adverse moisture conditions that develop in wet seasons of the year.

LACUSTRINE SEDIMENTS

For a considerable period, a glacial lake, which at various stages stood at elevations of up to approximately 1,000 feet, occupied parts of the Cayuga Lake Basin. Wherever fast-flowing, detritus-laden streams entered the quiet lake waters, they dropped coarse sand and gravel near the lakeshore. This material formed deltas, which are discussed under the heading "Glacial Outwash." The finer textured particles were carried farther into the lake before they settled. These are lacustrine sediments, commonly called "bottom sediments" by engineers. In places, they are stratified fine sand or silt; in other places, varved silt and clay. A few sand and silt lenses may be interbedded with the varved material.

All of these deposits may have a high water table, and wet silt and clay may underlie the surface material. Bottom sediments generally become increasingly wet with depth. Brown silt and clay generally occur at the surface where aeration is possible. Gray, wetter material usually underlies the oxidized portion. Infiltration is restricted, and wherever topography is flat, runoff is slow.

The landform is either a plain or a dissected terrace. Part of the campus of Cornell University is a lake plain. Terraces occur in the valley of Cayuga Inlet. In places these terraces have been dissected. Wherever steep fronts occur, erosion is serious and landslides are numerous.

Soils of the following series formed on lacustrine sediments; Arkport, Collamer, Canandaigua, Dunkirk, Rhinebeck, Lamson, Niagara, Hudson, Madalin, and Williamson.

In proportion to their extent, soils formed on lacustrine sediments present more engineering problems than any other soils in the county. For the most part, these sediments occur below the 1,000 foot elevation where highway and building activity is concentrated, and some of the areas are part of or contiguous with urban and university areas. The high incidence of engineering problems results from the location, the low strength, and the poor drainage of these sediments. The gradeline of highways should be kept moderately high. The sediments are highly susceptible to frost, and they lose strength seasonally when thawing increases the moisture content. A base course of granular material beneath the pavement is necessary. If crushed stone or coarse gravel is used for the base course, consideration must be given to the use of a properly graded filter course under the gravel, to prevent intrusion of soil fines into the base course.

Cuts are generally troublesome. The material below the brown surface layer is likely to have a high moisture content and to be unsuitable for embankment construction unless it is properly dried and compacted. Drying may be difficult and uneconomical. Moreover, it is generally poor for foundations. Considerable settlement may take place under heavy fills and structures. Bridges and buildings generally require pile foundations unless the loads are only light to moderate. Thorough subsurface investigation and analysis is always necessary to determine soil strength and settlement characteristics. Special protective measures may be required to prevent sloughing in cuts.

During most of the time when the ground is not frozen, trafficability over heavy-textured material is difficult.

properties of soils—Continued

Soil features that affect engineering—Continued							
Infiltration systems	Dikes and levees	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
		Reservoir areas	Embankments				
Seasonally high water table; slow permeability in layer beginning at depth of 1½ to 3½ feet.	Fair to good stability if compacted; moderate to slow permeability.	Seasonally high water table; moderate to slow permeability.	Fair to good stability and slow permeability if compacted.	Seasonally high water table; cut slopes unstable; stratified very fine sand subject to piping.	Slow water-intake rate; fair water-holding capacity.	Slowly permeable layer beginning at depth of 18 inches.	Seasonally high water table.

[5] Wet, unstable, or otherwise unsuitable soil material may be encountered. This has to be removed and replaced with suitable material, to such depth as is necessary to provide uniform and adequate subgrade support.

[6] Adverse ground-water conditions may require extensive measures for control of seepage in basements.

[7] Proper foundation design depends on adequate subsurface investigation and analysis.

[8] No interpretation is feasible without adequate subsurface investigation.

This generalization may not apply to well-drained areas during protracted dry spells in late summer.

ALLUVIAL SEDIMENTS

This stratified material consists of sediments dropped by streams and occurs as terraces, first and second bottoms, and alluvial fans. There may be two levels adjacent to a stream. The level generally closest to the stream is called the first bottom. If a higher level or terrace occurs, it is commonly called the second bottom. On the first bottom the deposits are recent alluvium; on the second, the deposits are old alluvium. Alluvial fans occur where some upland streams deposit sediments on the more nearly level areas downstream. These fan deposits are crudely stratified and may contain flags and channers.

Recent alluvium commonly has a high water table; old alluvium generally has a low water table. First bottoms are subject to periodic overflow; second bottoms are occasionally flooded. Alluvial fans may be subject to occasional flash flooding. Surface drainage varies.

The material in each deposit may vary in texture. In places contiguous strata differ appreciably and the surface material may bear no resemblance to material deep in the profile. Portions of the alluvium along the Cayuga Lake Inlet, for example, are underlain by lacustrine sediments. Generally, alluvial deposits are loose or soft. They may contain organic surface or subsurface layers.

Alluvial land and soils of the following series occur on alluvial sediments: Eel, Genesee, Holly, Middlebury, Papakating, Sloan, Tioga, and Wayland.

A highway gradeline on first-bottom alluvium should be high enough to provide protection against possible flooding.

Foundation conditions are generally poor on alluvial sediments. Thorough investigation and, in most locations, special analysis and design are required before foundations for bridges and high embankments are constructed on these soils.

First bottoms should be avoided as building sites. The possibility of flooding on second bottoms should be carefully evaluated before these higher areas are utilized for building purposes. Sewage disposal by leaching will always be troublesome because of the seasonally or permanently high water table.

Most alluvial soils are satisfactory sources of topsoil.

MUCK AND PEAT

These accumulations of plant and animal remains in poorly drained areas are mostly organic matter but may contain varying amounts of inorganic material. They are found in swamps and at the surface of other poorly drained depressed areas. In places, they are underlain by marl.

The mapping unit for organic soils is called "Muck and Peat."

Muck and peat are ordinarily entirely unsuitable for highway and other embankment sites because they are highly compressible and unstable. Generally muck and peat and any other unsuitable material underlying it should be removed and replaced with suitable material. For highway purposes, after unsuitable materials are removed, replacement below the water table should be made with granular material or broken rock. No method of construction will entirely eliminate post-construction settlement on organic soils. The gradeline on these areas must be above the expected high water level.

Muck and peat may be used to amend mineral soils.

BEDROCK

For the most part, the bedrock in this county is interbedded shale, siltstone, and sandstone. There is also, however, the Tully limestone, which begins north of the county and continues toward Cayuga Lake, where it is exposed along either side of the lake. Exposed bedrock is mapped as Rock outcrop. In many places, bedrock is close to the surface, particularly in the soils that formed on shallow till.

All of the bedrock furnishes excellent foundations for highway embankments. Bedrock encountered in foundations for dams to store water must be properly sealed to prevent excess seepage. For building foundations, each site should be investigated for structural weaknesses in the rock, particularly if the proposed structure is one that concentrates a heavy load on a small area. High rock slopes may require special design. Structure and weathering characteristics are the properties that influence stability in cut slopes and govern the design in rock cuts. Benching may be necessary if highway embankments are constructed on steep rock surfaces.

Pavements underlain by rock at a shallow depth are subject to differential frost heaving. Seepage water accumulates and freezes between the pavement and the underlying rock. Seepage should be intercepted by constructing adequate ditches, by blasting rock trenches, or by both. Depressions in the rock surface should be drained or filled with material that is not susceptible to frost action. If the surface of the bedrock is flat, a moderately high gradeline may eliminate the need for blasting rock in ditch excavations.

Except for the Tully limestone, most of the bedrock of the county is too soft to be suitable for use as commercial aggregate material.

Soils and engineering construction

Highways, dams, bridges, buildings, drainage installations, and other engineering structures are founded on or are constructed partly of earth material, and the design of such structures should reflect the nature and physical properties of the soils involved. Some features of engineering works are highly dependent on soil conditions. The following paragraphs describe the effects of general soil conditions on engineering structures for soil and water conservation work and on building foundations, slope stability, soil compaction, and winter embankment construction. They also describe the effect of frost action in soils and discuss the use of topsoil.

SOIL AND WATER CONSERVATION WORK

Agricultural drainage, irrigation, farm ponds, dikes and levees, diversions, and waterways are used to conserve soil and water in this county.

Some of the soils derived from glacial till are underlain by a compact fragipan, or platy substratum, that retards the movement of water. Seepage along the top of this layer causes wet spots, and interception drains of both surface and subsurface types may be required. The installation of irrigation systems in these soils or in soils that are shallow to bedrock calls for careful investigation because of the limited depth of tillable soil.

Most of the glacial till soils in the county are slowly permeable and are suitable for the construction of farm ponds (fig. 18). Some, such as Ellery, Erie, Kendaia, and Langford soils, contain sandy lenses that can cause excess seepage from the reservoir. These sandy lenses may also cause piping and instability in drainage structures.

Figure 18.—**Farm pond in soil having dense, slowly permeable fragipan. Farm ponds provide year-round recreation. Fragipan soils are good pond sites.**

The soils derived from glacial outwash and alluvium as a rule are composed of larger particles and are more permeable than the soils derived from glacial till. If farm ponds for storing water above ground are built in these soils, a sealing agent should be used to prevent seepage of water from the reservoir. Ponds that are dug out to store water below the surface have been successful in places where the water table is close to the surface. Layers of poorly graded silt, fine sand, or sand present problems if open ditches or subsurface drains are installed, because these materials are subject to erosion, sloughing, and slumping. Subsurface drainage systems installed in such layers must be protected against plugging with the silt and fine sand. The fact that gravelly and sandy outwash soils are normally droughty and have a low water-holding capacity should be considered when planning an irrigation system.

BUILDING FOUNDATIONS

For building foundations, special subsurface investigation and special design are required to fit the structural requirements to the nature and bearing capacity of the soil. A general subsurface investigation may suffice for residential or very light commercial buildings. Foundations for heavy or monumental structures require detailed subsurface exploration, testing, and analysis.

Wet basements are a troublesome problem. This problem can be solved by proper selection of building sites or appropriate use of foundation drains, or both, and by dampproofing or waterproofing.

SLOPE STABILITY

Erosion control is necessary on all cut or fill slopes. If the slopes are stable against sloughing or sliding, the establishment of a vegetative cover helps to control erosion.

The likelihood of slope instability caused by inadequate strength of the foundation soil layers can be determined by extensive sampling, laboratory testing, and analysis. To prevent this type of instability, deep subdrainage or