SOIL SURVEY

Tioga County
New York

Series 1939, No. 20  Issued June 1953

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with the
CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION
How to Use THE SOIL SURVEY REPORT

Farmers who have worked with their soils for a long time know about the soil differences on their own farms, perhaps also on the farms of their immediate neighbors. What they do not know, unless soil surveys have been made, is how nearly their soils are like those on experiment stations or on other farms either in their State or other States where farmers have gained experience with new or different farming practices or farm enterprises. They do not know whether higher yields obtained by farmers in other parts of their county and State are from soils like theirs or from soils so different that they could not hope to get yields as high, even if they followed the same practices. To know what kind of soil one has so that it can be compared with those on which new developments have proved successful is a means by which some of the risk and uncertainty can be taken out of trying new methods and new varieties.

Soils of a Particular Farm

The soil map is in the envelope inside the back cover. To find what soils are on any farm or tract of land, the farm or tract must first be found and located on the map. This is easily done by finding the township the farm is known to be in and by using such landmarks as roads, streams, villages, dwellings, and other features that help to locate the boundaries.

Each kind of soil mapped within the farm or tract is marked on the map with a symbol. All the areas marked M0s are Mardin channery silt loam, sloping phase. The color with which the soil areas are shown on the map will be the same as the color in the legend.

To find out what the soil is like, turn to the section on Descriptions of Soil Units and find Mardin channery silt loam, sloping phase. There will be found a statement of what the soil is like, what it is mainly used for, and some of the uses to which it is suited.

How productive is Mardin channery silt loam, sloping phase? Find this soil in the left-hand column of table 7 and read the yields given opposite it under the names of different crops. This table also gives estimated yields for all the other soils mapped in the county.

What are considered good uses and management practices for Mardin channery silt loam, sloping phase? Read what is said about this soil in the section on Descriptions of Soil Units. Look also at the section headed Use and Management. Here the soils suited to the same use and management practices are grouped together. Read what is said about crops, crop rotations, liming, fertilizing, drainage, erosion control methods, and other management practices on this group of soils. It will apply to Mardin channery silt loam, sloping phase.

Soils of the County as a Whole

A general idea of the soils of the county is given in the introductory part of the section on Soils, which tells about the principal kinds of soils in the county, where they are found, and how they are related to one another. At the same time study the soil map and notice how the different kinds of soils tend to be arranged in different parts of the county. These patterns are likely to be associated with well-recognized differences in type of farming, land use, and land-use problems.

A newcomer to the county, especially if he considers purchasing a farm, will want to know about the climate; the types and sizes of farms; the principal farm products and how they are marketed; the kinds and conditions of farm tenure, including tenancy; kinds of farm buildings, equipment, and machinery; churches, schools, roads, and railroads; the availability of telephone and electric services and water supplies; the industries of the county; cities, villages, and population characteristics. Information about all these will be found in the section on General Nature of the Area and in the section on Agriculture.

Those interested in how the soils of the county were formed and how they are related to the great soil groups of the world should read the section on Morphology, Genesis, and Classification of Soils.

This publication on the soil survey of Tioga County, N. Y., is a cooperative contribution from the—

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SOIL SURVEY OF TIOGA COUNTY, NEW YORK


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United States Department of Agriculture in cooperation with the Cornell University Agricultural Experiment Station

CONTENTS

<table>
<thead>
<tr>
<th>Page</th>
<th>Soils—Continued</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Descriptions of soil units—Con. Page</td>
</tr>
<tr>
<td></td>
<td>Canfield field... 37</td>
</tr>
<tr>
<td></td>
<td>Canfield gravelly silt loam: 37</td>
</tr>
<tr>
<td></td>
<td>Undulating phase... 37</td>
</tr>
<tr>
<td></td>
<td>Rolling phase... 39</td>
</tr>
<tr>
<td></td>
<td>Eroded rolling phase... 40</td>
</tr>
<tr>
<td></td>
<td>Hilly phase... 41</td>
</tr>
<tr>
<td></td>
<td>Eroded hilly phase... 42</td>
</tr>
<tr>
<td></td>
<td>Chenango series... 43</td>
</tr>
<tr>
<td></td>
<td>Chenango gravelly silt loam, nearly level phase... 43</td>
</tr>
<tr>
<td></td>
<td>Chenango gravelly loam: 45</td>
</tr>
<tr>
<td></td>
<td>Rolling phase... 45</td>
</tr>
<tr>
<td></td>
<td>Hilly phase... 46</td>
</tr>
<tr>
<td></td>
<td>Steep phase... 47</td>
</tr>
<tr>
<td></td>
<td>Alluvial-fan phase... 47</td>
</tr>
<tr>
<td></td>
<td>Chenango fine sandy loam, nearly level phase... 48</td>
</tr>
<tr>
<td></td>
<td>Chenango silt loam, nearly level phase... 49</td>
</tr>
<tr>
<td></td>
<td>Chippewa series... 50</td>
</tr>
<tr>
<td></td>
<td>Chippewa channery silt loam... 50</td>
</tr>
<tr>
<td></td>
<td>Chippewa stony silt loam... 51</td>
</tr>
<tr>
<td></td>
<td>Fremont series... 51</td>
</tr>
<tr>
<td></td>
<td>Fremont and Volusia channery silt loams... 52</td>
</tr>
<tr>
<td></td>
<td>Gently sloping phases... 52</td>
</tr>
<tr>
<td></td>
<td>Holly series... 53</td>
</tr>
<tr>
<td></td>
<td>Holly silt loam... 54</td>
</tr>
<tr>
<td></td>
<td>Howard series... 55</td>
</tr>
<tr>
<td></td>
<td>Howard gravelly loam: 55</td>
</tr>
<tr>
<td></td>
<td>Nearly level phase... 55</td>
</tr>
<tr>
<td></td>
<td>Rolling phase... 56</td>
</tr>
<tr>
<td></td>
<td>Hilly phase... 57</td>
</tr>
<tr>
<td></td>
<td>Steep phase... 58</td>
</tr>
<tr>
<td></td>
<td>Howard gravelly silt loam, nearly level phase... 58</td>
</tr>
<tr>
<td></td>
<td>Howard loam, nearly level phase... 60</td>
</tr>
</tbody>
</table>

1 The Division of Soil Survey was transferred to the Soil Conservation Service on November 15, 1932.
FARMING has been the principal industry in Tioga County since settlement began in 1785. The pioneers first settled along the river valleys, and agriculture extended to the uplands as the hardwood forest was cut for timber. Railroads built about 1850 gave access to large city markets and greatly encouraged dairying and poultry raising, enterprises to which the county is naturally suited. Hay, corn, and small grains raised to feed the dairy cattle and poultry are now the main crops; minor crops are potatoes and other vegetables grown for market. Permanent pasture covers a large area, and nearly a third of the county is in woodland from which some timber is still cut. Several small plants process farm and forest products, but industrial enterprise is limited. To provide a basis for the best agricultural uses of the land this cooperative soil survey was made by the United States Department of Agriculture and the Cornell University Agricultural Experiment Station. Field work was completed in 1939, and unless otherwise specifically mentioned, all statements in this report refer to conditions in the county at that time.
GENERAL NATURE OF THE AREA
LOCATION AND EXTENT

Tioga County, in south-central New York, has an area of 521 square miles, or 333,440 acres. Owego, the county seat on the Susquehanna River somewhat southeast of the center of the county, is 150 miles northwest of New York City, 140 miles southeast of Buffalo, and 25 miles south of the New York State College of Agriculture at Ithaca (fig. 1).

![Map of New York State showing Tioga County](image)

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

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

Tioga County is in the glaciated Allegheny Plateau section of the Appalachian Plateaus province (3). The Allegheny Plateau extends westward across southern New York into northwestern Pennsylvania and northeastern Ohio but terminates northward in a relatively distinct escarpment a few miles south of Schenectady, Utica, and Syracuse. The escarpment is less distinct westward through the Finger Lakes area, and the plateau slopes gently to the Central Lowland province. From the Finger Lakes to Buffalo the escarpment is again distinct and extends from Buffalo southwest to the New York-Pennsylvania line a short distance southeast of Lake Erie. The southern boundary is marked by the southern limit of the Late Wisconsin glaciation. On the east the plateau terminates in an

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2 Italic numbers in parentheses refer to Literature Cited, p. 133.
escarpment overlooking the Hudson Lowland, except in southeastern New York where it grades upward into the higher more deeply dissected Catskill Mountains.

The Allegheny Plateau is underlain by acid shale and sandstone of Devonian age. The rock formations are nearly level-bedded and dip very gently to the south. Far in the geologic past this plateau was a nearly level plain, but later uplifts have rejuvenated the streams, and the area is now deeply dissected by stream action. Relief ranging from 500 to 1,000 feet is common. The smaller streams have the dendritic drainage pattern typical of regions underlain by level-bedded rocks of fairly uniform character. The plateau presents a nearly even sky line when viewed from the higher elevations, but local swells or protrusions above the general level have persisted in places where more resistant rocks are exposed at the surface. Although the major features of the area have been formed by stream erosion, these have been modified by glacial action over a long period, and local features may be largely or entirely of glacial origin. All the higher uplands are covered with a relatively thin sheet of glacial till, and the valleys are filled with relatively thick deposits of glacial outwash, lake sediments, and in places glacial till. The hills are smooth and round, and some valleys have been deepened and their sides made steeper by glacial action.

Tioga County is near the center of the Allegheny Plateau and has features typical of much of the area as a whole. The Susquehanna River flows from east to west across the southern part of the county. The valley of this river is about a mile wide and is filled mainly with gravelly outwash material deposited during and immediately following glacial times. Low younger terraces are prominent in places, and recent alluvium occurs in relatively narrow strips on the present flood plains of the streams. Relief is nearly level to rolling over most of the valley, but local areas of hilly and steep relief are prominent on some of the older outwash terraces and on the kames and till-covered hills bordering the valley. The river is about 800 feet above sea level where it enters the county and 760 feet where it leaves. Terraces rise 100 to 200 feet above the level of the river.\(^3\)

The upland parts of the county north and south of the Susquehanna River are deeply dissected by the valleys of tributary streams. In the north and beginning at the western edge of the county, the larger of these valleys are those drained by Cayuta Creek, which joins the Susquehanna River southeast of Waverly; Ellis Creek, joining just east of Waverly; Pipe Creek, at Tioga Center; Catatonk Creek, at Owego; and Owego Creek at Owego. From the south two creeks enter, the Wappasening, at Nichols, and the Apalachin, at Apalachin. In the northwestern part a broad valley extends westward from Candor to the Chemung County line, and a northern extension continues from Spencer to the county line and there grades into the north-sloping Cayuga Valley.

The valleys of the county were apparently not formed solely by streams of the size of those now occupying them but by ice and glacial outflow during the glacial period. The valleys do not widen from head to mouth but have relatively uniform width through their entire

\(^3\) Elevation data from United States Geological Survey topographic maps.
lengths. Stream divides on the valley floors are not commonly marked by a distinct pass, but places may be found where water flows outward from opposite ends of broad swampy areas.

The valley walls are remarkably smooth and straight and have no projecting spurs. The lower valley walls are steep to very steep. The valleys are partly filled with gravelly glacial outwash, and there are narrow strips of recent alluvium along the larger streams. In many places gravelly moderately compact till is on hills along the borders of a valley. Slopes are dominantly undulating to rolling, but on the bordering till-covered areas and at the edge of some terraces, they are hilly and steep. Broad low fans are conspicuous where tributary streams enter the longer valleys. Swampy areas are also common, chiefly at stream divides. In the northern part of the county the heads of the larger valleys range from an elevation of 950 feet near Willsieville to about 1,140 feet north of Richford. These larger tributary valleys fall rather gradually to about 800 feet above sea level where they enter the Susquehanna River Valley.

The walls of the Susquehanna Valley rise sharply, in many places as much as 500 feet in less than a fourth of a mile, to the maturely dissected uplands. After this first abrupt rise the hills slope more gradually upward for an additional 200 or 300 feet, reaching an average elevation between 1,500 and 1,600 feet over most of the county. In the northern part, however, the hills range from 1,700 to 1,900 feet. Broad smooth slopes of moderate gradient are dominant on the broader divides, but local relief of 100 to 200 feet is not uncommon, and hilly and steep slopes abound along small intermittent streams. The higher elevations have been preserved by the level-beded more resistant sandstone. Terracelike benches and rather steep ascents and descents to areas of less resistant rocks in places mark the location of these sandstone layers.

In general, the features of this upland area have been altered mainly in being smoothed by glaciation. The entire area, however, is covered by a thin layer of glacial till 3 to 10 feet thick, and in local areas or pockets the till is deeper. The till is compact, strongly acid, medium-textured, and contains a large quantity of angular sandstone and shale fragments. The compactness of the till and the long slopes that accumulate seepage water are chiefly responsible for the high proportion of imperfectly and poorly drained soils in the upland areas.

**CLIMATE**

Tioga County has a cool temperate continental climate. Summers are relatively cool and short; winters are rather severe and long. The annual precipitation is 35 to 38 inches, about half of which falls during the growing season (11, 16).

Relatively cool summer temperatures, adequate rainfall, and the short growing season favor the growth of forage crops for hay and pasture and have been important in the development of the dairy industry in the county. These climatic factors have discouraged production of corn and other crops requiring long warm growing seasons to reach maturity. The relatively heavy summer rainfall and only moderate evaporation losses that promote rather rapid and
thorough leaching of the soils have been important in the development of the podzolized soils of the county.

For the most part rains are of moderate intensity; summer thunderclouds may form quickly, cause heavy rainfall for a short time, and then pass on, leaving the sky clear and the sun shining. Destructive hailstorms are rare, but hail occasionally falls in most parts of the county. Tornadoes are very rare. Extreme droughts and wet periods are infrequent. Spring rains may delay or prevent planting and cultivating, and during June and July, especially on the poorly drained soils of the uplands, rains commonly interfere with curing the hay crop.

The average frost-free growing season extends from May 5 to October 7, a period of 155 days. The susceptibility of any locality to frost varies somewhat with the elevation, relief, and nearness to bodies of water. High-lying areas ordinarily are less subject to frost than valley positions into which the cooler air settles. This condition may be reversed during fall months, when fogs form in the valleys and prevent frost.

Those soils having a heavy compact subsoil relatively close to the surface are especially subject to heaving when the surface is exposed to alternate freezing and thawing. Snow blankets reduce this tendency to a large extent, but the condition is common on such soils as the Volusia and Fremont.

Climatic conditions in various parts of the county do not differ greatly, although snow remains longer on the hills than in the valleys. In most years soils in the valleys can be worked 10 to 15 days earlier in spring than those of the higher uplands. Cultivation of the uplands is delayed not only by elevation but also by dense subsoil. The upland subsoil retains excess moisture after winter freezing and therefore requires a longer time to dry than does the more freely drained subsoil of the valleys.

Prevailing winds are from the northwest most of the year, but late in summer they blow dominantly from the south. The strongest winds are late in winter and early in spring.

The county is in a relatively cloudy belt. Through the growing season the sun shines 56 percent of the possible time; for the rest of the year, 36.4 percent. The annual average relative humidity at 8 a. m. is 80 percent; at noon, 63 percent (II). Slight to moderate seasonal variations from these annual averages are recorded. The relative humidity is somewhat below average in spring and early summer and slightly above for the rest of the year.

Detailed data on temperature and precipitation considered representative of climatic conditions in this county are given in table 1. These figures are from records of the weather station at Binghamton, in nearby Broome County.

WATER SUPPLY

Easily accessible supplies of water are available in most parts of the county. Driven wells and deep dug wells are dependable sources of water for domestic use, livestock, and other farm uses. In 1945 about 75 percent of the farms reported running water in the farm dwelling.
Table 1.—Normal monthly, seasonal, and annual temperature and precipitation at Binghamton, Broome County, N. Y.

[Elevation, 858 feet]

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean temperature</th>
<th>Precipitation</th>
<th>Total for the driest year</th>
<th>Total for the wettest year</th>
<th>Average snowfall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>° F.</td>
<td>Inches</td>
<td>Inches</td>
<td>Inches</td>
<td>Inches</td>
</tr>
<tr>
<td>December</td>
<td>28.2</td>
<td>2.31</td>
<td>1.40</td>
<td>1.65</td>
<td>10.4</td>
</tr>
<tr>
<td>January</td>
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<td>2.45</td>
<td>1.59</td>
<td>4.07</td>
<td>11.7</td>
</tr>
<tr>
<td>February</td>
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<td>2.27</td>
<td>2.65</td>
<td>2.53</td>
<td>11.6</td>
</tr>
<tr>
<td>Winter</td>
<td>25.4</td>
<td>7.03</td>
<td>5.64</td>
<td>8.25</td>
<td>33.7</td>
</tr>
<tr>
<td>March</td>
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<td>2.62</td>
<td>3.17</td>
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<td>April</td>
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<td>2.48</td>
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<td>2.3</td>
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<tr>
<td>May</td>
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<td>3.31</td>
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<td>Spring</td>
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<td>10.27</td>
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<td>June</td>
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<td>1.54</td>
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<td>34.58</td>
<td>122.42</td>
<td>45.44</td>
<td>51.2</td>
</tr>
</tbody>
</table>

1 In 1900.  
2 In 1945.

The many surface streams and springs are sources of water for pastures in much of the county, especially in the valleys. Most of the large streams are perennial, and nearly all the minor ones have water in some parts of their channels, even in comparatively dry years. Perennial surface streams are rare in the higher uplands, and more dependence is placed on dug or driven wells as a source of water for livestock. In recent years a few farmers in the uplands have constructed ponds to catch and store water for livestock. Water supplies are usually ample for domestic and livestock needs, but occasionally, as in the summer of 1939, severe droughts make necessary transportation of water for long distance for livestock.

Most of the water supply of the area contains some dissolved minerals and is at least moderately hard. One small lake, Spencer Lake, has some recreational value, and many sites along the Susquehanna River are utilized for summer cottages.
VEGETATION

This county is in the northeastern hardwoods region and its entire area was originally covered by a dense forest (10, 14). The stand varied from place to place according to soil and moisture conditions. Sugar and red maples, northern red, white, black, and scarlet oaks, birch, aspen, basswood, chestnut, elm, hickory, butternut, northern white cedar, tamarack, hemlock, and white and red pines were important constituents of the forest. In places fully half of the stand was chestnut. The pines were confined largely to the drier uplands. Maple, elm, and hemlock were dominant on the wetter uplands and in the valleys where moisture was more abundant.

At present about a third of the county is in forest, chiefly in small farm wood lots. Some fairly large forested areas are on the steeper and stonier uplands. The present upland forests consist largely of white and red oaks, sugar maple, beech, yellow-poplar, and ironwood with some hemlock and white and red pines in places. Elm, hickory, ash, and soft maple are more abundant on the lowlands. Undergrowth includes witch-hazel, hazelnut, Juneberry, hawthorn, sumac, wild rose, American alder, dogwood, and red cherry. Smaller shrubs are lowbush blueberry, late upland blueberry, dwarfbush honeysuckle, sweetfern, poison-ivy, trailing-arbutus, and wintergreen. Mountain-laurel is common in the undergrowth at the higher elevations in the western part of the county.

In old fields and pastures encroachments of hawthorn, seedling apple, wild blackberry, dewberry, sweetfern, and seedlings of various forest trees are common in many places. Herbaceous plants in these fields, along fence rows, and in other waste places include cinquefoil, Queen-Anne's-lace, Indian paintbrush, yarrow, mullen, Canada thistle, daisy, giant teasle, goldenrod, poverty oatgrass, wild aster, ragweed, and in places some escaped cultivated clovers and grasses. Where these areas are pastured occasionally, forest reproduction is kept down. The unpastured areas gradually revert to forest. On unimproved pastures and cleared but idle land, poverty oatgrass is associated with a variety of herbaceous weeds.

ORGANIZATION AND POPULATION

Settlement of the area now included in Tioga County began immediately after the Revolutionary War. In August 1779, the army brigade of General James Clinton, a part of General Sullivan's expeditionary force against the Indians of central New York, passed down the Susquehanna River. The soldiers—mainly from Massachusetts, Connecticut, New Jersey, and eastern New York—were so favorably impressed with the country that soon after the close of the war many of them with their families and friends settled in the region.

The first recorded settler was James McMaster, who arrived at the present site of Owego in 1784 and established residence there the following year. In the few years following, pioneers, including some from the Wyoming Valley of northeastern Pennsylvania, rapidly settled within the present limits of the county.

Tioga County was first organized under its present name by legislative act in 1791, and it then included the areas of Chemung, Broome,
and Chenango Counties. These counties were formed from the original Tioga County, which became its present size March 29, 1836 (4).

The population was 24,212 in 1920, and by 1950 had increased to 30,166, of which 62.3 percent was classed as rural. The increase in population has been largely in rural areas but not on farms. Industrial workers from cities in other counties have moved to rural residences in this one. The actual farm population continues to decline. The population averaged 57.5 persons to the square mile in 1950, but it was by no means uniformly distributed. The population in rural areas is concentrated much more heavily in the broader valleys where soil conditions are most favorable. Broad areas of hilly and steep uplands with thin stony soils are very sparsely settled, there being less than one farm dwelling to the square mile (8).

Several villages have grown to meet the need of the rural population for trading and shipping centers. The villagers gain their livelihood principally by furnishing needed services to the farm population and by working in small plants engaged in processing or manufacturing products from the farms and forests. Waverly with a population 6,037 and Owego with 5,350 are the largest villages. Both serve as trading and shipping centers and support several small industries. Owego also is the seat of the county government. The other larger villages, chiefly trading centers, are Candor, Newark Valley, Nichols, and Spencer.

INDUSTRIES

Agriculture is the chief industry of the county, but many people in the towns of this or adjoining counties are employed in factories, processing plants, and service occupations. Shoes, chairs, and lumber are manufactured in Owego; and paint, milled feeds, and oat products in Waverly. Many rural residents employed in industries also practice part-time farming.

TRANSPORTATION AND MARKETS

The three railroads serving the county provide adequate transportation. The main line of the Lehigh Valley Railroad passes through Waverly and along the western side of the county to Spencer and northward to Ithaca. The Auburn branch of this railroad extends from Waverly to Owego and northward through Newark Valley. The main lines of the Delaware, Lackawanna, and Western Railroad, and the Erie Railroad follow the valley of the Susquehanna River across the county. The Ithaca branch of the Erie line extends north from Owego through Candor and Willsieville.

The county is covered by a close network of State and local highways. State Highway No. 17 follows the Susquehanna Valley through the southern part and leads to Elmira to the west and Binghamton to the east; No. 34 follows Cayuta Valley in the western part; No. 96 traverses Catatonk and Willsieville Creek Valleys; No. 38 follows the East Branch Owego Creek; and No. 79 crosses the northern part and passes through Richford. All are hard-surfaced roads and extend to the large cities and villages in the adjoining counties.

Hard-surfaced and graveled county roads traverse the valleys not served by State highways and extend into the more thickly populated
uplands. In the thinly settled upland areas graded dirt roads are common. These roads are passable most of the year, but may be blocked with snow in winter and are very muddy in spring.

The highway network provides the farm population an easy and rapid means of communication with villages and cities in Tioga and adjoining counties. Most farm products are hauled to market by truck, and feed, fertilizer, and other products are delivered to farms in the same way.

CULTURAL DEVELOPMENT AND IMPROVEMENT

Elementary and high schools are in most of the villages, and most one-room schools have been consolidated with the village schools. Children are now transported by bus to these centrally located schools. Some one-room schools are still maintained, however, mostly in the more remote upland areas. Associated with many schools are Future Farmers’ Clubs, 4-H Clubs, and allied organizations, which serve as a center of social activities for rural youth and parents and carry out educational programs as well. Many rural churches have closed in the past twenty years; church attendance has centralized in the villages.

Farm dwellings and other buildings on the larger dairy farms in the valleys are well built and carefully maintained. Most homes have running water, bathrooms, electric lights, refrigeration, modern electric or gas cooking stoves, telephones, radios, and other facilities of modern life. The dairy farms have also milking machines, litter carriers, electric feed grinders, refrigeration equipment, and other accessories required in modern dairying. By contrast the farms of the higher upland areas are much less well equipped. Although the house and barn are in many places as large as in the valleys, they are generally in a poor state of repair and lack most of the modern equipment of the valley farms.

AGRICULTURE

Agriculture has always been the chief means of livelihood in Tioga County. The Indians practiced agriculture with marked success before the white settlers arrived. When Sullivan’s forces invaded the area in 1779, fields of corn, beans, pumpkins, squash, and mature apple trees were growing at the site of Owego and at other points along the Susquehanna River. General James Clinton reported that the corn was the finest he had ever seen, and one of his officers states that ears of corn measured 22 inches in length (4). The success of the Indians in agriculture has been attributed to methods they learned from the French.

The agriculture of the early white settlers consisted mostly of growing food and feed crops, such as corn, wheat, and vegetables, and raising livestock. The settlers first occupied the valleys, which were easily accessible and in many places partly cleared. The uplands supported heavy stands of timber, but lumber was in demand, and its production began early and continued actively for several decades. As the timber was removed, the uplands gradually were used for agriculture.
Raising livestock, especially cattle and sheep, early became important. The animals were raised without intensive effort and driven overland to city markets when they matured. The Susquehanna River was a means of transportation before the coming of railroads. Up to about the time of the Civil War, vast quantities of lumber were rafted down the river at the time of spring freshets to Baltimore and other tidewater points. Many agricultural products were shipped by flatboats or rafts to coastal cities.

The Owego and Ithaca Railroad, beginning in the early 1830's aided in the development of the region; and the service of the Erie Railroad, on its completion through the county in 1849, greatly encouraged agriculture. The railroads provided easier access to markets and hastened the change from livestock production for meat to dairying. Production of livestock and livestock products has been the main enterprise on most farms since about 1850, but intensive dairying has had its greatest growth in the last two or three decades (pls. 1 and 2). A nearby accessible and expanding market in New York City, favorable climate, and suitable soils encouraged livestock raising and dairying.

The dairy type of farming, with some specializing in poultry, now predominates. The production of hay, oats, barley, wheat, corn, and minor forage crops for feed and the care of livestock are the important activities on most farms. The cash farm income is derived mainly from the sale of dairy and livestock products, but some buckwheat and other grains are sold. Potatoes are important on some farms, and on a few others the main income is derived from forest products or vegetables.

In recent years increasing demand and favorable prices have caused considerable interest in commercial production of potatoes and other vegetables. Misled by smooth slopes and favorable climate, some farmers have attempted to produce potatoes on the Volusia soils. Low yield and inferior quality on these poorly drained soils led to the abandonment of the enterprise and discouraged farmers from attempting to grow potatoes on the associated well-drained well-suited soils of the Bath and Lordstown series. The suitability of the soils for various uses, especially their suitability for potatoes, is discussed in the section on Use and Management.

CROPS

The acreages of principal crops in Tioga County from 1919 to 1944 are shown in table 2.

Although the acreage of most crops has decreased, the trend of average yields has generally been upward. Use of improved varieties, better control of insects and diseases, increased use of fertilizer and lime, and abandonment of the less productive soils are among the practices responsible for these increased yields. Weather conditions may seriously affect both acreage and yields for any given year, and extremely poor or good weather during the year that the census was taken may give yields or acreages that vary widely from the general trend.

Hay has always been the most important farm crop and now occupies slightly more than 60 percent of the cultivated cropland. The
### Table 2.—Acreage of the principal crops and number \(^1\) of bearing fruit trees and grapevines in Tioga County, N. Y., in stated years

<table>
<thead>
<tr>
<th>Crop</th>
<th>1919</th>
<th>1920</th>
<th>1939</th>
<th>1944</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acres</td>
<td>Acres</td>
<td>Acres</td>
<td>Acres</td>
</tr>
<tr>
<td>Oats</td>
<td>15,498</td>
<td>10,372</td>
<td>10,665</td>
<td>10,815</td>
</tr>
<tr>
<td>Barley</td>
<td>375</td>
<td>381</td>
<td>133</td>
<td>184</td>
</tr>
<tr>
<td>Wheat</td>
<td>2,277</td>
<td>1,413</td>
<td>2,061</td>
<td>2,552</td>
</tr>
<tr>
<td>Rye</td>
<td>813</td>
<td>147</td>
<td>132</td>
<td>19</td>
</tr>
<tr>
<td>Buckwheat</td>
<td>8,308</td>
<td>9,363</td>
<td>3,783</td>
<td>(4)</td>
</tr>
<tr>
<td>Corn:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For grain</td>
<td>2,845</td>
<td>844</td>
<td>1,564</td>
<td>1,776</td>
</tr>
<tr>
<td>For silage</td>
<td>15,178</td>
<td>6,228</td>
<td>6,967</td>
<td>8,459</td>
</tr>
<tr>
<td>Potatoes</td>
<td>3,498</td>
<td>2,585</td>
<td>1,527</td>
<td>1,194</td>
</tr>
<tr>
<td>Vegetables</td>
<td>(4)</td>
<td>394</td>
<td>198</td>
<td>193</td>
</tr>
<tr>
<td>Beans, dry</td>
<td>159</td>
<td>41</td>
<td>120</td>
<td>99</td>
</tr>
<tr>
<td>Hay, total</td>
<td>63,216</td>
<td>47,004</td>
<td>44,329</td>
<td>53,314</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>63</td>
<td>803</td>
<td>1,703</td>
<td>2,448</td>
</tr>
<tr>
<td>Timothy alone</td>
<td>12,337</td>
<td>(4)</td>
<td>(4)</td>
<td>(4)</td>
</tr>
<tr>
<td>Timothy and clover</td>
<td>46,660</td>
<td>36,161</td>
<td>34,218</td>
<td>48,942</td>
</tr>
<tr>
<td>Annual legumes</td>
<td>18</td>
<td>42</td>
<td>48</td>
<td>(4)</td>
</tr>
<tr>
<td>Clover alone</td>
<td>1,702</td>
<td>5,321</td>
<td>261</td>
<td>(4)</td>
</tr>
<tr>
<td>Other tame and wild grasses</td>
<td>2,058</td>
<td>4,482</td>
<td>7,594</td>
<td>2,741</td>
</tr>
<tr>
<td>Small-grain hay</td>
<td>378</td>
<td>195</td>
<td>505</td>
<td>183</td>
</tr>
<tr>
<td>Apple:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trees</td>
<td>52,877</td>
<td>33,081</td>
<td>17,333</td>
<td>17,903</td>
</tr>
<tr>
<td>Peach</td>
<td>5,162</td>
<td>1,156</td>
<td>614</td>
<td>866</td>
</tr>
<tr>
<td>Pear</td>
<td>4,755</td>
<td>2,426</td>
<td>897</td>
<td>1,587</td>
</tr>
<tr>
<td>Plum and prune</td>
<td>3,694</td>
<td>2,253</td>
<td>1,109</td>
<td>1,042</td>
</tr>
<tr>
<td>Cherry</td>
<td>6,780</td>
<td>2,528</td>
<td>1,371</td>
<td>1,112</td>
</tr>
<tr>
<td>Grapevines</td>
<td>2,596</td>
<td>2,426</td>
<td>806</td>
<td>3,219</td>
</tr>
</tbody>
</table>

\(^1\) Number of bearing fruit trees and grapevines for all years except 1944; the 1944 figures are for trees of all ages.

\(^4\) Not reported.

\(^4\) Includes all silage crops.

\(^4\) Soybeans only.

total area in hay declined gradually until 1939 and then increased in 1944. The decline in number of work stock, the decrease in demand for hay in city markets brought about by the advent of automobiles, and the substitution of silage as roughage are largely responsible for the decrease in the hay acreage. Hay is grown on practically all farms. Timothy and clover, occupying about 90 percent of the acreage in hay, are commonly seeded in small-grain crops following corn. Lime is applied by most farmers, but except for top dressings of manure applied to old stands, fertilization is not ordinarily practiced. The seedings of clover and timothy are generally cut the first 2 years, and then either pastured or cut for hay until the proportion of weeds and poverty oatgrass in the stand is so large it reduces the yield to a very low level. On the better valley soils the sod is usually turned under for corn after the second year of hay.

Much of the hay is stored loose in barns, but small quantities are stored in the open when barn space is limited. The use of pickup balers has become common in recent years. Much of the hay is overripe when harvested and of relatively poor quality. It is commonly fed to dairy cattle and work stock on the farms where it is produced, but some is sold in local markets.
Large dairy farm on Howard soils, where several families are employed and a large quantity of milk is produced.
Modern dairy farm in the Catatonk Valley west of Candor. Howard soils are most extensive on the farm, but small areas of Holly silt loam and Middlebury soils are included.
Alfalfa, the other important hay crop, is grown almost entirely on the deep well-drained Chenango, Howard, and Tioga soils in the valleys. Lime and superphosphate are applied by most farmers, but other management is about the same as for the mixed hay.

Small acreages of millet, vetch, sweetclover, Sudan grass, soybeans, and small grains cut for hay make up the minor forage crops. Small areas of wild grass are harvested for forage by a few farmers.

Oats have long been the second most important crop from the standpoint of acreage. They are now grown on nearly all the crop soils of the county and follow corn in the rotation. They receive little fertilizer other than manure, but lime is applied where legumes are seeded with the oats. Practically all the oats are fed to livestock on the farm, but small quantities are sold for processing into livestock feed or other oat products. Oats are an important crop mainly because they are used as a companion crop for new seedings of hay.

Corn is another important crop, although the total acreage for all purposes has fluctuated rather widely. Since 1929 the acreage of corn for grain has increased moderately, and the acreage of corn for silage has increased markedly. The production of silage corn has been encouraged by the increase in intensive dairying. Long-term yields of corn for grain show only moderate fluctuations, but there has been a rather sharp rise in yield recently. The use of better varieties and hybrids on the better adapted soils having more favorable growing seasons have probably contributed to the increase in grain yield.

Corn generally follows hay in the crop rotation and normally receives fairly heavy applications of barnyard manure. The grain corn is grown mainly on the valley soils, as the Howard, Chenango, Tioga, and Middlebury, but silage corn is grown on all soils of the county on dairy farms. The grain corn is used mainly in ground or chopped feed mixtures or as shelled corn for poultry. Silage is very important as feed on all dairy farms.

Buckwheat is an important crop on the poorer soils. It is used as a catch crop on poorly drained soils when wet spring weather delays the planting of corn or oats or results in crop failure. Ordinarily soil amendments are not used on this low-value crop, although some farmers may apply manure or superphosphate. Much of the buckwheat is sold as a cash crop, but moderate quantities are fed to poultry on the farms, usually in mixed poultry feeds.

Wheat is now much less important than in earlier days, but the yield has increased. Planting of better varieties, limiting the crop to the more productive soils, and better fertilization have contributed to the higher yields. Practically all the wheat is fall-sown. Late planting greatly reduces yields, and inability to plant on time after silage corn limits the acreage. Most of the crop is now grown in the valleys on Chenango, Howard, and associated soils. Top dressings of manure are commonly applied, and where legume seedings are made, lime is used. Most of the wheat is harvested with combines. It is sold for cash by nearly all farmers. Small quantities are used for feeding poultry and other livestock.

Minor field crops are rye, barley, mixed grain, and beans. Rye was formerly an important crop and in some years occupied nearly as
large an acreage as wheat, but it has declined in importance in recent years. Barley has never been an important crop. Mixed grains, chiefly oats and barley, are grown and ground for dairy feed. A few acres of dry beans have been grown in recent years near Spencer.

Potatoes were an important cash crop in the latter part of the past century, but the acreage has declined steadily. The few large commercial producers use the well-drained Lordstown and Bath soils of the uplands and the Unadilla and Chenango soils in the valleys. The small growers operate mainly on the well-drained uplands, but potatoes for home use are produced in all parts of the county, even on the poorly drained soils.

Commercial potato growers have complete mechanical equipment and use large quantities of commercial fertilizer, but the smaller growers plant potatoes as the row crop in the diary-farm rotation. Most of the crop is marketed in nearby cities, but one or two growers produce certified seed potatoes for sale to other potato-producing areas in southern New York State.

Commercial vegetable production is important on only a few farms in the valleys, but many vegetables for home use are grown in gardens on farms in all parts of the county. Sweet corn, cabbage, tomatoes, snap beans, and green peas are the main vegetables harvested for sale although a small acreage of other vegetables and melons was grown for sale. The vegetables are sold in nearby urban centers and from roadside stands.

Fruits and berries are widely grown but largely for home use. Apples were important in the late nineteenth century, but the number of trees has declined steadily. Only a few small commercial apple orchards now remain. Apples are produced mainly for home use. The production of apples and other tree fruits has declined because the county has a less favorable climate than areas near large bodies of water. Grapes, pears, cherries, plums, and peaches are grown mainly for home use, but small quantities are marketed by some farmers. Strawberries, raspberries, and small quantities of blackberries and blueberries are also grown.

ROTATIONS AND FERTILIZERS

Corn, oats, and mixed hay for feeding dairy cows are important crops on most farms in the county, and rotation and fertilization practices are concerned mainly with those crops. Corn is grown continuously on some of the more favorable areas of Tioga and Middlebury soils on the bottom lands, but such is not the usual practice for the county. Corn is commonly planted on plowed sod land and followed by oats the next year. A timothy and clover mixture is seeded with or following the oats and remains 2 to 4 years or more. The timothy-clover seeding is mowed for hay the first 2 years and may be used for pasture or cut for hay for the rest of the period. Wheat is sometimes substituted for oats but more commonly follows the oats and precedes the timothy-clover mixture. Some farmers use alfalfa-grass mixtures as the hay crop on the better soils. On the poorer upland soils a buckwheat-oats-mixed hay rotation is
common. Buckwheat often serves as a catch crop when corn or oats fail on poorer soil in wet springs.

The larger commercial potato growers commonly use a rotation of potatoes, oats, and clover, but sometimes practice more intensive management in which potatoes are followed by rye. The rye is plowed under in spring as a green manure, and the land is again planted to potatoes. As a rule neither the small-scale potato grower nor the truck-crop farmer follows a regular rotation.

Stable manure is the principal fertilizer used on farms of this county. In recent years adding superphosphate to the manure in the barn as it is produced has become a common practice on most dairy farms, and the fertilizing value of the manure is thereby considerably increased. Much of the manure is applied to sod prior to plowing for corn, but the better practice is to use moderate quantities as a top dressing for wheat and hay. Small applications of superphosphate are made for buckwheat. If superphosphate is not added in the manure applications, it is often used separately on corn and on legume seedings.

Where manure is lacking, about 100 pounds an acre of 4–16–4 or a similar mixture is used on small grains. Heavy applications of 1,000 pounds an acre or more of complete fertilizer of a 1–2–1 ratio are used on potatoes by large producers, but small growers do not fertilize so heavily. The use of lime has increased rapidly in recent years. Preceding the hay in the rotation, many farmers apply about 1 ton an acre of ground limestone. Smaller applications of hydrated lime are favored by some farmers for use on the more fertile soils with limy substrata. The depletion of the natural elements necessary to fertility, the increased acreage of legume hays, subsidies, and more favorable farm prices have encouraged the use of more lime and fertilizer in recent years.

PERMANENT PASTURES

About a fourth of the land in farms in Tioga County is permanent pasture, and of this total 75 percent is on imperfectly to very poorly drained and shallow stony soils of the uplands, including those of the Mardin, Volusia, Chippewa, and Lordstown series. More than half of the remaining permanent pasture is on the poorly drained and strongly sloping soils of the valleys, and the rest is in small areas on the more favorable valley soils. In addition to the open pasture land, there were 15,131 acres of woodland pasture in 1945, chiefly in the uplands.

The pastures on upland soils are of poor quality and consist of poverty oatgrass, paintbrush, goldenrod, blackberry briers, thornapple, and in many places small forest trees. The valley pastures on many of the imperfectly drained soils are of similar composition, but on the wetter soils sedges, reeds, and rushes are common. More nutritious pastures containing a fairly large quantity of bluegrass and white clover are on some of the more favorable valley soils, especially on those that are plowed occasionally. Improvement of pastures by using lime and fertilizer, seeding of better mixtures, and controlling weeds by clipping is not generally practiced. These practices would

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4 Percentages, respectively, of nitrogen, phosphoric acid, and potash.
improve the quality of the grazing, and by increasing the carrying capacity of the pasture, would permit a reduction in pasture acreage.

LIVESTOCK AND LIVESTOCK PRODUCTS

Livestock and livestock products sold, traded, or used by the farm household accounted for nearly 80 percent of the farm income in 1939, and dairy products made up more than half of this amount. Dairy cows are the most important livestock in the county; poultry, mainly chickens, is second. Sheep and hogs were important in the early agriculture but have decreased to very small numbers in recent years. The numbers of important livestock for certain years are shown in table 3.

Table 3.—Livestock on farms in Tioga County, N. Y., in stated years

<table>
<thead>
<tr>
<th>Livestock</th>
<th>1920</th>
<th>1930</th>
<th>1940</th>
<th>1945</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number 1</td>
<td>Number 1</td>
<td>Number</td>
<td>Number 1</td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>26,837</td>
<td>13,583</td>
<td>25,102</td>
<td>30,810</td>
</tr>
<tr>
<td>Horses</td>
<td>6,219</td>
<td>4,023</td>
<td>3,480</td>
<td>3,107</td>
</tr>
<tr>
<td>Mules</td>
<td>204</td>
<td>161</td>
<td>100</td>
<td>43</td>
</tr>
<tr>
<td>Sheep</td>
<td>5,693</td>
<td>8,351</td>
<td>2,264</td>
<td>2,063</td>
</tr>
<tr>
<td>Goats</td>
<td>38</td>
<td>195</td>
<td>88</td>
<td>147</td>
</tr>
<tr>
<td>Swine</td>
<td>4,041</td>
<td>1,706</td>
<td>1,353</td>
<td>2,769</td>
</tr>
<tr>
<td>Chickens</td>
<td>157,124</td>
<td>248,697</td>
<td>272,485</td>
<td>375,987</td>
</tr>
<tr>
<td>Other poultry</td>
<td>2,208</td>
<td>1,222</td>
<td>(8)</td>
<td></td>
</tr>
<tr>
<td>Beeswax</td>
<td>2,866</td>
<td>2,169</td>
<td>1,320</td>
<td>(8)</td>
</tr>
</tbody>
</table>

1 All ages.  
2 Over 3 months old, Apr. 1.  
3 Over 6 months old, Apr. 1.  
4 Over 4 months old, Apr. 1.  
5 Not reported.

Dairy cattle have long been important in the agricultural economy of this county. The number of cows and heifers generally fluctuates according to economic conditions, there being an increase when prices are favorable and a decrease during depressions. The number of cows on each farm has increased, and this tendency to keep larger herds on a small number of farms indicates a trend toward concentration of the dairy industry.

The most intensive dairying is practiced in the valleys where the relatively productive soils permit heavy feed production and where access to markets is easy (pl. 3). Dairying is important in nearly all the county, although the number of dairy animals has decreased greatly in the northeastern and southwestern parts on the poor soils of the higher rougher uplands.

Holstein-Friesians are the principal dairy breed and constitute more than 80 percent of the dairy herds. Ayrshires, Guernseys, and Jerseys make up the rest. Most dairymen now own purebred registered sires or use artificial insemination, and a steady improvement in the quality of dairy animals is reflected by increased milk production for each cow. A few dairymen produce purebred stock for sale.

Practically all the hay, pasture, and silage required for dairy cows is raised on the farms where they are kept, and much of the grain is
Poultry-dairy farm in the Catatonk Valley on Howard and associated soils.
converted to dairy feed. Additional feed, mostly protein supplements, such as cottonseed meal, soybean meal, and other concentrates, is purchased from outside sources. The quantity of feed purchased varies with milk prices; much less is bought when prices are low than when they are high.

The bulk of the milk produced in the county is shipped daily to New York City, where it is sold as market milk. Small quantities of fresh milk are sold in local markets, and some is processed into butter and cheese. In 1945 the production of milk was 12,419,279 gallons, and of this quantity, 11,074,225 gallons, or about 90 percent, was sold as whole milk. In addition farmers reported the sale of 45,773 pounds of butterfat and 21,143 pounds of butter. The sale of butter and butterfat was less than half that reported in 1940.

Horses are the most important of the work stock, although mules are kept on a few farms. In 1945, 1,317 farms reported 3,107 horses, or an average of 2.4 animals to the farm. Most horses are the heavier draft type, mainly Percheron. Few horses are raised in the county, and replacements are shipped in, mostly from the Middle West. Grain and hay are normally raised in sufficient quantity to feed work stock.

The value of poultry and poultry products sold or traded was slightly more than half that of dairy products in 1939. Poultry is kept on about two-thirds of the farms, but the trend in recent years has been toward specialization, or the keeping of larger flocks on fewer and smaller farms. Specialization in poultry raising is combined with dairying, especially in some of the upland areas. Many part-time farmers or rural residents who work in shop or factory or at a part-time trade operate specialized poultry farms.

On the larger farms most of the feed is produced, but some protein supplements are purchased for laying hens and young poultry. On many of the small highly specialized farms nearly all feed is purchased.

Poultry and poultry products are sold mainly in New York City markets, but moderate quantities are sold locally and in the industrial areas of adjoining counties. Small numbers of ducks, geese, and turkeys are kept on a few farms in addition to chickens. The trend in recent years has been toward a decrease in numbers of poultry other than chickens, although there has been a small increase in turkeys. A few farms specialize in turkeys.

Other livestock on farms are swine, sheep, goats, and bees. The number of swine has decreased steadily. The decrease in acreage of corn for grain, lack of surplus milk for hog feed, competition from more efficient hog producers in the Middle West, and concentration of interest in dairying have contributed to the decline. Chester White, Duroc, and Berkshire are the principal breeds of swine. Swine are kept in small numbers on farms in all parts of the county, but more are kept on the smaller subsistence or general farms than on the large dairy farms. Most swine are slaughtered and consumed on the farms where they are raised, but some are sold in local markets. Considerably more pork is consumed in the county than is grown.

Interest in sheep decreased with the growth of dairying. Winter housing and feeding of sheep is necessary and production costs are therefore so high that competition with western sheep growers is prevented. Sheep, mostly grade Shropshires, are generally kept in
the higher uplands where large areas of native pasture are available. Lambs are sold to local dealers. The 1939 wool clip was 14,023 pounds. Goats are unimportant. In 1940 the honey production was 60,871 pounds, but the number of beehives has been decreasing steadily.

TYPES OF FARMS

Farms are classified into types according to the enterprises that provide the main source of income. In 1940 about 92 percent of all the farms were classified: Dairy, 910; subsistence, 584; poultry, 366; livestock, 90; field crops, 58; vegetables, 6; horticultural specialties, 7; and forest products, 20. Dairying was the important enterprise on about 43 percent of these; production of food for the farm family was the main pursuit on 27 percent; and poultry raising was of first importance on 4 percent.

LAND-USE CHANGES

Land in farms reached a maximum acreage at the beginning of the present century, declined gradually until 1940 (8), and then increased slightly. A total of 264,229 acres, or about 78 percent of the county, was in 2,076 farms in 1945. Of the total land in farms, 118,960 acres, or about 45 percent, was cropland; 23 percent, woodland; 25 percent, pasture; and 7 percent, idle, in feed lots, farmyards, and other miscellaneous uses.

Of the 101,473 acres of land not in farms, about 60 percent is in forest. Most of the remaining 40 percent is probably abandoned farm land, but a small percentage is in urban areas, rural residences, cemeteries, roads, and other miscellaneous uses. Most of the land not in farms, other than that in urban areas, is on the more strongly sloping uplands. The cropland is confined largely to the soils of the valleys and to the smoother uplands, whereas the permanent pastures and farm woodlands are on the more strongly sloping, stony, and imperfectly and poorly drained soils of the uplands.

The decrease in land area in farms has been confined entirely to the higher upland areas on the Volusia, Mardin, and Lordstown soils. Several social and economic factors have contributed to the gradual abandonment of the upland areas. The soils are low in productivity as compared with those more fertile and more easily worked; returns are low, considering the capital invested and the relatively high wages offered by industry; and the areas are so far distant from more thickly populated centers that the social contacts and economic advantages of more accessible areas are lacking.

The slight increase in land in farms between 1940 and 1945, likely stimulated by very favorable farm prices during that period, resulted mainly because of greater use of poor upland soils. This trend may reverse itself with the restoration of normal economic conditions, and the abandonment of large areas of these marginal lands may continue (8).

Both acreage in farms and number of farms have declined steadily since the beginning of the present century. The average size of farms, however, has increased from 110 acres in 1920 to 127 acres in 1945.

The number of farms of 180 acres or more has increased slightly, whereas the number of smaller farms has somewhat decreased. Ex-
ceptions among the smaller farms are those of less than 3 acres, as they increased in number between 1940 and 1945. The general trend seems to be toward farms of larger size, and this is likely related to the abandonment of farms in the uplands and the consolidation of two or more farms in one unit.

The area of harvested cropland increased from 85,459 acres in 1929 to 87,077 acres in 1944. The proportion of harvested cropland was higher on smaller farms than on the larger in 1944. On farms 10 to 179 acres in size, 51.8 percent of the area was harvested cropland; and on those 180 to 499 acres in size, 41.8 percent. On farms of more than 500 acres only 6 percent was harvested cropland.

Changes in the number and size of farms and in the total acreage of land in farms have been accompanied by changes in use of land. The acreage in forest gradually decreased until about 1900. The clearing of new land continued until the decline of lumbering activities, but in recent years the trend has reversed. Abandonment of the poorer upland soils has lead to a moderate increase in the forested areas.

Data on land use are given in table 4 for 1937–38.

Distribution of cropland, meadow, idle land, pasture, woodland, and land used for urban sites is by no means even. More than 90 percent of the forest and 90 percent of the idle land is in the high uplands on the Lordstown, Mardin, Volusia, and Chippewa soils. The rest of the forested and the idle land is mostly on the steep and poorly drained soils of the valleys. About two-thirds of the pasture is on upland soils, although some good pasture is on the more poorly drained soils of the valleys. About 60 percent of the cropland is on the higher uplands. Proportionately the upland soils are used to a small extent for crops, whereas the productive soils in the valleys are mostly in crops.

FARM TENURE

In 1945, 1,688 farms were operated by owners, 302 by part owners, 6 by managers, and 80 by tenants of all kinds. Nearly 95 percent of the farms are therefore operated by owners and part owners, only about 4 percent by tenants, and less than 1 percent by managers. The proportion of farms operated by tenants has always been small, and the trend has been toward a decrease in tenancy.

Slightly more than half the tenants paid cash rent in 1945, about a fourth rented on shares, and the rest rented on a share-cash or other basis. The rental system varies with different farms, depending on numbers and kinds of livestock and other factors, but the terms are commonly adjusted so that the owner receives about one-half of the farm returns.

FARM INVESTMENTS AND EXPENDITURES

Work stock and farm machinery are adequate on most farms. The larger farms in the valleys are relatively much better equipped than those in the uplands. In recent years tractors and trucks have replaced horses on most farms. In 1940 there were 649 farms using 681 tractors; in 1945, 1,015 farms used 1,133. Trucks increased in like proportion. Small to medium-sized tractors with rubber tires are commonly used. The greatest number of tractors and trucks are on the larger farms in the valleys, but they are also used on most of the
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1 Compiled from detailed acreage measurements made on soil survey field sheets by the Soil Conservation Service, U. S. Department of Agriculture.
TABLE 4.—Percentage of soils in certain uses in Tioga County, N. Y., 1937-38—Continued

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larger farms in the uplands. On the tractor-powered farms, combines for harvesting grain and seed crops, corn binders, mechanical corn pickers, hay loaders, side-delivery rakes, and other modern machinery are used for most operations.

Feed for livestock has been the most important item of expense on Tioga farms in recent years, both in total expenditure and in number of farms reporting purchases. In 1945 a total of $2,709,722 was spent for feed, an average expenditure of $1,500 for each farm. The increase in intensive dairying and poultry production is the probable cause of
this larger expenditure. On many of the specialized poultry farms nearly all the feed is purchased rather than raised.

Wages of hired labor are the second largest expenditure, but there has been a moderate decrease in the number of farms hiring labor. In 1940, 1,046 farms paid a total of $512,773 in wages, or an average of slightly more than $500 a farm.

The number of farms reporting expenditures for lime and fertilizer material has increased moderately. In 1940, 1,067 farms used 11,634 tons of liming material, and 1,102 farms, 2,781 tons of fertilizer.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field. The soil scientist walks over the area at intervals of not more than one-quarter mile apart and bores into the soil with an auger or digs holes with a spade. Each such boring or hole shows the soil to consist of several distinctly different layers, called horizons, which collectively are known as the soil profile. Each layer, or horizon, is studied carefully for the things about it that affect plant growth.

The color of each layer is noted. The darkness of the topmost layer is usually related to its content of organic matter; streaks and spots of gray, yellow, and brown in lower layers generally indicate poor drainage and poor aeration. Texture, or the content of sand, silt, and clay in the layer, is determined by the feel of the soil and is checked by mechanical analysis in the laboratory. Texture has much to do with the quantity of moisture the soil will hold available to plants, whether plant nutrients or fertilizer will be held by the soil in forms available to plants or will be leached out, and how hard the soil may be to cultivate. Structure, or the way the soil granulates, and the proportion of pore or open space between particles indicate how easily plant roots can penetrate the soil and how easily water enters it. Consistence, or the tendency of the soil to crumble or stick together, indicates how difficult it is to keep the soil open and porous under cultivation. The kind of rocks from which the soil has been developed, or its parent material, affects the quantity and kind of plant nutrients the soil may have naturally. Simple chemical tests show how acid the soil may be. The depth to bedrock or to compact layers is determined. The quantity of gravel or stones that may interfere with cultivation, the quantity of soil lost by erosion, and other external features are observed.

On the basis of all these characteristics, soil areas that are much alike in kind, thickness, and arrangement of their layers are mapped as one soil type. Some soil types are separated into two or more phases. For example, many of the soils of Tioga County have slopes that range from 1 to 30 percent. Where the slope pattern is simple, they are mapped in three phases, a gently sloping phase (0 to 5 percent), a sloping phase (6 to 15), and a moderately steep phase (16 to 30). Where the slope pattern is complex the terms undulating, rolling, and hilly are used as the slope phase names. A soil that has been

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5 The reaction of the soil is its degree of acidity or alkalinity, expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality; higher values, alkalinity; and lower values, acidity.
eroded in places may be mapped in two or more phases, an uneroded or normal phase (denoted by the name of the soil type only), an eroded phase, and perhaps a severely eroded phase. A soil type may be broken into phases primarily because of differences in the soil other than those of kind, thickness, and arrangement of layers. The slope of a soil, the frequency of outcropping bedrock, the extent of erosion, or artificial drainage are examples of characteristics that might cause a soil type to be divided into phases.

Two or more soil types may have similar profiles; that is, the soil layers may be nearly the same, except that the texture, especially of the surface layer, may differ. As long as the other characteristics of the soil layers are similar, these soils are considered as belonging to the same soil series. A soil series, therefore, consists of all the soil types that have about the same kind, thickness, and arrangement of layers, except for texture, particularly of the surface layer, whether the number of such soil types be only one or several.

To illustrate, Woosern is the name of a moderately deep friable well-drained gravelly soil series found on deposits of moderately compact acid glacial till. The Woosern soils are relatively uniform in texture and only one type, the gravelly silt loam, is recognized in this county. This soil type occupies a wide range of slope, however, and, on the basis of slope, is divided into four phases—undulating, rolling, hilly, and steep.

When very small areas of two or more kinds of soil are so intricately mixed that they cannot be shown separately on a map of the scale used, they are mapped together as a unit, as for example, Fremont and Volusia channery silt loams, gently sloping phases.

Areas, such as bare rocky mountainsides, coastal beach, or dune sand that have little true soil are not designated with series and type names but are recognized as miscellaneous land types and are given descriptive names, such as rough stony land, coastal beach, dune sand, riverwash, gravel pits, and similar designations. Steep stony land, (Lordstown soil material) is such a land type in Tioga County.

The soil type, or where the soil type is subdivided, the soil phase, is the unit of mapping. It is the unit or the kind of soil that is most nearly uniform and has the narrowest range of characteristics. For this reason land use and soil management practices can be more definitely specified for it than for broader groups of soil that contain more variation. One can say, for example, that soils of the Woosern series need lime for alfalfa; but Woosern gravelly silt loam, undulating phase, has mild slopes, and in addition to needing lime, is suited to row crops in a short rotation with small grain and hay, whereas Woosern gravelly silt loam, hilly phase, has slopes that fall more than 15 feet in 100, is hard to work with heavy machinery, erodes easily, and should be used principally in long-term hay or pasture. Both are included in the Woosern series.

SOILS

The soils of Tioga County were formed under an environment of cool temperate climate and mixed hardwood forests from material derived chiefly from the weathering of acid sandstone and shale. Because of the relative uniformity of origin, the soils have many features in common. All of them, with the exception of the Howard
soils, which have alkaline subsoil, are medium to strongly acid throughout their profile. All are light- to medium-textured and contain a relatively large quantity of gravel or angular stone fragments. They are generally low to medium in organic matter, low in phosphorus and nitrogen, and probably somewhat deficient in potassium.

Although relatively uniform in general properties, the soils exhibit rather wide variations because of differences in physiographic position, manner of deposition of parent material, slope, drainage, and age. About 42 percent are well drained, 24 percent imperfectly drained, 30 percent poorly drained, and 4 percent very poorly drained. About 7 percent of the soils are subject to annual overflow. Two percent are severely eroded; about 65 percent, moderately eroded; and 33 percent, uneroded or only slightly eroded.

Because of differences in characteristics the soils vary widely in suitability for agriculture and in management requirements. In general about 9 percent have been rated as excellent to good; 32 percent, good to fair; 43 percent, fair to poor; 4 percent, poor; and 12 percent, very poor. More than 80 percent of the land can be used for crops; but all the soils have deficiencies, and on more than half of the land suitable for crops, these deficiencies are serious enough to limit the kinds of crops that can be grown and to make necessary exacting management practices.

The soils of this county are generally lower in lime and plant nutrients than those in the high-lime belt of central New York. On the average they are also more stony, more strongly sloping, and somewhat less favorable in moisture conditions. They compare favorably with soils of counties in southern New York and northern Pennsylvania but are definitely lower in lime and organic matter than the darker colored soils of the Corn Belt area of the Midwestern States.

SOIL SERIES AND THEIR RELATIONS

A soil series is a group of soils having similar genetic layers, except for the texture of the surface soil, similar arrangement of layers in the soil profile, and similar parent material (15). Members of a soil series may have moderate variations in texture and may have a wide range of relief. The relations of the soil series are shown in figure 2.

The soils of Tioga County are classified in 17 series according to differences in parent material, drainage, age, and related profile features. To show relations of the series to each other they are placed in four groups on the basis of their position as follows: (1) Soils of glaciated uplands; (2) soils of glacial outwash terraces; (3) soils of postglacial terraces; and (4) soils of stream-bottom lands.

The soils of glaciated uplands are on the higher lands above the stream valleys. They are underlain by glacial till that ranges considerably in thickness, and the till is in turn underlain by level-bedded acid sandstone and shale bedrock. On the basis of good, moderate, poor, and very poor drainage the soils of the glaciated uplands are divided into four subgroups.

The soils of glacial outwash terraces occupy valley positions at elevations considerably lower than those of the uplands but well above the level of present stream overflow. Their parent materials
Figure 2.—Cross section showing position, topography, and parent material of the soil series of Tioga County, N.Y.
are deposits of sand, silt, and gravel, generally many feet thick, carried out from the glaciers by streams flowing from the melting ice. Soils of glacial outwash terraces are placed in four subgroups on the basis of good, imperfect, and poor drainage.

The soils of postglacial terraces have been deposited by the present streams in positions intermediate between the older glacial outwash terraces and the present flood plains and in places may be subject to overflow in times of extremely high floods. This group is formed from silt, sand, and gravel many feet thick. All the stream-terrace soils have good drainage, and subgroups are not recognized.

The soils of stream-bottom lands are on the flood plains of the stream valleys. They are derived from recent deposits of somewhat stratified sand, silt, and clay that are many feet thick. This group is divided into three subgroups on the basis of good, moderate, and very poor drainage.

SOILS OF GLACIATED UPLANDS WITH GOOD DRAINAGE

The soils of the glaciated uplands with good drainage—members of the Lordstown, Bath, and Woostern series—are widely distributed over the entire upland. They form the largest group of soils and cover about a third of the county.

The Lordstown soils have a grayish-brown surface soil and a yellowish-brown subsoil and contain large quantities of rock fragments. The underlying glacial till is shallow, and consolidated sandstone bedrock is at depths of 3 feet or less in most places. The Bath soils are similar to the Lordstown in color of both surface and subsoil but have a much thicker and more compact underlying layer of till. The Woostern soils resemble the Bath but contain mostly rounded gravel rather than angular fragments of stone, and the till is not so compact as that under the Bath soils.

SOILS OF GLACIATED UPLANDS WITH MODERATE DRAINAGE

The Mardin and Canfield are the glaciated upland soils with moderate drainage. They cover about 20 percent of the county and occur on all the uplands. The two series differ mainly in parent material and position. The Mardin soils are from compact channery glacial till composed mainly of local sandstone and shale occurring on the higher uplands. The Canfield soils are at lower elevation, and the till is deeper and contains more material from distant places.

SOILS OF GLACIATED UPLANDS WITH POOR DRAINAGE

The soils of glaciated uplands with poor drainage are members of the Volusia, Fremont, and Allis series. They are on the smooth flats or long smooth gentle slopes in uplands and are differentiated chiefly in parent material, color, depth, and degree of hardpan. The Volusia soils are from compact glacial till of medium depth. This till is entirely of local origin in areas associated with Mardin soils but contains some foreign material where associated with the Canfield soils. Volusia soil is grayish throughout and has a very strongly expressed hardpan. The Fremont soil is at higher elevations than are the Volusia and is derived from glacial till entirely of local origin. It is browner than the Volusia soils, and its hardpan is deeper and possibly less strongly expressed.
TIoga COUNTY, New York

The Allis soil is developed on very shallow glacial till derived from acid brittle shale, and consolidated bedrock is at a depth of 3 feet or less.

SOILS OF GLACIATED UPLANDS WITH VERY POOR DRAINAGE

The soils of the glaciated uplands with very poor drainage are those of the Chippewa series and Muck. They occupy depressions on broad flats in the uplands. The Chippewas are gray mottled mineral soils that are waterlogged most of the year. Muck consists of a few feet of moderately well-decomposed organic deposits overlying acid mineral soil material.

SOILS OF GLACIAL OUTWASH TERRACES WITH GOOD DRAINAGE

The Howard and the Chenango are soils of the glacial outwash terraces with good drainage. They are in many of the larger valleys on nearly level to steep well-drained slopes formed from deposits of glacial outwash (pl. 4). The soils of the two series are similar in most profile characteristics, but Howard soils are alkaline in the lower subsoil and calcareous in the substratum, whereas Chenango soils are acid in both the subsoil and substratum. The Howard soils are generally somewhat brownish, especially in the subsoil, than the Chenango and commonly have a heavier textured layer above the gravel parent material. The soils of both series have a wide range of use suitability and respond to good management. They are the most important agricultural soils in the county.

SOILS OF GLACIAL OUTWASH TERRACES WITH IMPERFECT DRAINAGE

The Braceville is the only soil of the glacial outwash terraces with imperfect drainage. It is closely associated with Chenango soils but differs from them in being less well drained and in having properties associated with poorer drainage.

SOILS OF GLACIAL OUTWASH TERRACES WITH POOR DRAINAGE

The only soil of the glacial outwash terraces with poor drainage is the Atherton. It is an unimportant soil associated with members of the Chenango and Braceville series and occupies the most poorly drained positions on the outwash terraces.

SOILS OF POSTGLACIAL TERRACES

The low-terrace, or high-bottom, soils of postglacial terraces are all well drained and are members of only the Unadilla series. The terraces on which Unadilla soils developed are lower and younger than those of the Chenango soils and are notably free of gravel in the upper 3 or 4 feet.

SOILS OF STREAM-BOTTOM LANDS

The soils of the stream-bottom lands belong to three series—the Tioga, Middlebury, and Holly—and Alluvial soils, undifferentiated. These soils, like those of other groups, are divided into three subgroups on the basis of drainage difference, but the subgroups are not listed separately here because only one series is in each drainage class. All of the soils are on stream-bottom lands and are derived from recently
deposited young alluvium. They have very weakly expressed soil profile features.

**DESCRIPTIONS OF SOIL UNITS**

In the following pages the soils of the county are described in detail, and their agricultural relations are discussed. Their location and distribution are shown on the accompanying soil map, and their acreage and proportionate extent are given in table 5.

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<th>Acres</th>
<th>Percent</th>
<th>Soil</th>
<th>Acres</th>
<th>Percent</th>
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1 Less than 0.1 percent.

**ALLIS SERIES**

Allis soil occupies poorly drained positions in small widely separated areas throughout the higher uplands and is associated with Volusia and Mardin soils. It differs from Volusia soils, as it is developed almost entirely from material derived from acid brittle shale and is shallower, generally less than 3 feet, over rock. Shallowness to underlying rock, poor moisture conditions, and deficiency of plant nutrients make the Allis soil poor for crops or for pasture. Only one type, Allis channery silt loam, gently sloping phase, is mapped. Because of its limited use suitability and small area, this soil is of little agricultural importance.
Water-rounded gravel in Howard and Chenango soils. Gravel content of these soils is high enough in some places to interfere with tillage.
Small strip of poorly drained Atherton silt loam at the base of an upland slope where water is plentiful; better drained Chenango and Braceville soils in the foreground.
Allis channery silt loam, gently sloping phase (3–8% slopes) (Acl).—This shallow poorly drained soil is in small irregularly shaped areas or narrow strips. Areas are widely separated throughout the uplands but somewhat concentrated in the eastern part of the county. The soil is generally on smooth slopes of glacially scoured rock terraces or benches and in many places is at the edge of smooth slopes breaking to stronger ones. The parent material is thin compact acid glacial till derived from the gray to olive level-bedded brittle shale that underlies the soil at depths of 3 feet or less. This shallow depth to rock, the impervious nature of the soil, and seepage from adjacent high slopes contribute to poor drainage.

The original vegetation consisted of hardwood forest, chiefly maple, elm, and other moisture-loving trees. Most of the soil has been cleared, and the effects of native vegetation have been modified to some degree by tillage.

Profile in a tilled or pastured field:

0 to 6 inches, light yellowish-brown friable silt loam with a small to medium quantity of organic matter.
6 to 12 inches, pale-yellow moderately friable to somewhat brittle silt loam, faintly mottled with shades of gray; permeable to air, water, and plant roots.
12 to 24 inches, hardpan layer of heavy silt loam to silty clay loam; material very compact in place but breaks into large blocky lumps when removed that are difficult to break but shatter into smaller fragments under strong pressure; material dominantly yellow but strongly mottled with gray and yellowish red.
24 to 30 inches, dense compact shaly yellow silt loam, strongly mottled; material brittle and more easily crushed to a friable mass than the hardpan layer.
30 inches +, level-bedded gray to olive brittle acid shale interbedded with fine-grained sandstone and siltstone.

This soil is strongly to very strongly acid throughout, except where lime has been applied. The entire profile contains moderate to large quantities of sandstone and shale fragments. The relatively impermeable hardpan and shallow depth to rock combine to create very poor moisture conditions for crop plants. During fall, winter, and spring the whole profile is saturated with water; but in summer, when rainfall is lower and evaporation and transpiration losses are greater, the entire soil is very dry because of the low reserve supply of water and slow movement of moisture.

The soil varies from 18 to 36 inches or more in depth to rock; forested areas are covered with 1 to 3 inches of litter, and the upper inch or two is stained brownish gray with organic matter. A few small areas are free of channers, and in the eastern part of the county the stone fragments are large flags.

Use and management.—The impermeable hardpan, poor drainage, strong acidity, and low natural fertility of Allis channery silt loam, gently sloping phase, combine to limit seriously its use suitability. About 25 percent of the land is in woodland, 40 percent in pasture, and 20 percent in crops. Most of the rest is idle. Mixed hay and buckwheat are the chief crops, but some corn and small grain are grown in places.

*A channery soil contains thin, flat fragments of sandstone, limestone, or shale, measuring up to about 6 inches along the longer axis.
The cropped areas are used in long rotations. Corn for silage is followed by oats or buckwheat, and the land is then seeded to mixed hay that remains 4 to 6 years. Some fertilizer and manure are applied to corn or grain crops, but little of the soil is limed at regular intervals. Hay seedings generally contain some clover, but after the second year the stand consists almost entirely of timothy mixed with wild grasses and weeds. Average acre yields of 0.8 ton of hay and 11 bushels of buckwheat can be expected.

Most pastures consist largely of timothy mixed with poverty oatgrass, paintbrush, and various other weeds. Ordinarily neither fertilizer nor lime is applied to pastures, but in places some manure is added. Grazing is fair to good on these pastures in spring, but it is dry and poor in summer, and in fall the less palatable weedy plants are common.

Because of poor drainage, low natural fertility, strong acidity, and shallow depth, this soil is poorly suited to many crops. It is best suited to hay and pasture in which Ladino clover, timothy, and wild white clover are the chief forage plants. Birdsfoot trefoil is a legume tolerant of the soil conditions. All hay and pasture crops require 1 ton of lime an acre at about 5-year intervals and heavy applications of phosphorus.

Engineering structures for water control are not commonly used. Hillside ditches to divert runoff and intercept seepage have been built in a few places. Drainage might be improved by building diversion terraces on the deeper areas of this soil, and if this were done tilled crops could be successfully grown in a long rotation. A suitable rotation would be silage corn, oats, and 4 to 6 years of hay. As on pastures, heavy applications of phosphorus and lime would be needed for good production.

ALLUVIAL SOILS, UNDIFFERENTIATED (O-3% SLOPES)

Alluvial soils, undifferentiated (A), is made up of areas of young soils relatively unimportant because of their limited range of use suitability. They occur in relatively long narrow strips on the bottom lands of many of the small streams in all the strongly dissected uplands of the county. The small stream valleys are nearly flat, but the walls are commonly steep, and the valleys have a fairly strong downstream slope. The stream channels meander and lace the narrow bottom lands and cut the soil areas into many small segments. Drainage varies from imperfect to poor.

The parent material is recent alluvium of local origin that contains imperfectly stratified silt and sand and a large volume of channers, gravel, and flags. The soils of the adjacent uplands are members of the Lordstown, Mardin, Volusia, and Chippewa series.

The original forest vegetation consisted of elm, soft maple, sycamore, willow, and other moisture-loving trees. In some of the wetter areas cattails, sedges, pussy willow, and other water-tolerant plants are common.

All the soils of this separation are young and do not have definitely expressed genetic profiles. In general they have properties ranging from those of the Middlebury soils to those of the Holly, but in places they consist of 2 or 3 feet of rather loose channery loam. Mottling
extends to the surface in much of the soil, but it is usually not encountered above depths of 18 inches. In some places small areas of soil as well drained as the Tioga soils are included, and some small very poorly drained areas have mucky surface layers. Compact beds of gravel or channers at depths of 2 to 3 feet are common in many places.

Use and management.—Stoniness, unfavorable moisture conditions, and strong acidity prevent the use of much of Alluvial soils, undifferentiated, for crops. Slightly more than half the area is in pasture; about 30 percent is in woodland; small areas, about 10 percent of the total, are idle or wasteland; and the rest is in crops, principally corn and mixed hay.

Crops are confined to the better drained small Tioga-like or Middlebury-like areas, generally as small inclusions in fields predominantly on soil of the adjacent uplands or terraces. Soil and crop management practices in these areas are the same as those on the other soils in the field.

This land is physically best suited to pasture or forest. On the more favorable sites good stands of wild white clover mixed with timothy and bluegrass are common; on the less well-drained areas the mixture consists mainly of native coarse grasses and weeds; and in the wettest places reeds, sedges, cattails, pussy willow, and other water-loving plants prevail. Because of a more abundant water supply, pastures on these alluvial soils have the advantage of not drying up and becoming dormant during the warm summer, but they remain wet long in spring and are subject to "punching" by the hoofs of animals.

Pastures do not ordinarily receive any special management. Lime and phosphorus should be applied, although fair grass-legume pastures can be obtained without them in many places. Most of the forested area is so poorly drained that good pastures cannot be established. Such areas should remain in woodland. The idle and wasteland areas are also best used if allowed to revert to forest. The small better drained areas are suited to corn, mixed hay, and possibly small grain. Their management requirements are similar to those for the Tioga and Middlebury soils.

ATHERTON SERIES

Atherton soil occurs chiefly as long narrow strips in small depressed areas along the small intermittent drainageways of the terraces. It is unimportant in the agriculture of the county because of its small area and limited use suitability. Most of it is in pasture of native grasses, sedges, and woody plants. Only one type, Atherton silt loam, is mapped.

Atherton silt loam (0–3% slopes) (A1).—This gray mottled very poorly drained soil occurs in many widely separated small areas on the outwash terraces of the larger stream valleys. It is associated with Braceville soil and differs from it principally in having poorer drainage and the properties associated with very poor drainage. It is unimportant in the agriculture of the county.

The soil is on nearly level land or in shallow depressions in glacial terraces (pl. 5). In many places it lies immediately adjacent to the uplands where moderate to large quantities of seepage are received from the slopes. Chenango and Braceville soils are on the associated
better drained terraces; Lordstown and Woostern are on the nearby steep uplands.

The parent material of this soil is acid glacial outwash of sand, gravel, and silt. The quantity of fine material is greater than in the associated Chenango and Braceville soils. In many places, significant quantities of recent local slope-wash from adjacent uplands have contributed to the soil. Most of the soil was formed under forests of soft maple, elm, willow, and other water-tolerant trees.

Profile description under pasture cover:

0 to 8 inches, brownish-gray moderately friable silt loam mottled with yellow and brown; material fairly high in organic matter and typically contains fragments of party decomposed plant roots, stems, and leaves.

8 to 14 inches, light-gray heavy silt loam of fairly distinct blocky structure that contains few plant remains.

14 to 30 inches, light-gray massive compact heavy silt loam to light silty clay loam, strongly mottled with yellow and brown.

30 inches +, gray sandy clay or silt loam interbedded with sand and gravel.

The soil profile is acid throughout in all areas except those mapped in association with the Howard soils, which are alkaline to calcareous in the last layer. On some of the wettest areas the surface soil is very high in organic matter to a depth of several inches and nearly black when moist.

Use and management.—Very poor drainage and strong acidity limit seriously the use of Atherton silt loam. About two-thirds of the land is in pasture; several small areas are in woodland; and most of the rest is idle or wasteland. Idle areas are generally small patches included in fields with better drained soils that are cropped. The quality of pasture on most of this soil is poor, for the stand consists chiefly of sedges and coarse marsh grasses. In the best-drained places wild white clover and bentgrass are fairly common. Pasture improvement on most of this soil is difficult without artificial drainage. In places reed canary grass could be planted, and tile drainage of small spots in cultivated fields is justified if it simplifies tillage operations on the field as a whole.

BATH SERIES

The Bath soils are in small areas on the glaciated uplands in the northeastern part of the county. They are closely associated with the Lordstown soils and are similar to them in color of surface soil and subsoil, but their underlying till is much firmer and deeper, as it extends downward 5 to 10 feet or more.

The Bath soils are not important for they make up less than half of one percent of the county area. The total area is about equally divided between these two phases.

The moisture-supplying capacity is relatively much more favorable on Bath soils than on the Lordstown. Management requirements are concerned chiefly with maintaining or increasing the supplies of lime, phosphorus, potassium, and organic matter and with conserving the soil material and moisture. Only two phases of Bath channery silt loam, the moderately steep phase and the sloping phase, are mapped.

Bath channery silt loam, sloping phase (6–15% slopes) (Bcs).—This grayish-brown well-drained deep acid soil occupies smooth well-drained higher slopes in strongly dissected parts of glaciated
uplands. Most of it is in small- to medium-sized irregularly shaped areas in the northeastern part of the county. It is closely associated with members of the Lordstown series and is of minor importance to agriculture because of its small area.

The parent material is compact olive to gray acid channery glacial till derived from the underlying acid gray sandstone and brittle shale. This material is similar to that of the Lordstown soils but is much deeper, the depth to rock ranging from 5 to 10 feet or more. The original vegetation was beech, hard maple, and white ash, with smaller numbers of white pine, oak, and hickory.

Profile description in a slightly to moderately eroded cultivated field:

0 to 8 inches, grayish-brown very friable channery silt loam with a moderate quantity of well-decomposed organic matter.

8 to 28 inches, yellowish-brown very friable channery silt loam.

28 inches +, olive to gray compact acid glacial till with a large number of channers; fine material is loam to silt loam with some yellow and brown mottling.

The soil is strongly to very strongly acid throughout. It is easily permeable to air, roots, and moisture; but the medium texture retains sufficient moisture for plants. In forested areas the surface of the soil is covered with 1 to 2 inches of leaves, twigs, and other plant debris, the topmost layer of which is brownish-black to black well-decomposed organic matter, heavily matted with rootlets and underlain by ½ to 1 inch of ashy-gray loose silt loam. The rest of the forested profile is essentially the same as that of the cultivated. Several small areas are characterized by large flaggy stone fragments rather than the smaller channers.

Use and management.—The friability, favorable moisture content, and smooth slopes of Bath channery silt loam, sloping phase, make it suitable for a large number of crops, but strong acidity and low natural fertility make it somewhat exacting in management requirements. Slightly more than half of the soil is in crops; about 40 percent is in woodland; and the remaining small areas are idle or in pasture. Mixed hay, small grain, potatoes, and corn are the important crops.

The common rotation of this soil is corn, followed by oats, which are seeded as a companion crop for timothy and clover. The hay crop remains for 2 to 4 years or more. In the longer rotations the clover dies out and the old meadows are then pastured rather than mowed. Barnyard manure is applied before plowing for corn, and some may be used as a top dressing on small grain. In addition, some farmers apply superphosphate to corn and grass. Lime is applied at the rate of 1 to 2 tons an acre once in the rotation prior to the hay seeding by some farmers, but liming is not universally practiced. Where potatoes are grown commercially, large quantities of complete fertilizer are used.

Good drainage, smooth slopes, and friable soil allow prompt and easy tillage. Contour tillage and strip cropping are practiced by a few of the more progressive farmers, but tillage up and down rather than across slopes is common.

Average yields under ordinary management are corn for silage, about 7.2 tons; wheat, 18 bushels; and clover and timothy, 1.2 tons.
Potatoes average about 180 bushels an acre, but commercial growers who fertilize heavily obtain yields of 300 bushels or more.

Good physical properties make this soil suitable for most of the common crops of the county, but corn for grain may not mature in many years because of the short growing season, and alfalfa cannot be grown successfully unless the soil is limed regularly. A 4- to 6-year rotation of row crops, small grain, and hay is well suited to the soil. Required amendments for each rotation are about 8 to 10 tons of manure, together with 600 pounds of 20-percent superphosphate; 150 pounds of muriate of potash; and 1 ton of lime.

Contour tillage should be practiced where feasible to conserve moisture and soil material, and strip cropping may be necessary on the longer, more sloping fields. Pastures can be maintained at a high level of fertility by application of about 1 ton of limestone and 600 pounds of 20-percent superphosphate every 5 years.

**Bath channery silt loam, moderately steep phase (16–25% slopes)**

This soil differs from the sloping phase of Bath channery silt loam mainly in occupying steeper slopes, but the upper soil layers may be slightly thinner and the content of stone fragments greater. It differs from Lordstown soils on comparable slopes in having a greater depth of soil material over bedrock.

The soil is on well to somewhat excessively drained slopes in the higher uplands, is underlain by acid compact moderately deep glacial till, and was formed under a mixed forest of beech, maple, and some oak, hickory, and pine. It occurs in small- to medium-sized irregularly shaped areas, chiefly on the higher uplands in the northeastern part of the county, and is associated with the sloping phase of Bath channery silt loam and with Lordstown soils.

The soil profile is similar to that of the sloping phase, except that more material has been lost through erosion. The 6- to 8-inch surface soil is grayish-brown very friable silt loam, and the subsoil is very friable yellowish-brown silt loam. Olive to gray compact acid till begins at 24 to 30 inches and extends to 10 feet or more. The entire profile is strongly acid and contains a large number of channery sandstone fragments. Forested areas have nearly black and light-gray upper surface layers like those of the sloping phase. Several areas with large flaggy stone fragments on the surface and in the soil are included.

**Use and management.**—The strong slopes of Bath channery silt loam, moderately steep phase, limit its use. A third of it is in woodland. The cleared part is about evenly divided between pasture and idle land, but some small areas are in crops. Corn, wheat, buckwheat, and hay are the common crops. The hay seeding used is timothy and clover, and the stand is cut the first 2 or 3 years for hay. On many farms the stand is left for several more years, and sometimes it is used for pasture until the remaining timothy is crowded out by weeds. The soil is then plowed and planted to corn followed by wheat or oats. Manure, if available, is applied to corn, but amendments are not commonly used on the hay.

Most permanent pastures consist of poverty oatgrass, paintbrush, and other weeds; but where lime and phosphorus are used, good stands of tame grasses and legumes are obtained. Where fields are not regularly grazed, thornapple and wild blackberries soon become established
and then follows the encroachment of small forest trees. An acre of average pasture will provide about 35 days of grazing for one cow during the year.

Because of the relatively strong slopes, moderate erosion, and susceptibility to further erosion, the soil is best used for pasture. Where it is used for crops, long rotations, preferably without a row crop, should be followed. Application of lime is essential for success with legumes. Additional supplies of potassium in amendments are also needed on most areas. Strip cropping and contour tillage are generally needed where the soil is used for rotations that include row crops.

**BRACEVILLE SERIES**

The Braceville soil is moderately well drained and is derived from acid gravelly glacial outwash. It occupies nearly level to somewhat depressed positions on the glacial outwash terraces. Only one type, Braceville gravelly silt loam, is mapped.

**Braceville gravelly silt loam** (0–3% slopes) (Bo).—This is an imperfectly drained acid soil of low natural fertility. It occurs in many small areas, generally in relatively long narrow strips, and mainly on the outwash terraces in the Susquehanna River Valley. To some extent it is represented in a few of the other larger valleys. It is closely associated with the Chenango soils, is suited to rather intensive use, but is of only moderate agricultural importance because of its small total area.

The soil is on nearly level slopes or slightly depressed positions on glacial outwash terraces and in many places is close to adjacent uplands where seepage and surface runoff are received (pl. 6). Runoff is slow, but water seldom stands on the soil. Internal drainage is impeded by a compact lower subsoil. The parent material consists of stratified silt, sand, and gravel. The original forest vegetation was elm, maple, sycamore, and other species tolerant of moist sites.

Profile description in a cultivated field:

0 to 8 inches, grayish-brown friable silt loam with a moderate quantity of well-decomposed organic matter.

8 to 20 inches, pale-yellow to light yellowish-brown friable silt loam, commonly mottled with rust brown below a depth of 12 or 18 inches.

20 to 30 inches, moderately compact olive-gray silt loam to light silty clay loam, heavily mottled with yellowish brown, brown, and gray.

30 inches +, gray to yellowish-brown silt and sand; with increasing depth gravel layers are encountered and the material becomes loose and open.

The entire profile is strongly to very strongly acid. A moderate quantity of gravel occurs throughout, but the soil is typically less gravelly than most of the associated Chenango soils. Its upper layers allow air and moisture to move freely and they are easily penetrated by plant roots, but the hardpan is very slowly permeable to water and air and few roots enter it.

Two or three small areas east of Waverly that were included with this soil would be more properly classified in the Caneaede series, but they are too small to justify separation. These areas are derived from moderately heavy gray clays laid down in the quiet waters of lakes or ponds. These fine sediments are commonly calcareous below 4 feet. The 6- to 8-inch surface soil of the included areas is grayish-brown moderately friable heavy silt loam. The upper subsoil is
yellowish-brown moderately friable silt loam. At 12 or 15 inches this 
silt loam grades into a heavy compact yellowish-brown silty clay loam 
to silty clay heavily mottled with gray and yellow. The gray clay 
parent material begins at 38 to 36 inches. Water movement is some-
what slower and maintenance of good tilth is more difficult on these 
areas than on the typical Braceville soil.

A few areas of Braceville soil southeast of Owego and near Spencer 
in the northwestern part of the county are alkaline at depths of 
16 to 20 inches, and the parent material is calcareous. This property 
is common to most of the soils associated with members of the Howard 
series.

Use and management.—Smooth slopes, friable soil, and fair to good 
moisture conditions during most of the growing season make Brace-
ville gravelly silt loam responsive to good management and suitable for 
intensive use. Slightly more than 50 percent of the land is in crops 
and about 30 percent is in pasture. Most of the rest is idle land, but 
there are several small patches in woodland. Corn, small grain, and 
mixed hay are the principal crops. The imperfect drainage and 
relatively poor climate do not favor potato production. The pasture 
consists of timothy, bluegrass, and wild white clover, with some 
paintbrush, cinquefoil, and other weeds.

Under ordinary management the common rotation is corn, wheat or 
oats, and 2 years of red clover and timothy hay. Wheat may follow 
oats in the rotation, however, and potatoes or other vegetables may 
replace the corn on some farms. Alfalfa is used in the hay mixture 
on part of the better drained sites. Manure is commonly applied to 
corn at the rate of 8 to 10 tons an acre, and top dressings of manure 
are used on the small grain. Many farmers supplement the manure 
with moderate quantities of superphosphate. Little potassium 
fertilizer is used.

Tile drains are rare, but in places open ditches are used to divert 
some of the surface water. Tillage operations are delayed in spring 
in wet years, and many areas are in poor tilth because they were 
worked when too wet.

The yields that may be expected under common management 
practices are corn for silage, 8 tons; wheat, 18 bushels; and mixed 
hay, 1.3 tons.

Under good management this soil can be used for row crops several 
years in succession; but because a dairy system of farming prevails in 
the county, a short corn-small grain-hay rotation is suitable. In this 
rotation some difficulty may be experienced with lodging of small 
grains, especially oats. Red clover is a legume that will do well in 
the short rotation, but if the stand is to remain more than 2 years, 
alsike clover, Ladino clover, and birdsfoot trefoil should be used be-
cause they are more tolerant of the imperfect drainage.

Manure, supplemented with superphosphate, is necessary to main-
tain or increase the fertility of this soil, and fairly large quantities of 
potassium are needed under heavy cropping. Lime is needed at the 
rate of about 1 ton an acre every 5 years. Artificial drainage is 
probably feasible on much of this soil and should insure a more even 
supply of moisture during the growing season and permit earlier tillage. 
Good tilth will also be more easily maintained.
Small patches of Braceville and Atherton soils occupy level area in the foreground; Chenango soils, the low rise in background.
Chenango soils on low fan in foreground and center; Woostern soils on higher hills in background. Farmstead was abandoned when several small farms were combined.
Pastures of bluegrass and wild white or Ladino clover can be established on the soil, but lime and superphosphate are required for maintenance of good stands. Application of potassium fertilizer may also be necessary, especially where pastures contain a large proportion of legumes. Clipping to control weeds and to remove excess herbage in seasons of flush growth is also necessary.

**CANFIELD SERIES**

The Canfield soils are closely associated with the Woostern and differ from them primarily in being less well-drained and in having a hardpan. The profile is similar to that of the Mardin soils but the underlying till is deeper and contains more material transported from distant places.

The Canfield soils are mainly in small- to medium-sized areas on the smoother slopes of the larger valleys, but some broad areas extend well into the uplands in the southeastern part of the county. The series is represented by the undulating, rolling, eroded rolling, hilly, and eroded hilly phases of Canfield gravelly silt loam.

Hay, pasture, and small grains are the most important crops on Canfield soils, but some acreage is in corn and potatoes. About 10 percent of the land is idle and 20 percent is in forest. Management requirements are similar to those for the Mardin soils and center about supplying lime, phosphorus, and potassium, conserving soil material, and controlling water.

**Canfield gravelly silt loam, undulating phase** (0–8% slopes) (CdU).—This imperfectly drained grayish-brown gravelly acid soil has a hardpan. It is closely associated with Woostern and Volusia soils on lower slopes, and occurs in many irregularly shaped areas bordering the stream valleys. The largest areas are in the southern part of the county. The soil is moderately important agriculturally because of its fairly large acreage and location in the valleys where agriculture is most intensive.

Like other members of the Canfield series, this soil is on the smoother moderately well drained slopes of deep morainic deposits consisting of mixed sand, silt, and rounded gravel. Some of this material has been transported for fairly long distances but much is derived from local sandstone and shale. Maple, beech, elm, hemlock, and pine were the dominant trees in the original forest cover.

Profile description in a cultivated area:

- 0 to 8 inches, grayish-brown friable silt loam containing a moderate quantity of organic matter.
- 8 to 20 inches, pale-brown to yellowish-brown silt loam; upper part is moderately friable; lower 6 inches is mottled with gray, yellow, and brown and somewhat less friable than the material above it.
- 20 to 32 inches, pale-olive very compact silt loam heavily mottled with yellow and brown; layer impedes movement of water and air and is not penetrated by roots of most crop plants.
- 32 inches +, olive to gray compact silt loam with much gravel, part of which is granite, red sandstone, and other rocks from distant places; upper part of layer is strongly mottled but this decreases with depth; material extends to depths of more than 10 feet in most places and may reach depths of 50 feet.

The soil and its parent material are strongly acid, and the entire profile contains a moderate to large quantity of round to subangular gravel. The upper 12 to 15 inches is well drained and aerated throughout the
growing season, but below this depth conditions are unfavorable for development of plant roots. The soil is saturated late in fall and early in spring, and this delays tillage operations and inhibits growth of some perennial plants.

The depth to hardpan ranges from 18 to as much as 30 inches. Several small areas in the northeastern part of the county contain a fairly large quantity of angular flaggy stone fragments throughout the profile. Moderate variations in reaction and in organic-matter content may be expected because of differences in management.

Use and management.—Present use and management are only moderately well adjusted to the suitability and requirements of Canfield gravelly silt loam, undulating phase. About 60 percent of the land is in crops, 15 percent in pasture, and 10 percent idle. The rest is wooded. Corn, small grain, and mixed hay grown in a 4- or 6-year rotation are the important crops. Buckwheat is grown in wet years as a catch crop in many places, and potatoes and vegetables are minor row crops.

Manure is commonly applied prior to corn planting, and some superphosphate is used on both corn and small grains. Liming has become a fairly common practice in recent years and has been accompanied by increases in the proportion of legumes in hay mixtures. Spring plowing and planting are delayed by failure of the soil to drain in wet years. Pastures consist of mixed grasses with some clover but commonly contain fairly large quantities of weeds. Regular fertilization and liming of pastures is practiced only on the better farms.

Average yields that may be expected under ordinary management are grain corn, 25 bushels; silage corn, 8 tons; oats, 30 bushels; wheat, 18; buckwheat, 18; and mixed hay, 1.3 tons.

The relatively low natural fertility, strong acidity, and imperfect drainage place some limitation on use of this soil, but its smooth slopes, friable consistence, medium texture, and moderately good moisture conditions in normal growing seasons make it fairly responsive to good management. The common forage crops are fairly well suited to the soil, although alfalfa will not do so well as on the better drained Wooster soils. Corn is suited to the soil, and small grains do fairly well. Spring planting of oats may be delayed in wet years, and wheat yields may be reduced significantly by frost injury. Buckwheat fills a useful place in the use and management of this soil because its short growing period permits planting in exceptionally wet years when it is too late for small grains. The soil is not well suited to potatoes because of its impeded drainage and the relatively unfavorable climate.

Under conditions prevailing in the county a 4- or 5-year rotation of corn, small grain, and hay is best suited to this soil, but more intensive use can be practiced under good management. Manure supplemented with superphosphate and some potash fertilizer is required for maintenance of fertility. Use of more legumes than is now common is desirable. Ladino clover is well suited to the soil and birdsfoot trefoil is another legume that shows promise on this and similar moderately well drained soils.

Some improvement in moisture conditions can be attained by construction of diversion terraces, and contour tillage should be practiced where mechanically feasible. Regular applications of lime
and phosphorus and occasional clipping to control weeds are the chief pasture management requirements.

**Canfield gravelly silt loam, rolling phase** (9–16% slopes) (Cdr).—This is the most extensive member of the Canfield series and one of the more important agricultural soils of the uplands. It has brownish upper soil layers and compact hardpan typical of Canfield soils.

In most respects this soil is similar to the undulating phase; it differs principally in slope and features associated with slope. The soil is on rolling moderately well drained slopes of valleys and is underlain by deep compact acid gravelly glacial till. It is closely associated with Woostern and Volusia soils in all of the valleys. The largest acreage is in the southern and southeastern parts of the county. The areas are small to medium in size and roughly rectangular. The soil was formed under mixed hardwoods with some white pine and hemlock in places.

The profile is essentially the same as that of the undulating phase, but slightly more soil material has been lost through erosion. The profile consists of a 6- to 8-inch grayish-brown surface layer; a yellowish-brown silt loam subsoil about 12 inches thick, the lower part of which is mottled; and a 10- to 12-inch hardpan layer of compact olive-gray mottled silt loam. The compact acid olive to gray gravelly glacial till begins at 28 to 36 inches and extends downward 10 to 50 feet. The surface layer is fairly well supplied with organic matter; the entire soil profile and parent material are strongly acid; and the hardpan layer impedes water and air movement. The soil is characterized by extremes of moisture conditions; it remains too wet for normal tillage until moderately late spring and becomes very dry in the upper layers in the drier summer months.

A few areas, about 3 percent of the total acreage, have a large quantity of sandstone flags on the surface and in the soil and parent material. These areas are mainly in the northern part of the county.

**Use and management.**—The present general level of management for Canfield gravelly silt loam, rolling phase, is among the highest practiced on any of the soils of the uplands. About 50 percent of the land is in crops; 20 percent is in pasture; and 10 percent is idle. The rest is in forest. As on the undulating phase, corn, small grain, and mixed hay are the important crops; but rotations are somewhat longer, generally 4 to 6 years in length. Buckwheat is sown as a catch crop in the years that the soil remains wet too late for planting corn or oats.

Fairly heavy applications of manure, averaging 8 to 10 tons an acre, are made preceding the planting of corn; and some additional manure is applied as a top dressing on wheat. Superphosphate also is applied to some of the corn and wheat. Liming has become more common in recent years, but over the county as a whole, applications are considerably less than the quantity needed to correct soil acidity and maintain or increase calcium supplies.

Diversion terraces, contour tillage, and strip cropping are used for water and soil conservation in places, but much of the soil remains in rectangular fields and is cultivated up and down slopes. In wet springs many areas of the soil are plowed when too wet and tilth is seriously impaired.
Pastures consist of tame grass mixtures with some legumes in places and a fairly high proportion of weeds, as paintbrush, cinquefoil, and wild carrot. On older pastures, where fertility has not been maintained with needed amendments, poverty oatgrass is the usual vegetation.

This soil has moderately favorable slopes and is moderately easy to maintain in good tillth; but its impeded drainage, low natural fertility, and strong acidity make it somewhat exacting in management requirements and limit its use to some extent. Grass-legume mixtures for hay or pasture are among the best suited crops, and small grains do fairly well. Because this soil has a slightly longer growing season, corn will do somewhat better on it than on Mardin soils on comparable slopes. It is less favorable than those soils for potatoes.

A 4- to 6-year rotation of a row crop, small grain, and hay is suited to the soil. Liberal applications of manure, supplemented with superphosphate, and some potash are necessary to maintain fertility; and 1 ton an acre of lime during each rotation, applied preceding the hay seeding, is essential for success with legumes. Pastures also require regular applications of fertilizer and lime.

If rotations include row crops, contour tillage, strip cropping, and diversion terraces, alone or in some combination, are necessary to conserve soil material and maintain good moisture content for crop growth.

Canfield gravelly silt loam, eroded rolling phase (9–16% slopes)
(CP3)—This soil differs from the rolling phase chiefly in having lost a large part of the original surface layer and some of the upper subsoil through erosion. It occupies small areas in all the valleys of the county but is unimportant agriculturally because of its small acreage and limited use suitability.

The soil is in moderately well drained valley-wall positions, generally on the more strongly rolling slopes near the upper limits of the slope range, and is associated with other Canfield soils and those of the Woostern series. Except for the accelerated erosion its formation is essentially the same as that of the rolling phase of Canfield gravelly silt loam. The eroded condition has developed because it has been used as cropland or pasture under relatively poor management. The soil is generally underlain by deep gray to olive acid gravelly glacial till and was originally covered with hardwood forests.

The profile was once similar to that of the rolling phase, but erosion has removed most of the original grayish-brown surface layer, and the present surface soil is the upper part of the original subsoil. The subsoil is thinner and the hardpan is at a shallower depth than in the rolling phase. The present plow layer is 6 to 8 inches of light grayish-brown gravelly silt loam. The upper 2 to 4 inches of the subsoil is yellowish-brown silt loam, and the lower 4 to 6 inches is gray-and-brown mottled and somewhat brittle. The gray mottled compact hardpan is at a depth of 12 inches or less in most places.

The content of organic matter in the plowed layer is very low, and the entire soil is strongly to very strongly acid. The shallow depth of well-aerated soil above the mottled lower subsoil and hardpan limits plant roots to a relatively thin layer and reduces the water-supplying capacity of the soil. Small gullies occur in many places.
Use and management.—Practically all of Canfield gravelly silt loam, eroded rolling phase, is cleared. About two-thirds is used for crop-land, and the rest is about equally divided between pasture and idle land. Buckwheat, mixed hay, small grains, and corn are the main crops, and they are commonly grown in a 4- to 6-year rotation. Pastures are mixtures of tame and wild grasses with some legumes and large quantities of weeds. Practices for use of amendments, water control, and tillage are about the same as on the rolling phase, although less care in their application is probably the cause of the more serious erosion of this phase. Silage corn yields 6 tons an acre; wheat, 10 bushels; buckwheat, 13; and mixed hay, 1 ton.

The shallow depth of this moderately well drained and aerated soil, its low organic-matter content, and its fairly strong slopes combine to make it still more susceptible to erosion, to limit its use suitability, and to make its management requirements more exacting. The soil is probably best used if it is kept in hay or pasture as long as the legume will stay in the stand. A rotation made up of a row crop, small grain, and hay for several years can be used safely only if the land is well managed. Requirements for fertilizer and other amendments, tillage practices, and water control are about the same as for the rolling phase, but more care in application of water-control measures is necessary to prevent further erosion.

Canfield gravelly silt loam, hilly phase (16–30% slopes) (CdH).—This phase differs from the rolling phase mainly in having stronger slopes and properties associated with slope. The fairly large roughly rectangular areas or long narrow strips border most of the large valleys, and the largest acreages are in the southern part of the county. This is the second most extensive of the Canfield soils, but it is of only moderate agricultural importance because of limited use suitability. It is associated with other Canfield soils and those of Wooster series on lower uplands of the valleys and in many places occurs on slopes adjacent to small intermittent streams.

Other than in slope, the soil is essentially the same as the rolling phase, and the profiles of the two soils are similar in most respects. The depth to hardpan is slightly less on the average, however, and the depth of soil material over bedrock is probably less.

About 5 percent of this soil has slopes in excess of 30 percent, and a somewhat larger area has a preponderance of large flaggy stone fragments on the surface and in the soil layers. Small seep spots having soil profile features of the Volusia series that were too small to delineate on the map are included with this soil in many areas.

Use and management.—Much of Canfield gravelly silt loam, hilly phase, is used in a manner poorly adjusted to its physical properties. About 25 percent is cropland; 10 percent is idle; and the rest is about equally divided between pasture and forest. Long-term hay is the principal crop, but some buckwheat, small grain, and corn are produced. Timothy is dominant in the hay fields, but the growth in most pastures is largely poverty oatgrass, paintbrush, and other weeds. Manure and superphosphate are used on the corn and grain crops, but amendments are not commonly applied to hay or pasture after the initial seeding. The idle fields are generally abandoned hay or pasture land on which weeds and brush have crowded out the tame
grasses and legumes. Many woodlands are grazed rather heavily, and much of the understorey has been destroyed and the leaf litter dissipated.

An acre of pasture on this soil will carry one cow for about 35 days. Mixed hay gives average yields of 1 ton an acre; and buckwheat, about 11 bushels.

The strong slopes and compact subsoil of this phase encourage rapid runoff and make it susceptible to severe erosion when bare of vegetation. The soil is well suited to a rotation in which 1 year of grain is followed by several years of hay or pasture, but it is not good for a more intensive use. Areas not needed for crops or pasture should be considered for reforestation.

Ladino clover-grass mixtures will do well on this soil, and birdsfoot trefoil will probably yield heavily under good management. For forage crops, apply lime at the rate of about 1 ton an acre, 600 pounds of superphosphate, and some potash at the time of seeding. Additional quantities of lime and fertilizer are required at 5-year intervals. Top dressings of manure can be used to furnish nitrogen and potassium for hay or pasture. Occasional clipping of pastures is necessary for weed control.

Where crops are rotated, contour tillage, strip cropping, and diversion terraces are essential for good erosion control and moisture conservation. Protection of forested areas from fires and grazing reduces runoff by encouraging accumulation of duff and improving the physical properties of the upper layers, and thereby hastens reproduction of the stand.

Canfield gravelly silt loam, eroded hilly phase (16–30% slopes) (Cdy).—This soil differs from the eroded rolling phase chiefly in having stronger slopes and from the hilly phase in being more eroded. It occurs in many widely separated small areas associated with Wooster and other Canfield soils but is not important agriculturally, because it occupies a small acreage and is limited in use suitability.

This phase is on hilly slopes of uplands underlain by gravelly till. It formed under an environment similar to that of the rolling phase, and its profile is the same as that of the eroded rolling phase. Areas with variations in slope, stoniness, and drainage similar to those described for the hilly phase are included with this soil in mapping.

Use and management.—The eroded condition of Canfield gravelly silt loam, eroded hilly phase, reflects poor adjustment of use and management. Slightly more than a third of the soil is in cropland, and small patches amounting to about 10 percent are in woodland. The rest is about equally divided between idle and pastured land. Fairly long rotations of row crops, small grains, and mixed hay are used on the cultivated land. Management is similar to that of the hilly phase, but good practices are not so consistently applied, and pastures are generally somewhat poorer.

Because it is severely eroded, susceptible to further erosion, strongly sloping, and low in moisture-absorbing and moisture-retaining capacity, this soil is very poorly suited to crops. Good conservation practices will permit its use only for pasture or long-term hay. Pasture management requirements, as for the hilly phase, should include use of adequate soil amendments, control of grazing in wet and dry seasons, and occasional clipping to control weeds.
Areas not needed for pasture should be reforested, either by natural reproduction from adjacent woodlands or by artificial planting of suitable trees. Protection from fire, grazing livestock, and rodents is the most important management requirement for young tree plantings. Such protection and planned cutting will maintain the older woodlands.

**CHENANGO SERIES**

The Chenango soils are on nearly level to steep slopes of glacial outwash terraces in all the broader valleys of the county (pl. 7). The largest areas and greatest total acreage are in the valleys of the Susquehanna River and Owego Creek. The soils are well suited to a wide variety of crops and are among the most intensively used in the county.

The series is represented by the following phases:

| Chenango fine sandy loam, nearly level phase | Chenango gravelly silt loam, nearly level phase |
| Chenango gravelly loam: Aluvial-fan phase Hilly phase Rolling phase Steep phase | Chenango silt loam, nearly level phase |

About two-thirds of the total area of Chenango soils is in cropland, and most of the rest is in pasture. Small areas of idle land and patches of woodland are on some of the steeper slopes. Most of the villages of the county are situated partly or wholly on these soils. All the common field crops will do well on them, although they are somewhat less favorable for potatoes than soils of the higher uplands. Small areas on hilly and steep relief are relatively much poorer cropland than the soil on smoother slopes.

Intensive use with short rotations and heavy fertilization and liming is best for these soils. Under good management alfalfa, commercial vegetables, and other crops exacting in management requirements can be expected to yield heavily.

**Chenango gravelly silt loam, nearly level phase** (0–3% slopes) (CLN).—This grayish-brown acid friable gravelly soil occurs in the broader valleys on the well-drained smooth nearly level glacial outwash terraces, well above present stream overflow. Here it is associated with other Chenango soils and on the nearby lower terraces and bottom lands with Unadilla, Tioga, Middlebury, and Holly soils. It differs from the Howard soils on similar slopes in being acid in the lower subsoil and substratum, rather than alkaline and calcareous.

The soil is derived from stratified acid sand and gravel laid down by streams flowing from the melting glaciers that once covered the region. It occurs in medium-sized irregularly shaped areas in several of the larger valleys, some of the largest tracts being in the vicinity of Lounsberry, Flemingsville, and North Spencer. It is one of the most productive soils of the county and is important agriculturally because of suitability for intensive use.

The original vegetation consisted of heavy forests of beech, sugar maple, white ash, and white pine, but most of the soil has been cleared so that the effects of this vegetation have been modified by long cultivation.
Profile description in a cultivated field:

0 to 8 inches, friable grayish-brown gravelly silt loam.
8 to 28 inches, yellowish-brown friable gravelly silt loam; lower part somewhat browner.
28 inches +, grayish-brown to yellowish-brown stratified sand, silt, and gravel; gravel particles are mostly gray sandstone and shale but some granite and other rock from distant places is included; tongues of the more brownish subsoil extend downward into this layer in many places; deposits are many feet thick and rest on level-bedded acid sandstone or shale.

The entire profile is strongly acid. The surface layer is less acid where lime has been applied. The parent material is also acid, though less so than the soil. Some areas do have small quantities of lime at depths below 10 feet. The entire profile is readily permeable to air, roots, and moisture, and the soil has a deep rooting zone and large moisture-storage capacity.

Use and management.—Chenango gravelly silt loam, nearly level phase, is one of the more intensively used soils of the county. About 80 percent is in cropland, 10 percent in pasture, and the rest is small patches of idle land and in urban uses. Short rotations of 3 or 4 years are commonly followed, although in a few areas more intensive use for continuous row crops is practiced. Silage corn, oats, wheat, and mixed hay are the principal crops, but some alfalfa is grown, and locally, potatoes and vegetables are important.

Manure, supplemented with superphosphate, is the main fertilizer on cropland, but complete commercial mixtures are used where potatoes and vegetables are grown. The use of lime is limited mainly to areas where legumes are seeded. Plowing and other tillage operations are easily and promptly accomplished on this smooth well-drained soil.

This is among the most productive soils of the county. Silage corn yields 10 tons an acre; grain corn, 35 bushels; oats, 35; wheat, 22; and mixed hay, 1.5 tons. Much higher yields can be obtained under more intense management. Excellent grazing is possible, except during the drier part of the summer.

The nearly level smooth slopes, easy workability, and favorable moisture conditions make this one of the best agricultural soils of the county, but it has some special management requirements because of strong acidity and relatively low natural fertility. Nearly all crops do well under good management, although climate is less favorable for potatoes than on soils of the higher uplands. Short rotations of corn, grain, and hay are well suited to this soil in the prevailing dairy type of farming, and row crops should be concentrated on it. The more sloping land can then be kept in sod-forming crops for long periods.

Manure and superphosphate are needed on corn and small grain; and under heavy cropping, potash is also required. Lime is necessary for alfalfa, the most productive legume for this soil. Red clover probably fits into short rotations better than alfalfa. In the rotations commonly used, additional fertilizer is not ordinarily needed on the hay crop, but where alfalfa remains for several years top dressings of superphosphate and possibly potash are needed at 3-year intervals.

Special practices for water control are not ordinarily needed. Where this valuable soil is used for pasture, high productivity should be maintained by application of lime and phosphate to legume-grass
mixture. Rotation grazing and occasional clipping for weed control are other important pasture management practices.

**Chenango gravelly loam, rolling phase** (6–15% slopes) (Cgr).—This acid soil is on the well-drained rolling parts of old glacial outwash terraces and is associated with other phases of Chenango soil. The parent material consists of stratified acid sand and gravel. The soil occurs in many widely separated areas, principally in the valley of the Susquehanna River. From Chenango gravelly silt loam, nearly level phase, it differs in having a stronger slope and in being somewhat coarser textured. It differs from Howard soils on similar slopes chiefly in being more acid. The original forest cover included beech, maple, white pine, hickory, and oak.

Profile description in a cultivated field:

0 to 8 inches, grayish-brown loose mellow gravelly loam.
8 to 24 inches, yellowish-brown friable gravelly loam to silt loam; lower part of layer is in places more brown and somewhat brittle; gradual transition to layer below.
24 inches +, stratified acid gravel, sand, and silt of brownish-gray to yellowish-brown color; material is many feet thick.

The entire soil profile is acid, and the parent material generally contains no free lime. Small quantities of lime have been observed below a depth of 10 feet in a few places. The gravel is mostly gray sandstone of local origin, but some granite, quartzite, and red sandstone from areas farther north are included in places. The gravel does not ordinarily interfere with tillage but is sufficient to permit rapid drainage and reduce water-holding capacity. This soil was originally classified in the Otisville series. A few areas of silt loam soil with profile features similar to those of the gravelly silt loam are included.

**Use and management.**—Chenango gravelly loam, rolling phase, is intensively used, but because of its small acreage and stronger slope, is less important agriculturally than other less sloping Chenango soils. About 55 percent is in cropland; nearly 10 percent is idle; and the rest is about evenly divided between pasture and forest. Rotations are commonly made up of corn, oats or wheat, and 2 years or more of mixed hay.

Manure supplemented with superphosphate is applied to corn, and additional phosphate and top dressings of manure are used on some of the small grains. Little additional fertilizer is applied to hay, although top dressings of manure are made on older stands in places. Where legumes are used in the rotation, the soil is limed. Special methods for water control are practiced on little of this soil. Some pastures are limed and receive superphosphate, but many receive no amendments.

Under present management grain corn yields 30 bushels an acre; silage corn, 7.2 tons; wheat, 16 bushels; and timothy and clover, 1.5 tons.

This soil is somewhat more exacting in management requirements than Chenango gravelly silt loam because of its stronger slopes and a somewhat lower supply of moisture. All the common grain and forage crops do well under good management. A rotation of corn, small grain, and hay lasting 4 years or longer is suited to the soil. Red clover and alfalfa are the most productive hay crops, but appli-
cation of about 1 ton of lime an acre during each rotation is essential to success with these crops. The equivalent of 600 pounds of 20-percent superphosphate every 4 or 5 years is needed. Under heavy cropping some potash fertilizer is also needed. If available, top dressings of manure should be supplied to hay—both to new seedings and old stands. Where practicable, contour tillage is needed on this soil, and on the few long smooth slopes strip cropping is a good practice.

Pastures require superphosphate and lime at regular intervals. Occasional clipping to remove weeds is necessary. Pastures tend to dry on this soil in summer, and supplemental pasture on other soils with more favorable moisture supplies is needed.

**Chenango gravelly loam, hilly phase (16–25% slopes) (Cox).—** This phase is on the slopes of small cone-shaped hills in areas where glacial outwash has very irregular and hilly slopes. Because of its strong slope, coarse texture, susceptibility to erosion, and tendency to droughtiness, this soil is much less desirable for agriculture than Chenango soils on smoother slopes. Parent material, drainage, and native vegetation are similar to those for the rolling phase. Surface runoff is more rapid, however, because of the stronger slopes, and the content of gravel and sand is probably somewhat greater. The soil occupies several irregularly shaped areas, chiefly near Waverly, Richford, and Tioga Center.

The profile of this phase is similar to that of the rolling phase but less strongly expressed and slightly less deep to unweathered parent material. In a cultivated field the 6- to 8-inch surface soil is grayish-brown gravelly loam, somewhat silty in places. Loose gravel interbedded or stratified with sand begins at a depth of 18 to 24 inches and extends downward many feet. Both the soil profile and the parent material are generally acid. In places small quantities of lime occur at depths of 10 feet or more. The gravel fragments consist largely of local gray sandstone with some granite, quartzite, and red sandstone. These sands and gravel are well suited to use as aggregate material for highway and other construction work and furnish easily accessible supplies of such material. Several gravel pits are on areas of this soil.

**Use and management.**—Present use of Chenango gravelly loam, hilly phase, is fairly well adjusted to soil suitability, but management is poor. About 25 percent of the area is in woodland; about 20 percent is idle; and the rest is in pasture or hay. Long-term hay is alternated with 1 or 2 years of small grain or 1 year each of corn and small grain. Lime and superphosphate are used on new seedings by most farmers, but amendments are not applied to hay after the initial seeding. Most of the older pastures contain large quantities of weeds, poverty oatgrass, and paintbrush. Special water-control practices are not commonly applied.

Under current management corn yields 20 bushels an acre; wheat, 13; and mixed hay, 0.8 tons. Pastures produce well in spring and fall, but they dry out during the middle of the summer and grazing is very poor.

The strong uneven slopes and coarse texture make this soil droughty, and this condition, together with the strong acidity, makes it poor for
crops that require tillage. Long-term hay or pasture, alternated with 1 or 2 years of small grain, or 1 year each of corn and small grain, is the most intensive use for this soil. Corn and grain need manure, superphosphate, and potash. Where the soil is used for tilled crops, contour tillage and strip cropping should be practiced, but the irregular slopes make these practices impossible in many places. Lime is essential for success with legumes, which produce well under good management. Alfalfa, Ladino clover, red clover, and birdsfoot trefoil are all suited to this soil under good management.

Top dressings of lime and phosphorus are needed for pasture maintenance. Both the quality and quantity of spring grazing can be improved by the use of a quickly available nitrogen carrier, as ammonium nitrate or nitrate of soda. Clipping to control weeds is necessary. The grazing capacity of pastures on this soil is low during the drier summer and fall months, and supplementary pasture is necessary to prevent overgrazing.

Chenango gravelly loam, steep phase (26–45% slopes) (Cor).—This gravelly soil is closely associated with the hilly phase of Chenango gravelly loam on kames and irregular hills of glacial outwash material. Other than slope, its formation is the same as that of the hilly phase. The soil profile is essentially the same, except that depth to unaltered sand and gravel is less because of more rapid erosion. This soil is even more droughty than the hilly phase because of its stronger slopes and more rapid runoff. About 40 percent of the area has slopes of about 45 percent. On these steeper slopes the soil is thinner and runoff is even more rapid. The soil occupies several small- to medium-sized irregularly shaped areas. The larger tracts are near Waverly and East Richford.

Use and management.—About 50 percent of Chenango gravelly loam, steep phase, is in woodland; 20 percent is idle land or wasteland; and the rest is in pasture. Pastures are of poor quality and low-carrying capacity and consist largely of poverty oatgrass and weeds with small quantities of legumes in places. Ordinarily neither fertilizer nor lime is used, and no special practices for conservation of soil material or water are followed. The idle land is mostly abandoned pasture in which the quantity of palatable plants is so low that little grazing can be obtained. These idle fields have many bushes and small trees in the cover. In a few places some of the fields with a better stand of grass are mowed for hay.

Because of its steep slopes, droughtiness, and strong acidity, pasturing is the most intensive use practical on this soil. Requirements for pasture management are about the same as those for the hilly phase, but because of its strong slopes and extreme droughtiness, it may not pay to apply an equal intensity of management to this soil. Where it is not actually needed for pasture it could well revert to forest. Reforestation can be accomplished in many places by natural reproduction from adjacent woodlands. In others artificial planting is required. It is important to protect young forests from fire and grazing. Sustained yields from old plantings can be obtained by harvesting only mature trees.

Chenango gravelly loam, alluvial-fan phase (3–12% slopes) (CoA).—Relatively wide distribution, fairly large acreage, and suitability to
intensive use make this grayish-brown gravelly acid soil of the valleys one of the most important agricultural soils of the county. It is younger than the other Chenango soils and has less distinct profile features.

The phase occurs in many small- to medium-sized areas in all of the broader valleys of the county. It occupies low gently sloping or undulating old alluvial fans at places where tributary streams enter the valleys (p. 8). The strongly acid parent materials are deep deposits of imperfectly stratified gravel and sand washed from the adjoining uplands. The gravel fragments consist of sandstone and shale. Many fragments are only partly rounded and resemble the channers and flags of the upland in shape.

Representative profile description:

0 to 8 inches, grayish-brown friable gravelly loam containing a moderate to large quantity of sandstone, gravel, and channers and a moderate supply of organic matter.
8 to 24 inches, yellowish-brown gravelly friable silt loam.
24 inches +, light yellowish-brown loam with many gravel, cobbles, and channers; materials are commonly in relatively homogeneous mixture but are in places imperfectly stratified; layer is many feet thick.

Both the soil profile and parent material are acid. The entire profile is easily permeable to roots, air, and water; but sufficient moisture for growing plants is retained by the medium-textured soil material. In many places small increments of soil material washed from adjacent high-lying uplands are received occasionally, and in these places the yellowish-brown subsoil is less distinct than normal.

The only important variation in the soil is in texture, and that is caused by the manner in which the materials are deposited. The quantity of coarse material and angular fragments is usually greater at the end of the fan adjacent to the uplands than at the outer edges.

Use and management.—Present use of Chenango gravelly loam, alluvial-fan phase, is fairly well adjusted to its suitability, but management is somewhat below that required for highest yields. Slightly more than two-thirds of the soil is in cropland, 15 percent in pasture, less than 10 percent in small patches of woodland and idle land, and the rest (about 7 percent) in urban use. Many of the farmsteads in the valleys are on this soil, and most areas are crossed by highways.

Practically all the common crops of the county, including corn, potatoes, oats, wheat, timothy, clover, and alfalfa, are grown on the soil with success. Climate is less favorable for potatoes than in the uplands, and alfalfa and clover cannot be successfully grown without the use of lime. Present management and management requirements are essentially the same as those for Chenango gravelly silt loam, nearly level phase, except that more careful practices for water control, as contour tillage and possibly strip cropping, are needed on the more sloping areas of this phase.

Chenango fine sandy loam, nearly level phase (0–3% slopes) (Cn).—This grayish-brown rather loose sandy acid soil occurs on the smooth well-drained slopes of glacial outwash terraces underlain by deep acid relatively gravel-free sand. It differs from the gravelly loam in being nearly free of gravel and in having a greater content of sand. It is of moderate agricultural importance.
Large area of Chenango gravelly loam, alluvial-fan phase, northeast of Owego. Fan was built by several tributary streams that carried material into the main valley.
Large area of poorly drained Holly silt loam in the Cayuta Valley just north of Lockwood; much of it is too wet for crops or pasture.
The soil is in long strips or broad irregularly shaped areas. Typical tracts are near Waverly, Barton, and Tioga Center. The original forest included beech, sugar maple, white ash, and in places some other hardwoods and white pine.

Profile description in a cultivated field:

0 to 8 inches, grayish-brown loose fine sandy loam.
8 to 28 inches, yellowish-brown friable fine sandy loam; lower 6 inches is brown.
28 inches +, stratified grayish-brown sand and fine gravel extending downward for many feet.

Both the soil profile and parent material are acid. The moderately coarse texture and looseness of the soil make it rapidly permeable to water, but water supplies for plants are only slightly less favorable than for the finer textured Chenango soils on smooth slopes. In places some coarse gravel is on the surface and in the soil profile and parent material.

Use and management.—About 45 percent of Chenango fine sandy loam, nearly level phase, is in cropland; 20 percent, idle; 10 percent, in pasture; and a few small areas are in woodland. The rest, about 25 percent, is urban land in Waverly and a few other villages in the Susquehanna River Valley. Corn, small grain, and hay grown in short rotations are the common crops. It is one of the most easily cultivated soils in the county and is especially well suited to early vegetables. General management practices are essentially the same as for Chenango gravelly silt loam, nearly level phase. Average yields are about the same, although they may be somewhat less in dry years because this phase is more droughty. Use suitability and requirements for good management are also essentially the same as for the gravelly silt loam.

Chenango silt loam, nearly level phase (0–3% slopes) (Csn).—This phase differs from most others of the Chenango series in being practically free of gravel. Also, it is the finest textured member of the series mapped in the county. There are several medium-sized long narrow strips of this soil on nearly level well-drained glacial outwash terraces, chiefly along West Branch Owego Creek. The soil is very good to excellent for agriculture and is important in a few localities, even though the total area is not large.

The parent material is stratified acid sand and silt containing a small to moderate number of gravel fragments. The profile is similar to that of the gravelly silt loam, except that the content of gravel is less. The original forest was beech, hard maple, and white pine with some oak, hickory, and elm.

Profile description in a plowed field:

0 to 8 inches, grayish-brown friable silt loam.
8 to 32 inches, yellowish-brown moderately friable silt loam, somewhat firm in the lower part.
32 inches +, light yellowish-brown stratified sand, gravel, and silty material many feet thick.

The soil profile and parent material are acid. A small quantity of sandstone gravel is on the surface and in the profile in places. The soil is readily permeable to air, roots, and water, but the medium-textured materials retain an ample supply of moisture for good plant growth.

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Use and management.—Chenango silt loam, nearly level phase, is one of the most intensively used soils in the county. More than 90 percent is cropland, and most of the rest is in pasture. Corn, small grain, and hay grown in short rotations are the important crops. Fertilization and other management practices are about the same as for Chenango gravelly silt loam, nearly level phase. The yields are slightly higher, especially in dry seasons, because of the greater moisture-holding capacity. Use suitability and management requirements are practically the same as for Chenango gravelly silt loam, nearly level phase.

CHIPEWA SERIES

The Chippewa soils are in small areas, generally in long narrow strips in all the upland parts of the county. They are closely associated with members of the Volusia and Fremont series but are less well drained than those soils and have a darker colored surface layer and a more strongly mottled subsoil. Two types, differentiated on the size of the stone fragments, are recognized—Chippewa channery silt loam and Chippewa stony silt loam.

The Chippewa soils are poor for agriculture. Somewhat more than half of the land is in pasture and about a fourth is in forest. Most of the rest is idle, but a few small areas are in crops, mainly hay. Pastures consist of native grasses, sedges, and reeds. Little can be accomplished by improved management, except that some surplus moisture can be removed by open ditches.

Chippewa channery silt loam (0–8% slopes) (Cc).—This very poorly drained gray acid soil is mainly in many widely separated areas in the uplands, generally in long narrow strips in depressed places or along intermittent drainageways. Some of it is on slopes where seepage keeps the soil permanently wet. Although a moderate acreage is mapped, the soil is not an asset to agriculture, because of its very poor drainage. It is closely associated with members of the Volusia, Mardin, Canfield, Woostern, and Lordstown series.

This soil is developed from relatively thin acid gravelly or channery glacial till derived mostly from local gray sandstone and shale. In places, however, some granite, quartzite, and red sandstone are included. The original vegetation consisted of forests of soft maple, willow, elm, white pine, swamp oak, and other water-loving plants.

Profile description in a pastured field:

0 to 6 inches, very dark-gray moderately friable gravelly silt loam; material faintly mottled and contains a fairly large quantity of organic matter.

6 to 24 inches, pale-yellow to light-gray gravelly silt loam, mottled with shades of yellowish brown and yellow; tongues of the darker upper layer extend down into this one in many places; lower part of this layer is compact in place and shatters with difficulty when disrupted.

24 inches +, olive-gray compact gravelly glacial till underlain by level-bedded sandstone and shale at 4 to 10 feet.

The soil and parent material are acid. The entire profile is saturated with moisture most of the year, and as a result, aeration is poor and root growth is inhibited.

Several moderate variations are included with the soil as mapped. Where it occurs in association with Canfield and Woostern soils, the stone fragments in the soil and parent material are well-rounded gravel and some material not of local origin is included. Where it is asso-
ciated with the Mardin and Lordstown series, however, it contains chiefly angular channers. The total depth to bedrock is also less where the soil is derived mostly from local material. The most poorly drained areas have a nearly black surface layer relatively high in organic-matter content. About 15 percent of the soil has slopes in excess of 8 percent, chiefly in the 8- to 15-percent range, with a few small areas on steeper slopes.

Use and management.—Use of Chippewa channery silt loam has been fairly well adjusted to its physical suitability. Slightly more than 25 percent is in forest and 55 percent is in pasture. Most of the rest is idle or wasteland, but a few better drained areas are in hay. Few, if any, special management practices are used for pasture. The common practice is to graze the natural growth, which consists of sedges, reeds, coarse wild grasses, and on the better drained sites, some bluegrass, redtop, and other tame grasses. Because the forage is of poor quality, the carrying capacity of these pastures is low. The pastures do have the advantage of furnishing some feed in the dry summer months when those on the better drained uplands are dry and relatively dormant.

Because of its very poor drainage, strong acidity, and low inherent fertility, pasture is the most intensive use to which this soil is suited. Where it is not needed for pasture it can well be allowed to revert to forest or other natural growth. Excess surface water can be removed to some extent by open ditches, but tile drainage is not ordinarily feasible, because of economic or engineering limitations. Where moisture conditions are moderately improved, the growth of the more desirable grasses and some legumes, as wild white clover or Ladino clover, is encouraged. Reed canary grass, a grass well suited to poor drainage, may be fairly well suited to this soil if the fertility level is raised. The supplies of both lime and phosphorus are low, but it may not be economical to use these amendments on most areas of this soil. Where the land is in forest, protection from fires and grazing and selective cutting should be practiced as a part of good forest management.

Chippewa stony silt loam (0–8% slopes) (Ch).—This soil occurs in many small depressed areas or in narrow strips along intermittent drainageways, chiefly in the higher uplands. It is associated with the Lordstown, Mardin, and Fremont-Volusia soils and differs from Chippewa channery silt loam mainly in having many large angular fragments and flags of sandstone on the surface and throughout the soil profile and parent material. The depth of till over bedrock is generally somewhat less than for the channery silt loam, but except for this and the difference in stone fragments, the two soils are the same in profile and were formed under essentially identical conditions.

Use and management.—About half of Chippewa stony silt loam is in woodland, and most of the rest is in pasture. Small areas of idle or wasteland make up 5 to 10 percent of the total acreage. Present management, use suitability, and management requirements are the same as for the channery silt loam.

FREMONT SERIES

The Fremont soils are typically in broad areas on the higher elevations. They occupy smooth slopes in association with members of the
Mardin and Bath series. In many respects, they resemble Volusia soils, but differ in being somewhat browner in the surface layer and in having a less distinct hardpan that may lie at greater depth. In drainage they are intermediate between the moderately well-drained Mardin and poorly drained Volusia soils.

The Fremont soils could not be mapped consistently in Tioga County and are included in a unit with associated Volusia soils. Only one unit is mapped, Fremont and Volusia channery silt loams, gently sloping phases.

Fremont and Volusia channery silt loams, gently sloping phases (0–8% slopes) (FVo).—This unit is on somewhat poorly drained areas at high elevations on broad interstream divides in all the higher uplands, but the greatest acreage is in the eastern and central parts of the county. It is closely associated with Volusia and Mardin soils that occupy the adjacent lower more sloping lands. The soils of this separation belong to two series and are derived from compact acid channery glacial till underlain by sandstone and brittle shale at less than 10 feet in most places and at 4 feet or less in some locations. The Fremont soils differ from the Volusia in having a browner surface layer and a slightly less distinct hardpan generally at greater depth. The original forests included elm, soft maple, ash, white pine, and some beech and sugar maple.

Profile description of Fremont channery silt loam, gently sloping phase, in a cultivated field:

0 to 6 inches, grayish-brown friable channery silt loam moderately well supplied with organic matter.
6 to 24 inches, pale-yellow moderately friable silt loam mottled with shades of gray and brown; upper few inches browner and the mottling fainter.
24 to 36 inches, pale-gray channery silt loam mottled with yellow, brown, and black; moderately compact in place.
36 inches +, olive-gray channery compact glacial till of silt loam texture; acid sandstone or acid brittle shale at depths of 4 to 10 feet.

The soil profile and parent material are strongly to very strongly acid. The substratum is slowly permeable to moisture and air and not easily penetrated by roots. The upper soil layers are wet until late in spring, but in dry years they become very hard and dry and the surface of the soil cracks. These extremes of moisture conditions and the accompanying extremes in aeration result in low crop yields.

About a third of the delineated areas of this unit have profiles similar to that described for Fremont channery silt loam, gently sloping phase. Most of the remaining areas are like the Volusia soils and have profiles like those of Volusia channery and gravelly silt loams, gently sloping phases. Small areas of Mardin soil are also included in the unit as mapped, principally on the stronger slopes.

Use and management.—Fremont and Volusia channery silt loams, gently sloping phases, have not been well adjusted to use suitability or management needs. At present about 30 percent of the separation is in woodland and 20 percent is idle or in wasteland. Most of the rest is in pasture or long-term hay, although possibly 5 to 10 percent is in crops. On cropland the common practice is to grow 1 year of corn for silage followed by oats seeded to timothy and clover. The
forage is cut for hay or pastured until the proportion of palatable grasses is so low that little feed is obtained. Available manure is generally applied to the corn and additional quantities to the small grains. Some superphosphate is applied as a supplement to manure. Additional fertilizer is not generally used on the hay, and liming is not a common practice. Buckwheat is a fairly important crop where these soils are cultivated. It is planted as a summer catch crop when wet spring weather prevents oat seeding or corn planting.

Permanent pastures consist largely of poverty oatgrass, paintbrush, and other weeds; and most of the older pastures have some growth of thornapple, seedling apple, wild blackberry, and small forest trees. Under the poor management that prevails on most pastured areas the brush and trees gradually become dominant, and the fields are abandoned even for pasture use.

Poor drainage slows drying and warming of these soils in spring and limits them to a rather narrow range of use. The land is probably best kept in permanent meadow for hay or pasture, but a grain followed by long-term hay or a rotation of corn, grain, and long-term hay can be used where the grains are needed on the farm and where areas of better drained soils are not available for production of these crops. The growing season is ordinarily too short to permit maturing of grain corn, but silage corn can be grown in most years. These soils are poorly suited to potato production and are too wet for deep-rooted legumes like alfalfa. Ladino clover and grass mixtures make a good hay, and tame grasses and wild white clover are good for pastures. Birdsfoot trefoil is a high-yielding legume apparently tolerant of the poor drainage of these soils and shows promise as a forage crop.

Corn and small grain need manure supplemented by superphosphate and potash. Lime is essential to success with most legume-grass mixtures and for most other crops. Old hay stands need top dressings of superphosphated manure or mixed fertilizer, as 0–20–20, about every fourth year. Lime, at the rate of 1 ton an acre every 5 years, and superphosphate are needed to maintain pastures at even fair levels of production. Occasional clipping to control weeds is also needed.

Tile drainage is not economically feasible on most areas of these soils, but properly designed diversion terraces can be used to improve moisture conditions in many places. Strip cropping may be necessary to prevent serious erosion on the stronger long slopes. Maintenance of good tilth is relatively difficult because of poor drainage, and needed tillage operations are delayed in wet springs so that oat and corn yields are seriously decreased.

This unit, as a whole, should be considered similar to Volusia soils on similar slopes, but those parts typical of the Fremont series are somewhat better drained, more productive, and adapted to a wider range of crops.

HOLLY SERIES

The Holly series includes a poorly drained soil of the bottom lands in all parts of the county. The soil is in narrow strips along small streams and occupies the entire flood plain in many places. It is associated with the Tioga and Middlebury soils but is much less im-
important to agriculture because of more limited use suitability. Only one type, Holly silt loam, is mapped in this county.

**Holly silt loam** (0–2% slopes) (HL).—This gray acid soil is in long strips on low or depressed positions on the poorly drained bottom lands along most of the larger streams (pl. 9). In many places it is adjacent to the uplands so that seepage water contributes to the permanently wet condition. It is closely associated with the Middlebury soils but differs from them in having poorer drainage.

The soil is derived from recently deposited acid stream alluvium washed almost entirely from acid sandstone and shale. The original vegetation was mostly forest of soft maple, elm, ash, oak, white pine, hemlock, and in places some spruce and tamarack.

Profile description in a cultivated field:

0 to 6 inches, brownish-gray moderately friable silt loam with threadlike yellow and brown streaks.
6 to 30 inches, light-gray firm or slightly compact silt loam, heavily mottled with shades of brown, yellow, and gray.
30 inches +, gray silt, clay, and sand, imperfectly stratified and containing gravel layers with increasing depth; material is many feet thick and rests on level-bedded acid sandstone or brittle acid shale.

Both the soil profile and underlying alluvium are acid. Water stands on the surface in spring and fall and in some places throughout most of the growing season. All except the top few inches is saturated with water most of the year, and consequently tillage is difficult or impossible and conditions for rooting of most crop plants are very poor.

Some of the poorer drained areas have almost black mucky surface layers several inches thick, whereas better drained areas approach the Middlebury soils in drainage and have little or no mottling in the upper 6 to 12 inches. Some areas with a silty clay loam surface layer and clay to silty clay subsoil are included.

**Use and management.**—Nearly 30 percent of Holly silt loam is in woodland, and about 20 percent is idle or in wasteland. Most of the rest, exceeding 40 percent of the total, is in pasture. Small areas with better drainage are used for hay meadows or in long crop rotations. Corn, buckwheat, oats, and hay are grown in these places and are managed as on the Middlebury soils. Pastures consist of sedges, rushes, some grasses, and many weedy herbaceous plants. On some of the better drained sites wild white clover and some tame grasses grow, but these plants are not common. Neither lime nor fertilizer is ordinarily used on pastures.

Even though this soil supports a heavy sward during the entire growing season, pastures have relatively low-carrying capacity because of the dominance of plants palatable to livestock. Pastures can be improved greatly by removing excess surface water by ditches. Ladino or wild white clover may do fairly well and reed canary grass will produce heavily on such drained areas. Increases of yields obtained by use of lime and fertilizer probably will not pay for their cost on much of this soil unless artificial drainage is provided. Tile drainage is impractical because of high cost as compared to increased returns, but open ditches are practical on many areas. In most areas suitable outlets for drainage are difficult to establish.
The well-drained Howard soils occur in fairly large roughly rectangular areas on glacial outwash terraces in the larger valleys. Those on the nearly level land are confined mainly to several of the larger creek valleys, and those on the hilly and steep slopes, to the Susquehanna River Valley (pl. 10). Howard soils are similar to the Chenango in most respects but differ in having a neutral to alkaline slightly heavier textured subsoil and a moderately calcareous parent material (pl. 11).

Slopes vary from nearly level to steep but most are in the nearly level to rolling range. Texture includes some loam and gravelly loam and considerable gravelly silt loam.

The series is represented in this county by the following phases:

- **Howard gravelly loam:**
  - Hilly phase
  - Nearly level phase
  - Rolling phase
  - Steep phase

- **Howard gravelly silt loam, nearly level phase**

- **Howard loam, nearly level phase**

About two-thirds of the total area of Howard soils is in crops, and much of the rest is in pasture. Small areas are idle and in woodland and about 10 percent is in village sites. Corn, wheat, oats, and alfalfa are the important crops. Management requirements are similar to those for the Chenango soils and center about the use of lime and fertilizer. Howard soils are the best in the county for clover and alfalfa because of the lime content of their lower layers, but a moderate application of lime is required to insure successful seeding of those crops.

**Howard gravelly loam, nearly level phase** (0–3% slopes) (HG N).—Relatively large areas of this soil occur in broader valleys on the smooth nearly level parts of well-drained glacial terraces underlain by deep stratified sand and gravel containing free lime (pl. 12). It is a well-drained acid soil differing from the Chenango soils with similar slopes mainly in having free lime in the substratum and in having a slightly heavier subsoil.

This is one of the most important agricultural soils in the county because it is suitable to intensive use and occurs in fairly large areas (pls. 13 and 14). Some of the largest areas are near Owego, Barton, Candor, Willsayville, and Spencer. The soil absorbs moisture freely and permits deep root penetration. Moisture content is normally adequate for plant needs, although some of the soil with a more porous open substratum is somewhat droughty in seasons of low rainfall. The content of organic matter, lime, and plant nutrients is higher than in most other soils of the county; the supply of these nutrients available is still below that needed for maximum crop production.

Profile description in a cultivated field:

- **0 to 8 inches, grayish-brown friable gravelly loam containing a moderate quantity of organic matter; acid unless lime has been applied.**
- **8 to 28 inches, yellowish-brown moderately friable gravelly loam; upper part acid, but lower part somewhat firm or brittle and only slightly acid or neutral; layer generally distinctly heavier textured below 20 or 24 inches.**
- **28 inches +, yellowish-brown to grayish-brown stratified sand and gravel many feet thick; upper 1 to 2 feet is neutral, but below about 4 feet free lime appears.**
Use and management.—Present use and management of Howard gravelly loam, nearly level phase, is fairly well adjusted to use suitability and management needs. Nearly 75 percent is in cropland, and 15 percent is in pasture. Small areas are idle or wasteland; a few patches are in woods; and approximately 7 percent is in village sites.

The common practice is to grow corn, oats or wheat, and mixed hay in a 3- to 4-year rotation. Potatoes are important in places, and alfalfa is used for hay to some extent. Manure supplemented with superphosphate is used on both corn and small grain, and some potash fertilizer is used as well. Lime is applied preceding seeding of legume hays by most farmers. The favorable texture and rapidity with which the soil warms and dries in spring permit easy and prompt tillage. Most pastures are old hayfields in which the legumes have run out, and they usually do not receive additional amendments or other special practices.

Under prevailing management the average yields of grain corn are 35 bushels; corn silage, 10 tons; wheat, 22 bushels; and mixed hay, 1.6 tons.

Smooth slope, medium texture, favorable moisture supply, and moderate lime content make this soil suitable for intensive use, and under a good system of management it is one of the most productive in the county (pl. 15). It can be conserved under several consecutive years of row crops, but a 3- or 4-year rotation of a row crop, a small grain, and hay is better adapted to the dairy system of farming so widely practiced. Nearly all the common crops will do well. Alfalfa and other legumes, corn, oats, wheat, and many vegetables produce heavily. Potatoes do not produce so well on this soil as on those of the cooler uplands with better air drainage, but large yields are obtained by some growers.

The soil needs lime at the rate of 1 ton in 5 years, or once in each rotation; manure; superphosphate on corn and small grains; and some potash. Large rectangular fields can be laid out on the gentle slopes, and tillage of these can be accomplished easily. Tillage approximately on the contour should be practiced on the more sloping areas. Where this valuable soil is used for pasture, lime, phosphorus, and potash should be applied to obtain heavy yields. Occasional mowing may be necessary to eradicate weeds and to remove excess herbage, but controlled grazing would accomplish this end.

Howard gravelly loam, rolling phase (6–15% slopes) (HGcr).—Stronger slopes bordering the limy gravelly terraces, are occupied by this soil. It usually occurs in small narrow strips adjacent to the smooth parts of the terraces, but small areas on the tops of the hummocky hills are included. This soil is unimportant to agriculture because of its small area.

The environment of this rolling phase is essentially the same as that for the nearly level phase, but slopes are stronger. The soil profile is similar to that of the nearly level phase, but somewhat more material has been lost by erosion and the depth to unweathered parent material is less. In a cultivated field, the 6- to 8-inch surface soil is grayish-brown friable gravelly loam. The subsoil is yellowish-brown gravelly loam, slightly to moderately heavier in the lower few inches. The alkaline parent material begins at about 2 feet, and free lime is at a
Howard soils on slope in background are best suited to pasture because they are on steeper relief and usually contain more sand and gravel than the smooth slopes on Howard soils in foreground.
Parent material of Howard soils; light streaks are lime accumulations in old tree-root channels.
View of Catatonk Valley from the hills southeast of Candor: Howard and associated soils are on the cleared valley floor; Lordstown soils on the forested steeply sloping valley walls; and mainly Volusia and Mardin soils on the more level plateau crest.
Large area of Howard gravelly loam near Candor. Soil is level, well-drained, easy to work, and contains enough lime for most crops, but fertilization is necessary to maintain productivity.
Gentle slope of Howard gravelly loam north of Spencer Lake; Lordstown soils on steep wooded slope in background.
Susquehanna Valley looking southeast from a point about 1½ miles north of Tioga Center. Narrow strips of Tioga soils are on the bottom land along the river in the foreground, but most of the level area in front of the farm buildings is occupied by Howard and Unadilla soils. Acid Chenango soils are on the somewhat higher terrace back of the nearest buildings.
depth of 4 to 5 feet. The surface layer is fairly well supplied with organic matter. The entire profile is permeable to moisture and air and is easily penetrated by plant roots. The relatively coarse texture and fairly strong slopes make this soil somewhat droughty.

Use and management.—Most of this soil is in very small areas associated with other phases of Howard soils, and its use suitability and requirements will be determined by those soils. About a third is in woodland; 15 percent is idle or wasteland; and the rest is about evenly divided between pasture and cropland. The wooded and pastured areas are mainly those associated with the hilly and steep phases of Howard soils, and the cropped areas are those associated with the nearly level phases. Management is similar to that practiced on the associated soils.

Howard gravelly loam, hilly phase (16–25% slopes) (Hgh).—Small isolated elongated hills or areas of hummocky or kame topography in the larger valleys are occupied by this soil. It occurs in several small-to medium-sized areas in the larger valleys; typical ones are near Spencer Lake and south of Smithboro. The soil is relatively unimportant to agriculture because of its small area and limited use suitability.

The parent material consists of alkaline to calcareous stratified gravel and sand deposited in cones or fans at the edge of melting glaciers by rapidly flowing waters. Surface runoff is rapid, and water percolates through the soil rapidly. The original vegetation was hardwood forests of beech, sugar maple, basswood, white ash, cherry, and, in places some white pine.

The profile is essentially the same as that of the rolling phase, although the depth to free lime is probably slightly less, and the firm lower subsoil is less distinct or is lacking. This soil is also more gravelly, and is droughty because of rapid runoff and the open porous nature of the profile and substratum.

Use and management.—About two-thirds of Howard gravelly loam, hilly phase, is now in pasture or idle and about 10 percent is in small patches of woodland. Most of the rest is in cropland. In many pastures the stand is largely bluegrass and wild white clover, which show the high lime content of the soil. Red clover and alfalfa are important constituents of some pastures. Little of the pasture receives amendments or other special management practices. Cropped areas are used in rotation. Grain is grown 1 or 2 years and followed by long-term hay, or a rotation of corn, small grain, and long-term hay is followed. Manure and superphosphate are used on the corn and grain, but additional amendments are not commonly applied to hay.

The average acre yields are grain corn, 20 bushels; silage, 5 tons; oats, 20 bushels; and mixed hay, 1.0 tons. An acre of pasture will furnish about 35 days of grazing for one cow.

Because of strong slopes, irregular topography, and droughtiness, this soil is best suited to pasture; but if soils better suited to crops are not available, long grain-hay or corn-grain-hay rotations can be used.

Corn and small grains need applications of manure supplemented with superphosphate, and probably potash. Wild white or Ladino
clover and grass are suitable pasture mixtures, but better legumes are alfalfa or birdfoot trefoil, for their deep roots are able to obtain lime and moisture from the lower soil layers. Lime is needed to establish legume seedings, and addition of superphosphate is necessary at regular intervals to maintain pastures at a high level of productivity. Some potash may also be needed. Weed control can be accomplished largely by proper grazing but occasional clipping of pastures may be necessary. Pastures on this droughty soil are dormant in dry summer months, and supplementary pasture is necessary.

The irregular slopes make strip cropping or contour tillage difficult or impossible on much of this soil. Areas not suited to these management practices should remain in long-term hay or pasture.

**Howard gravelly loam, steep phase (26–45% slopes) (Hor).**—This phase occupies several small or medium-sized areas on the steep slopes of hummocky glacial terraces or kames and is closely associated with the hilly phase. The two soils have the same origin, are essentially the same in profile, and are in the same parts of the county. Slope is the only important difference between them.

**Use and management.**—Howard gravelly loam, steep phase, is used in the same manner as the hilly phase. About 20 percent is in woodland, 20 percent idle or in wasteland, and most of the rest in pasture or long-term hay. A small acreage is in grain or corn. Fertilizer and lime are seldom used because spreading these amendments is difficult. Yields are somewhat low because amendments are not applied, slopes are steep, and the moisture content is low.

Because of strong slope and droughtiness, pasture is the most intensive use suited to this phase. The same pasture mixtures and the same management requirements as those for the hilly phase are suitable. Where not needed for pasture, this soil can well revert to forest.

The gravel and sand under both this and the hilly phase are excellent for construction uses, as in concrete aggregate, and are in many places easily accessible. One large area near Hooper Valley has been excavated for sand and gravel.

**Howard gravelly silt loam, nearly level phase (0–3% slopes) (Hsn).**—This brownish medium-textured gravelly soil occupies relatively large areas in the broader valleys. It is associated with other Howard soils on the smooth nearly level glacial outwash terraces. From Chenango soils of similar texture on similar slopes it differs chiefly in having an alkaline slightly heavier lower subsoil and calcareous parent material.

The formation of this soil, as to slope, drainage, native vegetation, and source of material, is essentially the same as that of Howard gravelly loam, nearly level phase. The parent material differs slightly, however, in containing more fine-textured material and somewhat less gravel.

The soil is readily permeable to water, but its fine soil material holds moisture well for plants. Favorable aeration, moisture content, and permeability permit good root development. This is a highly productive soil and under good management is one of the most important crop soils of the county. Some of the larger areas are near Spencer, north of Willsleyville, and south of Newark Valley.
The profile is similar to that of the gravelly loam but is somewhat heavier textured throughout, more distinctly firm in the subsoil, and commonly somewhat deeper over calcareous material.

Profile description in a plowed field:

0 to 8 inches, grayish-brown friable mellow gravelly silt loam fairly well supplied with organic matter; acid unless recently limed.

8 to 20 inches, yellowish-brown friable silt loam containing a moderate quantity of gravel; acid in reaction.

20 to 36 inches, dark yellowish-brown moderately firm, brittle gravelly silt loam or sandy clay loam; acid in reaction but less so than the layer above.

36 inches +, stratified silt, sand, and gravel; friable to loose and many feet thick; upper part is alkaline; from about 4 feet downward layer contains free lime as incrustations or concretions; part of the gravel particles are limestone.

The soil, as mapped, includes a few moderate variations. Depth to free lime ranges from 3 to 5 feet. A few small areas, between 3 and 4 percent of the total, have stronger slopes ranging to 25 percent.

Use and management.—Howard gravelly silt loam, nearly level phase, is one of the most intensively used soils of the county, and except for about 30 percent in village sites, nearly all of it is in cropland. Several areas, about 5 percent, are in pasture, and a few small patches are in woods or idle land. Corn, oats, and mixed hay grown in short rotations are the most common crops, but wheat, alfalfa, and potatoes are also important. Dairying is the chief enterprise on most farms. Manure supplemented with superphosphate is applied to both corn and small grain, but some crops, as potatoes, receive a complete commercial fertilizer. The better farmers apply lime prior to seeding legumes. Average acre yields under current management are silage corn, 10 tons; grain corn, 35 bushels; oats, 35; wheat, 22; and mixed hay, 1.6 tons.

Smooth slopes, medium texture, and good moisture content make this soil suitable for intensive use. Row crops can be grown continuously, but short rotations are probably better adapted to the prevailing dairy-type farming. The soil is suited to all the usual grain and forage crops, and alfalfa and such deep-rooted legumes do especially well because the subsoil and substratum are limy. High yields of potatoes can be expected, although some difficulty with disease may be experienced.

Heavy fertilization with manure and superphosphate should be practiced for feed-crop rotations, and probably some potash will be needed. High-value crops, as potatoes and vegetables, need complete commercial mixtures. Lime is needed to establish alfalfa and clover seedings and benefits other crops as well.

The soil dries and warms rapidly in spring and following rains, thus permitting prompt and easy accomplishment of needed tillage. Large rectangular easily tilled fields can be laid out on the smooth nearly level land. On the most strongly sloping areas tillage roughly on the contour may be beneficial, but no other special practices for conserving moisture or soil material are commonly needed.

Because of its high productivity in more intensive uses, this soil cannot be used economically for permanent pasture on most farms. Where this valuable soil is used for pasture, heavy fertilization with
phosphorus and the regular use of lime should be practiced to obtain a maximum return.

**Howard loam, nearly level phase (0–3% slopes) (HNN).**—This phase differs from the nearly level phase of Howard gravelly loam principally in having upper layers relatively free of gravel. It occupies similar positions and was formed under the same condition of drainage, the same type of forest, and from the same general type of parent material. Freedom from gravel in the upper 2 or 3 feet of material suggests that the topmost layers may have been deposited by slowly flowing or quiet waters. Except for the small quantity of gravel in the top 24 to 36 inches, the profile is the same as that of the associated gravelly loam. Only a few areas south of Spencer Lake and north of Litchfield are mapped.

Included with this soil are a few small areas, slightly more than one-fourth of the total acreage, of soil derived from lake-laid silt and sand. The included areas have a grayish-brown friable granular silt loam surface layer about 8 inches thick. The subsoil to a depth of about 28 inches is yellowish-brown moderately friable silt loam with a distinct nutlike structure. Below this depth the material is browner and somewhat finer textured. The underlying parent material is lake-laid calcareous silt and very fine sand many feet thick. This included soil is more retentive of moisture than the typical Howard loam and may be somewhat higher in fertility.

**Use and management.**—Howard loam, nearly level phase, is used in about the same way as Howard gravelly silt loam, nearly level phase. About two-thirds is in cropland, and the rest is in small patches of pasture, idle land, or woodland. Present management, use suitability, and management requirements are about the same as those of Howard gravelly loam, nearly level phase.

**LORDSTOWN SERIES**

The Lordstown soils are widely distributed over the higher more strongly dissected uplands of the county. They are typically in long narrow strips on slopes or narrow ridge tops but in places occupy relatively broad areas. They are the most extensive soils of the county. The associated soils are members of the Bath, Mardin, Volusia, and Chippewa series.

The following phases of Lordstown soils are mapped:

<table>
<thead>
<tr>
<th>Lordstown channery silt loam:</th>
<th>Lordstown flaggy silt loam:</th>
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<tr>
<td>Eroded moderately steep phase</td>
<td>Steep phase</td>
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<tr>
<td>Gently sloping phase</td>
<td>Very steep phase</td>
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<tr>
<td>Moderately steep phase</td>
<td></td>
</tr>
<tr>
<td>Sloping phase</td>
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</tbody>
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At present slightly more than half the Lordstown soils are in forest. Hay, pasture, grain, and potatoes are the important crops, but about a fifth of the cleared land is classed as idle. Under good management fair to good yields of these crops can be obtained on the smoother slopes and deeper soils, but pasture or forest is better suited to the stronger slopes. Corn is not well suited to the Lordstown soils, because of the short growing season. Lack of moisture caused by the shallow depth of soil decreases crop yields in years of low rainfall. Applications of lime, phosphorus, and potassium and conservation of
moisture and soil material are the more important management practices.

**Lordstown channery silt loam, sloping phase** (6–15% slopes) (Lcs).—This well-drained relatively shallow channery acid soil occurs in medium to large irregularly shaped areas throughout the higher uplands of the county. It is low in natural productivity, but because of its large acreage, is a moderately important agricultural soil. Associated soils on less well-drained slopes are members of the Mardin, Volusia, and Chippewa series. The soil occurs in all the uplands, but the larger tracts are northwest of Flemingville, southeast of Catatonk, and northeast of Richford.

Like the other Lordstown soils, this phase is derived from a thin layer of glacial till consisting of pulverized silty soil material and flat rock fragments from the underlying level-bedded sandstone and brittle shale. The soil is on the high more exposed upland where glacial scouring was active and deposition was slight. No foreign material—rocks from other localities—is ordinarily in the parent material. In most places glacial action apparently consisted mainly of plowing and mixing the soil and weathered rock material already present when the ice passed. The sloping uplands are thoroughly dissected by intermittent drainageways. The medium texture of the material and the fairly strong slopes provide good drainage.

The original forest cover included oak, chestnut, hickory, red maple, birch, aspen, and some white and red pines. Dogwood, huckleberry, and sourwood were among the commonest plants in the understory, and sugar maple and beech were on some of the more favorable sites.

**Profile description in a plowed field:**

0 to 7 inches, grayish-brown friable channery silt loam.
7 to 24 inches, yellowish-brown very friable channery silt loam.
24 to 36 inches, glacial till consisting of gray to brown loose silty soil material and flat sandstone and brittle shale fragments.
36 inches +, level-bedded gray sandstone with some brittle shale layers; bedrock generally occurs at a depth of 20 to 40 inches.

The surface layer contains a moderate quantity of organic matter. All the soil layers and parent material are strongly acid. The content of stone fragments is sufficient to interfere with tillage in most places. The soil is permeable to water but retains sufficient moisture for plant growth in normal years. In dry seasons, however, plants may be injured by lack of moisture.

The soil includes several variations. In forested areas the surface is covered with 1 to 2 inches of forest litter, and the upper 2 inches of soil is very dark-gray almost pure organic matter held in a mat of fine roots. It is underlain by a strong yellowish-brown layer that becomes more gray with depth. The upper ½ inch of this layer is commonly light-gray silt. The depth to bedrock varies from 1½ to 4 feet, and there are corresponding variations in moisture supply and depth of rooting.

Several small areas with severe erosion are also included. In these places the finer material of the original surface soil is missing, and the present surface layer is largely channers and upper subsoil material. Small gullies are common on these severely eroded areas. In these places tillage is more difficult and moisture supplies are low. On 10 to 15 percent of the soil, the stone fragments are large flags averaging
6 inches or more in size, and tillage is more difficult than on the normal soil. In addition to these variations, small areas of associated soil series are included. Where it is impractical to show them separately on the map, small areas of the poorly and very poorly drained Volusia and Chippewa soils are included where wet conditions caused by seepage exist, as well as small areas of Mardin soils in patches with restricted internal drainage. A few small areas of the deeper well-drained Bath soils are included locally.

Use and management.—Lordstown channery silt loam, sloping phase, has not received use and management well adjusted to its suitability and needs. About 40 percent of the soil is in forest, slightly more than one-fourth is in cropland, and the rest is about evenly divided between pasture and idle land. Corn for silage, oats, buckwheat, and mixed hay are the common crops. Potatoes are produced by a fewgrowers. Pastures are commonly of poverty oatgrass, although in places bentgrass, timothy, redtop, and some clover are included. Growth on idle land includes poverty oatgrass, paintbrush, blackberry briers, thornapples, seedling apples, fire cherry, young red pine, aspen, and other forest trees.

The common rotation of corn for silage, small grain, and mixed hay is used on this soil. The sod crop remains several years; sometimes it is cut for hay the first 2 years and then pastured until most of the tame grasses have died. Buckwheat is a catch crop used when late seasons in spring prevent seeding of oats or planting of corn. Manure is used on corn and to some extent on grain, and superphosphate is frequently added. Prior to seeding hay, lime is applied by the better farmers, but the practice is not common. Where potatoes are grown, fairly heavy applications of complete commercial fertilizer, as 5–10–5 or 5–10–10, are used. Special practices for conservation of moisture and soil material are not commonly used, although tillage is done roughly on the contour by some farmers. Pastures ordinarily receive no additional soil amendments nor other special management.

Under common management average acre yields are corn silage, 6 tons; oats, 20 bushels; buckwheat, 10; and timothy and clover hay, 1 ton.

Fairly smooth slopes and moderately good moisture content make this a fair soil for crops; but stoniness, low fertility, strong acidity, and fairly strong slopes combine to make management requirements somewhat exacting. Small grain and mixed hay are among the better suited crops. The well-drained friable soil and good climate favor potato production, but droughtiness of the shallow soil reduces yields in dry years, and potato production without water-control practices causes serious erosion. The growing season is too short in many years to permit grain corn to mature, but silage corn does fairly well. Buckwheat is well suited to this soil, for in addition to its short growing season, it is tolerant of the strong acidity and low fertility of the soil. Alfalfa is not well suited because the soil is strongly acid and shallow, but fair results can be obtained with this crop where the soil is heavily limed.

Corn and small grain require manure, superphosphate, and some potash. Lime is needed for legumes; additional manure and superphosphate are needed on old hay stands; and phosphorus and lime
applied at regular intervals are essential for productive pastures. Contour tillage is a soil- and water-conserving practice needed on all this soil, and on most areas additional supporting practices, including use of diversion terraces and strip cropping, are also needed. In addition to regular application of amendments, permanent pastures need occasional clipping for weed control. Supplemental pastures are needed late in summer when it is dry.

Forests on this soil are heavily cut-over and consist of oak, hickory, beech, and maple with undergrowth of dogwood, blueberries, and other shrubs. These forests require the common elements of good forest management, including protection from fires and grazing and selective cutting. Idle fields not needed for crops or pasture can well be allowed to revert to forest.

**Lordstown channery silt loam, gently sloping phase (0–5% slopes)** (LcG).—This phase occupies the relatively narrow gently sloping crests of higher ridges in the uplands. It has properties of workability and conservability superior to most other soils of the higher uplands and is a relatively important agricultural soil.

Except for slope this phase is the same as the sloping phase. It is associated with other Lordstown soils and the less well-drained Mardin, Volusia, and Chippewa soils throughout the uplands. Some of the larger areas are near Candor and northwest of Tioga Center.

The profile is similar to that of the sloping phase, but the combined thickness of glacial till over sandstone bedrock is probably slightly greater. This thicker profile, coupled with gentler slopes, results in more abundant moisture supplies for plants than Lordstown soils on steeper slopes provide.

There are variations in the soil as mapped. Several areas have large stone fragments 6 or more inches in diameter, and other small areas are so severely eroded that most of the original surface soil is missing. As for other Lordstown soils, small areas of Bath, Mardin, Volusia, and Chippewa soils too small to map or indistinct in boundaries are included with this soil. Ordinarily none of these variations is of sufficient extent to alter greatly the use suitability or management requirements.

**Use and management.**—Lordstown channery silt loam, gently sloping phase, is suited to the most intensive use of any of the Lordstown soils because of its mild slope. Moderately exacting management is required, however, owing to strong acidity, low natural fertility, and shallow depth of soil. A 4- to 5-year rotation made up of a row crop, a small grain, and mixed hay is suited to the soil. Potatoes are relatively better suited to this soil than corn because of the cool climate and short growing season, but corn for silage is a more necessary crop in the prevailing dairy-type farming. Contour tillage, as a soil and water conservation measure, is a good practice on this soil wherever feasible. Requirements for fertilizer and other amendments and for pasture management are essentially the same as on the sloping phase. Some areas are difficult of access and remote from other good soils and are probably best used for forest.

**Lordstown channery silt loam, moderately steep phase (16–25% slopes)** (Lcm).—In profile characteristics this soil is essentially the same as the sloping phase. Because of stronger slopes, however, it is
less well suited to crops, and even though the area is large, only
moderately important agriculturally.

Other than in slope, this phase is the same as the sloping phase. It
is in all the higher more dissected parts of the uplands and is associated
with other Lordstown soils and members of the Mardin, Volusia, and
Chippewa series.

The profile is the same as that of the sloping phase, although the
average depth to bedrock is probably slightly less because of more
active erosion, both accelerated and geologic. The 6- to 8-inch surface
soil is grayish-brown friable channery silt loam, and the subsoil is
yellowish-brown friable channery silt loam extending to depths of 20
or 24 inches. Below this is gray channery acid glacial till. Level-
bedded sandstone bedrock is at depths of 2 to 4 feet in most places, but
may be at shallower depths locally. The soil is strongly acid through-
out, permeable to air and moisture, and its layers are easily penetrated
by roots. Moisture content is limited by the shallow depth of soil, and
much water is lost by runoff on the stronger slopes.

Variations similar to those of the sloping phase are included in this
unit. The forested areas have a thin mat of forest litter underlain by
2 to 4 inches of almost pure humus. This rests on about one-half inch of
light-gray silt over the yellowish-brown subsoil. On about a fourth of
the soil stone fragments consist of flake or blocky fragments 6 inches or
more across, and cultivation is difficult in these areas. A few small
areas of shallow Mardin soil are included, as well as patches of Volusia
and Chippewa soil too small to be delineated separately.

Use and management.—Lordstown channery silt loam, moderately
steep phase, is rather poorly adjusted to proper use and management
requirements. About 55 percent of the soil is in forest; 10 percent is
idle; 15 percent is in pasture; and 20 percent is in crops. Corn, small
grain, and mixed hay grown in long rotations are the important crops.
As on other soils of the uplands, buckwheat is important as a catch
crop when cold and wet spring weather prevents planting corn or
sowing oats. Manure, the principal soil amendment, is applied before
corn and small grain and is used to some extent as a top dressing on
hay when the supply permits. Lime is applied before hay seedings by
some farmers, but the practice is not common. Pastures do not
ordinarily receive any amendments or other special management and
consist mainly of poverty oatgrass and weeds.

Tillage is roughly on the contour in places. Some farmers have
constructed hillside ditches to remove excess surface water, but prop-
erly constructed and maintained diversion terraces are not ordinarily
used and strip cropping or careful contour farming is not usually
practiced.

Average acre yields to be excepted under common management are
mixed hay, about 0.8 ton; oats, 20 bushels; and buckwheat, 10 bushels.

Strong slopes, high acidity, stoniness, and shallow depth limit the
use suitability of this soil and make it exacting in management require-
ments. It can be used in long corn, grain, and mixed hay rotations
where need for cropland justifies, but it is best used in long-term
meadows for hay and pasture. Ladino and red clovers, timothy,
redtop, and bentgrasses are among the plants that will do well, if the
soil receives lime and phosphorus, as well as potash fertilizer regularly.
Pastured areas need clipping for weed control and require careful
grazing in dry seasons. As with other soils of the uplands, supplemental pastures on soils with more favorable moisture content are needed during dry months. Where corn and small grain are grown in rotation with hay, liberal applications of barnyard manure, supplemented with superphosphate and some potash, are required for good yields. Lime is needed for legumes. If row crops occur frequently in the rotation, contour tillage, carefully designed diversion terraces, and strip cropping are essential for conservation of soil material and water on this strongly sloping soil.

**Lordstown channery silt loam, eroded moderately steep phase** *(16–25% slopes) (Lcp).*—This soil is closely associated with the moderately steep phase and includes areas from which most of the original surface layer has been removed by accelerated erosion. In many places gullies have formed. The unfavorable workability, conservability, and small acreage of this soil make it unimportant agriculturally.

The parent material, drainage, and native vegetation of this soil are the same as for the moderately steep phase. The present eroded condition has developed under use as cropland or unimproved permanent pasture.

The original profile of this phase was the same as that of the moderately steep phase, but it has been considerably altered by erosion. The soil now has a very stony surface layer, less organic matter, a thinner subsoil, and less thickness over rock.

Profile description in a cropped field:

- 0 to 6 inches, light grayish-brown moderately friable channery silt loam.
- 6 to 18 inches, yellowish-brown moderately friable channery silt loam.
- 18 inches +, channery acid gray glacial till of silt loam texture; level-bedded acid sandstone bedrock is at depths of less than 40 inches in most places and is as shallow as 18 inches in many places.

The surface of the soil is almost completely covered with sandstone channers. On a fourth or more of the soil, the stone fragments are large flags or blocks 6 inches or more in size. The content of organic matter in the plow layer is very low, and the entire profile is strongly acid. Small areas of Mardin, Volusia, and Chippewa soils too small to be delineated separately are included with this unit in mapping.

*Use and management.*—The eroded condition of Lordstown channery silt loam, eroded moderately steep phase, is evidence of poor adjustment of past use and management. Approximately a third of the soil is now cropland, and the rest is in pasture and idle land. Mixed hay, oats, buckwheat, and corn in 4- to 6-year rotations are the main crops. Potatoes are important on a few farms. Manure is the important soil amendment, although in places some superphosphate is applied and lime is used on seedings of legumes. Special practices for water control are not commonly applied. Pasture consists of poverty oat grass, paintbrush, and small quantities of tame grasses and clovers in some places. Pastures ordinarily receive no special management. Acre yields that may be expected under common management are oats, about 15 bushels; buckwheat, 10 bushels; and mixed hay, 0.8 ton.

Because of strong slopes, low fertility, high acidity, eroded condition, and susceptibility to further erosion, this soil is very poorly
suited to crops and is best left in permanent meadow for hay or pasture. Pasture management requirements are essentially the same as those of the moderately steep phase and are concerned largely with supplying needed soil amendments, controlling grazing, and eradicating weeds. Where it is needed for cropland, a rotation of small grain followed by long-term hay or of corn, small grain, and long-term hay can be used.

**Lordstown flaggy silt loam, steep phase (25–45% slopes) (Left).**—This soil occurs throughout the uplands, usually in long strips on steep slopes bordering the deep incised valleys of larger intermittent and perennial streams. Mardin and Volusia soils are on the adjacent higher smoother slopes. This phase differs from the moderately steep phase of Lordstown channery silt loam in having stronger slopes and larger flat stone fragments ranging from 6 inches upward in size. The strong slope and stoniness make the soil unimportant for agriculture even though the area is large.

Like other members of the Lordstown series this soil was formed on well-drained uplands from thin acid glacial till under mixed hardwood forests. The profile is similar to that of Lordstown channery silt loam, except that the stone fragments are larger and the depth to rock is somewhat less. Following is a profile description of a forested area under the 2- to 4-inch mat of raw humus:

- 0 to \( \frac{1}{2} \) inch, grayish-brown loose silt.
- \( \frac{1}{2} \) to 20 inches, yellowish-brown very friable silt loam that becomes lighter with depth.
- 20 to 30 inches, gray loose silt loam; below 30 inches level-bedded platy to somewhat massive fine-grained sandstone with some siltstone and shale layers.

The entire soil profile is strongly to very strongly acid. Sandstone flags 6 to 15 inches across are on the surface and throughout the soil mass. The total depth of soil is less than 20 inches in places, and part or all of the lower two layers is missing. In some places, especially at the higher elevations, there is a thin light-gray layer as much as 2 inches thick. In others the bedrock outcrops on the surface in narrow ledges. In these and other places considerable seepage occurs, and strips of poorly to very poorly drained shallow Volusia or Chippewa soils too small to be delineated separately are developed. Several small areas of the deeper Bath soils are included on areas of moderately deep very compact till.

On the cleared areas, that include about 40 percent of the total area, the upper three layers have been mixed and are now a grayish-brown loose to friable silt loam with a moderate to low organic-matter content. On about half of this cleared land most of the upper mixed layer has been removed by accelerated erosion so that the upper subsoil is at or near the surface. In these places the quantity of stone fragments on the surface is greater, and the surface layer is yellow, somewhat finer textured, and lower in organic matter than on the less eroded forested areas.

**Use and management.**—Lordstown flaggy silt loam, steep phase, is difficult to work and conserve and is very low in productivity of either cultivated crops or grasses. At present about 60 percent is in forest; nearly 30 percent is in meadow or pasture; and the rest is idle land or wasteland. Pastures consist principally of poverty oatgrass, paint-
brush, and other weeds and in many places contain a fairly large quantity of blackberry briers, thornapple, seedling apple, and small forest trees. Ordinarily these pastures receive no soil amendments or other special management. Idle lands contain the same type of growth as the pastured areas but more trees. Many areas are gradually reverting to forest. Small areas are cut for hay, and some fields with deeper soil are used for cropland and receive management similar to that of Lordstown channery silt loam, moderately steep phase.

Shallow depth of soil, steep slope, stoniness, strong acidity, low natural fertility, and low moisture content combine to make this soil very poorly suited to crops that require tillage and poorly suited to pasture. Continuous pasture is the most intensive use to which it is suited, and such use can be justified only where the better soils on the farm are needed for more intensive use. Lime and superphosphate are necessary to obtain stands of the more nutritious tame grasses and legumes; potash also is needed, at least with the initial seedings. Occasionally clipping for weed removal may be required, although the use of needed amendments and proper control of grazing will do much to improve pasture. Such management of this steep soil is extremely difficult.

The 60 percent of this soil in forest should remain in such use, and the more severely eroded cleared areas and those difficult of access or remote from areas of soils well suited to crops and pasture should be permitted to revert to forest. Forests on this soil are similar to those of the very steep phase; they have similar needs for maintenance and serve the same purposes.

**Lordstown flaggy silt loam, very steep phase (46–60% slopes)** (Lvfr).—This soil is essentially the same as the steep phase in all respects except slope. It was formed under similar environment and has a similar profile. The range of variation is about the same, although this phase probably includes a somewhat greater area of rock outcrop, and the average depth of soil material is somewhat less. This phase is on the steepest slopes bordering the stream valleys in the deeply dissected uplands. Representative areas are near North Spencer, Halsey Valley, Reniff, and Richford.

**Use and management.**—More than 80 percent of Lordstown flaggy silt loam, very steep phase, is now forested, and it is very poorly suited to any other use. About half of the cleared area is pastured to some extent, and the rest is idle land or wasteland. Pastures are poorly maintained for the most part and consist chiefly of poverty oatgrass and weeds with brush and small trees in many places. Some grazing is provided in spring, but the grasses are dormant in the warmer summer months and unpalatable weedy plants are dominant. In general it does not appear economically feasible to apply soil amendments to this soil or to use other practices for pasture improvement.

The present forests include oak, hickory, pine, hemlock, maple, and beech, and such trees as dogwood, sassafras, and sourwood in the understory. Most forests have been cut over two times or more, and some areas once cleared have reverted to forest. In many places the stand consists chiefly of weed, cull, and immature trees of little
use other than for firewood. Trees grow slowly on this shallow, droughty, stony soil. The growth of the more desirable timber species can be encouraged by removal of cull and weed trees and by protecting the stands from forest fires and grazing. In addition to their value for timber these forested lands provide a cover for game. They also retard runoff, thereby protecting adjoining upland and valley lands from erosion.

MARDIN SERIES

The Mardin soils are in all the smoother higher upland parts of the county and are associated with soils of the Volusia, Chippewa, and Lordstown series. They are intermediate in drainage between the Lordstown and Volusia soils, and the underlying till is thicker on the average than that of the Lordstown soils.

The Mardin series is represented by the following phases of Mardin channery silt loam:

<table>
<thead>
<tr>
<th>Eroded moderately steep phase</th>
<th>Sloping phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eroded sloping phase</td>
<td>Sloping shallow phase</td>
</tr>
<tr>
<td>Gently sloping shallow phase</td>
<td>Undulating phase</td>
</tr>
<tr>
<td>Moderately steep phase</td>
<td></td>
</tr>
</tbody>
</table>

About a fourth of the Mardin soil area is in forest. Of the cleared part, a fifth is in pasture and a like area is idle. The rest is chiefly in hay and grain, although moderate acreages are in corn, potatoes, and other crops. The content of lime, phosphorus, and potassium is low, and these elements need to be applied to obtain satisfactory yields of most crops. Control of runoff is important in management, especially on the stronger slopes.

Mardin channery silt loam, undulating phase (0–8% slopes) (Mcu).—This moderately drained soil is similar to Canfield soils in many respects but occurs at higher elevations and is underlain by glacial till derived almost entirely from local rocks. It is in small-to medium-sized areas on smooth ridge tops or benchlike positions in the higher uplands and is associated with other Mardin soils and members of the Volusia and Lordstown series.

The soil is derived from acid stony compact glacial till similar to that of the Bath and Volusia series, although the depth to rock is generally somewhat less than in the Bath soils. Surface drainage is medium, but internal drainage is impeded by the compact substratum. This is one of the more important agricultural soils of the higher uplands. The original forest cover included oak, hickory, white pine, beech, and maple and a heavy undergrowth of dogwood, sassafras, huckleberry, and other small trees and shrubs.

Profile description in a plowed field:

0 to 8 inches, grayish-brown friable channery silt loam containing a small to moderate quantity of well-decomposed humus.
8 to 15 inches, very friable yellowish-brown channery silt loam.
15 to 20 inches, mottled yellowish-brown, rusty-brown, and gray channery silt loam; moderately friable.
24 to 38 inches, light-gray to olive massive compact channery silt loam heavily mottled with gray, yellow, and brown.
36 inches +, compact olive to gray channery acid glacial till of silt loam texture; level-bedded gray sandstone bedrock at depths of 4 to 10 feet or more.
The profile is strongly acid throughout. The stone fragments are dominantly small flat ones less than 6 inches across, and are sufficiently numerous to impair workability to some extent. The upper 15 to 18 inches of the profile is well-aerated and permeable to roots and moisture most of the year, but the lower subsoil and hardpan are waterlogged in fall, winter, and early in spring. The hardpan restricts free water movement, so that the soil is characterized by extremes of moisture conditions. It is saturated near the surface during much of fall and spring and is very dry in the drier summer months.

The soil includes several variations as mapped. Slopes of included areas range from 3 to 8 percent, and some small areas are so severely eroded that most of the original surface layer is missing. In these eroded places the plow layer is now in the upper subsoil, and mottling is commonly within 6 to 8 inches of the surface. On other small areas the stone fragments are large flags more than 6 inches in diameter. In addition to these profile variations small areas of other soil series—the well-drained Bath and Lordstown soils, and more especially the poorly drained Volusia soils—are included in this unit, either because they were too small to delineate separately or because boundaries were indistinct.

Use and management.—The present use of Mardin channery silt loam, undulating phase, is fairly well adjusted to suitability, but management is below the level required for highest yields. Nearly half the soil is in cropland; 15 percent is idle; 15 percent is in pasture; and 20 percent is in woodland. Corn, oats, buckwheat, and mixed hay grown in 3- to 5-year rotations are the most common crops, but wheat, rye, and potatoes are important on some farms. Pastures are largely old hayfields in which poverty oatgrass, paintbrush, and other weeds have replaced most of the original tame grasses and legumes, although some timothy, redtop, and clover may remain in places. Thornapple, blackberry briers, and some trees are common in most of the older pastures.

Ordinarily lime and fertilizer are not applied and other special pasture management is not practiced. The vegetation on idle land is much the same as on the older pastures, except that trees are probably more numerous and larger and unless cleared will soon form the dominant cover. A rotation of buckwheat, oats, and mixed hay is used by some farmers. Buckwheat is important as a catch crop when corn or oats fail or when planting is delayed in cold wet springs.

Barnyard manure is the principal soil amendment and is used prior to planting corn and small grain. Top dressings are used on small grain on some farms. Much of the manure produced on the dairy farms is supplemented by superphosphate applied in the barn. Potatoes, where grown commercially, receive large quantities of complete commercial fertilizer. Lime is applied by some farmers preceding grass-legume hay, but the practice is not common. Ordinarily special practices for control of water and conservation of soil material are not followed.

Under prevailing management the average acre yield is corn silage, 7 tons; oats, 30 bushels; buckwheat, 15; and mixed hay, 1.3 tons.

The smooth even slopes of low gradient are favorable for crops, but the impeded drainage, strong acidity, and low natural fertility of
this soil limit to some extent the kind of crops that can be grown and make management requirements exacting. Small grain, buckwheat, and legume-grass hay are the crops best suited. In most years the growing season is too short for producing corn for grain, but corn for silage will do well under good management. Ladino, alsike, and red clovers and tame grasses are suitable for hay and pasture. The soil is not well suited to long-term alfalfa, as the impeded drainage inhibits root development, but alfalfa can be used in grass mixtures if the soil is limed. Impeded drainage makes the soil only fair for potatoes, even though climate is favorable. The soil can be conserved in a 3- to 4-year rotation of corn, grain, and hay if other management requirements are met.

Corn requires fertilization with barnyard manure that has been supplemented with superphosphate, and additional quantities should be applied to the new seeding if the supply of nitrogen is low. Except for top dressings of manure on old stands, additional fertilizer is generally not needed on hay. Lime is essential for success with all legume hay. Potassium is somewhat deficient in this soil, but on dairy farms where heavy applications of manure are made, potash from a commercial fertilizer may not be needed. Potatoes require heavy applications of complete commercial fertilizer.

Contour tillage should be practiced where feasible, but other supporting practices to conserve soil material, including terracing and strip cropping, are ordinarily needed only on the longest, steepest slopes. In some places diversion terraces may be used to advantage to improve drainage, thus permitting the soil to warm and dry earlier in spring.

Nutritious pastures of high carrying capacity can be obtained and maintained by regular use of lime and superphosphate on Ladino clover-grass mixtures. Initial seeding may need potash also, but the supply can be maintained by the scattering of droppings and by occasionally adding light top dressings of manure or muriate of potash. Weed control is attained largely through proper fertilization and grazing, but occasional clipping may be necessary.

**Mardin channery silt loam, sloping phase** (9–15% slopes) (Mc's).—This soil is essentially the same as the undulating phase except for slope. It differs from Canfield soils on similar slopes primarily in having yellower subsoil and in being derived from local sandstone and shale. It is the most extensive of the Mardin soils and is among the important agricultural soils of the higher uplands.

This phase, like the other Mardin soils, was formed in the uplands from a relatively thin olive to gray compact acid channery glacial till under mixed hardwood forests. The fairly strong slopes permit rapid surface runoff, but internal drainage is impeded by the compact substratum. The soil is in small- to medium-sized areas on the higher sloping ridges throughout the uplands. Associated soils are members of the Bath, Lordstown, and Volusia series.

The profile of this phase is very similar to that of the gently sloping shallow phase. In a plowed field the upper 6 to 8 inches is grayish-brown channery silt loam, and the subsoil to a depth of 18 or 24 inches is yellowish-brown channery silt loam mottled with rusty brown in the lower 6 inches. This rests on a hardpan layer 12 to 18 inches thick
that in turn is underlain by very compact channery glacial till. Bedrock is at 4 to 10 feet. Variations in the soil, as mapped, include small areas with large flaggy stone fragments on the surface and throughout the profile and small inclusions of Volusia soils occurring in areas of poorer drainage that were too small to be delineated separately.

Use and management.—Present use of Mardin channery silt loam, sloping phase, is about the same as that of the undulating phase except that the proportion of cropland is slightly less and that of pasture and idle land more. Management is similar, although rotations may be somewhat longer. About 40 percent of the soil is in cropland; 25 percent in woodland, and the rest about equally divided between pasture and idle land. The crops grown and the management—including rotations, use of lime and fertilizer, and water-control practices—are about the same as for the gently sloping shallow phase.

Acre yields are generally slightly less on this phase than on the gently sloping shallow phase. Under common management corn silage yields 6.5 tons; oats, 27 bushels; buckwheat, 15 bushels; and mixed hay, 1.2 tons.

This soil is suited to the same crops as those listed for the undulating phase. It requires the same kind of rotation but the hay crop should remain 1 to 2 years longer because of the stronger slopes and greater difficulty in conserving soil material. Requirements for amendments are also the same as for the gently sloping shallow phase, but more care to conserve soil and to control water is necessary. In addition to contour tillage, diversion terraces and strip cropping are supporting practices needed for conservation of most of this soil. Use of lime and superphosphate and proper control of grazing are important in good pasture management.

Mardin channery silt loam, eroded sloping phase (9–15% slopes) (Mcr).—This eroded moderately drained soil is in many small areas throughout the higher uplands. It is closely associated with the sloping phase. The total area is small, and although the soil is of little importance in the county as a whole, its use and management may present a serious problem on a few farms.

The same general factors operated in the formation of this soil as in the sloping phase, except that poor management under cropping has led to the removal of most of the original surface layer by accelerated erosion. Because of erosion the moderately well-drained yellowish-brown subsoil is thinner and the surface layer is more channery.

Profile description in a plowed field:

0 to 8 inches, light grayish-brown moderately friable silt loam.
8 to 16 inches, mottled yellowish-brown and gray silt loam; layer ordinarily mottled but in places the upper 2 inches is relatively mottle-free.
16 to 28 inches, hardpan layer of light-gray to olive-gray massive compact channery silt loam heavily mottled with gray, yellow, and brown.
28 inches +, compact olive to gray channery acid glacial till of silt loam texture; level-bedded gray sandstone bedrock at depths of 4 to 10 feet.

As on other Mardin soils, the entire profile is strongly acid. Permeability to roots and water is less favorable than on the sloping phase, and the supplies of moisture for plant growth are less favorable because of the shallow depth to the compact substratum. The principal variation in the soil, as mapped, is the inclusion of areas of Volusia soil too small to be delineated separately.
Use and management.—The eroded condition of Mardin channery silt loam, eroded sloping phase, is evidence of poor adjustment of past use and management to its suitability and needs. About half of it is in cropland, and the rest is about equally divided between idle land and pasture. A few small areas are wooded. Crops, rotations, use of amendments, and water-control practices are about the same as for the sloping phase, although row crops may be grown to a greater extent and water-control practices are even less well adjusted to soil needs. Average yields are somewhat lower. Under common management the acre yields are as follows: Silage, 6 tons; oats, 20 bushels; buckwheat, 10 bushels; and mixed hay, 1 ton.

This eroded soil is probably best suited to long-term hay or to grain-hay rotations, but row crops can be grown safely once in 5 or 6 years if needed. The requirements for fertilization, water control, and other practices are essentially the same as for the sloping phase, and pastures require similar management.

Mardin channery silt loam, moderately steep phase (16–30% slopes) (Mcmt).—This soil is on the moderately steep slopes of all the more sloping high uplands. It is associated with other Mardin soils and the Volusia soils, and small areas of these are included in mapping. Because of the strong slopes it is poorly suited to crops that require tillage, and this, with the moderate acreage, makes it an unimportant soil for agriculture.

The parent material, climate, and vegetation are essentially the same as for the undulating and sloping Mardin soils. Surface runoff is somewhat more rapid, but internal drainage is impeded by the hardpan and compact subsoil.

The profile of this soil is essentially the same as that of the undulating phase, but on the average slightly more material has been lost by erosion. The thickness to the mottled layer is slightly reduced, and the total depth over rock is slightly less. Several small areas have large stone fragments on the surface and in the profile, and others have slopes in excess of 30 percent.

Use and management.—The present use of Mardin channery silt loam, moderately steep phase, is fairly well adjusted to its suitability, but management is below the level needed for best returns and conservation. About 45 percent is in woodland, 25 percent in pasture, 10 percent in idle land, and 20 percent in cropland. Mixed hay, buckwheat, oats, and silage corn grown in 4- to 6-year rotations are the important crops. As on other Mardin soils, manure is the chief fertilizer, but it is generally used in smaller quantities and less regularly because it brings a lower response and is more difficult to apply on these steeper slopes. Lime is used less for the same reasons. Special practices for water control are not commonly applied, although tillage is roughly on the contour in places. Pastures are of poor quality. The stand consists of poverty oatgrass, paintbrush, and other weeds. In many places pastures are brushy and contain thornapple, blackberry briers, and small forest trees.

Under common management the average acre yields are silage corn, 6 tons; oats, 20 bushels; buckwheat, 10 bushels; and mixed hay, 1 ton.
Strong slope, imperfect drainage, low fertility, and high acidity combine to make this soil poorly suited to use as cropland, but fair moisture content and moderate response to soil amendments make it fair for pasture. Ladino clover-grass mixtures should do well when adequately limed and phosphated, and birdsfoot trefoil shows promise as a forage crop on this and other soils that have adverse moisture conditions. Where the land is needed for a cultivated crop, 1 year of small grain can be followed by long-term hay or pasture. Besides manure, the grain and new hay seeding will need some superphosphate and possibly additional potash. Where the land is not needed for pasture it should be permitted to revert to forest. The common practices of good forest management, including protection from fires and grazing and selective cutting, are needed.

*Mardin channery silt loam, eroded moderately steep phase* (16–30% slopes) (Mcp).—This soil is unimportant to agriculture because of its small acreage and limited use suitability. It differs from the moderately steep phase in being more eroded and from the eroded sloping phase in occupying stronger slopes. Other than slope, the two eroded phases are essentially the same. This soil is in small areas closely associated with the moderately steep phase in the higher uplands.

*Use and management.*—About 40 percent of Mardin channery silt loam, eroded moderately steep phase, is idle; and this indicates its poor suitability for agricultural use. About 20 percent is in cropland, 30 percent in pasture, and about 10 percent in woodland. Rotation, fertilization, and other management practices are similar to those of the moderately steep phase. Pastures are also managed about the same. Because of the strong slopes and eroded condition, pasture is the most intensive use to which the soil is suited. Pasture management requirements are about the same as for the moderately steep phase and include applications of lime and phosphorus, use of suitable mixtures of seed, control of grazing, and eradication of weeds. Where it is not needed for pasture, this soil should revert to forest. In many places this can be accomplished by natural seeding from adjacent forested areas, but in places planting may be necessary.

*Mardin channery silt loam, gently sloping shallow phase* (0–8% slopes) (Mcw).—This phase differs from the other Mardin soils chiefly in having bedrock at shallower depths and consequently a somewhat less favorable moisture supplying capacity. It is of minor agricultural importance because of small acreage.

This phase, like other Mardin soils, is formed on the higher uplands with moderately good drainage from acid compact glacial till under hardwood forests. The till is very thin, 3 feet or less in total depth to rock, whereas the depth of till in other phases ranges from 4 to 10 feet or more. The soil is in several small widely separated areas. Typical ones are 2 miles northeast of Catatonk and about 3 miles south of Halsey Valley.

*Profile description in a cultivated field:*

- 0 to 7 inches, grayish-brown friable silt loam.
- 7 to 15 inches, yellowish-brown very friable silt loam.
- 15 to 20 inches, yellowish-brown silt loam mottled with brown and gray.
- 20 to 34 inches, light-gray to olive very compact silt loam heavily mottled with gray, yellow, and brown; level-bedded gray sandstone at 34 inches and below.
The entire profile is strongly to very strongly acid. An accumulation of sandstone channers sufficient to interfere with tillage is on the surface and in the soil layers. The moisture content is erratic. The lower soil layers are wet enough much of the time to cause poor aeration and to inhibit root development. The whole profile is very dry during dry periods, even those of short to moderate duration.

**Use and management.**—The small area of this soil is about equally divided as cropland, pasture, forest, and idle land. Present management practices are about the same as for the sloping shallow phase. The soil is suited to the same kind of crops as the sloping phase and has about the same requirements for management of both crops and pasture; yields are lower, however. Construction of diversion terraces may not be feasible because of the shallow depth of soil.

**Mardin channery silt loam, sloping shallow phase** (9–15% slopes) (Mco).—Except for slope this soil is essentially the same as the gently sloping shallow phase. The profile is practically identical in all essential features. The soil occupies several widely separated areas in the higher uplands and is associated with other Mardin soils and the Volusia soils.

**Use and management.**—About two-thirds of Mardin channery silt loam, sloping shallow phase, is in cropland; the rest is in pasture and woodland. The kind of crops and general management practices are about the same as for the sloping phase, and the soil is suited to the same crops and needs about the same management. Control of water and conservation of moisture are especially important on this shallow soil, and strip cropping and contour tillage should be practiced wherever the soil is used in rotations. Construction of diversion terraces is not ordinarily feasible, because of the shallow depth to rock.

**MIDDLEBURY SERIES**

The Middlebury soils are in relatively long narrow strips along most of the larger streams of the county. Only two mapping units are recognized—Middlebury silt loam and its high-bottom phase. These soils are associated with those of the Tioga series in the bottom lands and differ from them chiefly in being less well drained. They are therefore more limited in use suitability.

About 40 percent of the Middlebury soil area is in pasture and a slightly larger percentage is in crops. Most of the remaining area is in woodland, but there are some small areas of idle land. Corn and mixed hay are the important crops. In favorable years, yields on Middlebury soils are about as high as on the associated well-drained Tioga soils, but the danger of summer flooding is greater, and in wet years planting is delayed longer in spring.

**Middlebury silt loam** (0–2% slopes) (Ml).—This fertile soil occurs in long relatively narrow strips on the moderately well-drained level bottom lands of most of the perennial streams and is subject to flooding one to several times each year, mainly in spring. The underlying alluvium is washed largely from the acid sandstone and shale material of adjacent uplands and is acid in reaction and silty to sandy in texture. The soil is associated with Holly and Tioga soils. It differs from the Tioga soils chiefly in having below a depth of about 18 inches a mottled layer caused by restricted drainage.
The soil was originally covered by heavy forests of soft maple, elm, willow, sycamore, and other moisture-loving or moisture-tolerant trees. Very heavy undergrowth was common in these forests. The soil is now important agriculturally because of its relatively high productivity and fairly large acreage.

Middlebury silt loam is a young soil and has much less strongly expressed profile features than the older soils of the uplands and terraces. Following is a profile of the soil in a plowed field:

- 0 to 18 inches, loose to friable mellow silt loam; the upper 6 to 8 inches, which is stirred by tillage, is generally grayish brown because of the content of well-decomposed organic matter; rest of layer is yellowish brown.
- 18 to 36 inches, firm to slightly compact gray to olive silt loam mottled with yellow, brown, and shades of gray.
- 36 inches +, silty to sandy imperfectly stratified alluvium, gray to olive and mottled with gray and brown; material is many feet thick.

The soil is strongly acid throughout, though generally somewhat less acid in the lower layers than in the upper one. Moisture and air circulate in the top layer fairly well, but the second layer is waterlogged during much of the year so that aeration is poor and root development is inhibited. In places the soil includes small quantities of gravel, but not in sufficient quantity to impair workability.

The soil includes some moderate variations. A few small areas mapped in the vicinity of Willseyville have acid surface layers but are alkaline below 18 or 20 inches. In other properties this variation is essentially the same as the typical soil. Small areas of poorly drained Holly and well-drained Tioga soils, and gradations between them and this Middlebury soil, are included in the mapping where they were too small to be delineated separately or where boundaries were not distinct.

**Use and management.**—Middlebury silt loam is used and managed in a way fairly well adjusted to its suitability and needs, but it could be used more intensively without injury. At present about 40 percent is in cropland; 40 percent is in pasture; 5 percent is idle; and 15 percent is woodland. Corn, oats, and mixed hay grown in 3- to 6-year rotations are the important crops. Hay and pasture ordinarily receive no fertilizer, but corn and grain crops receive some superphosphate and manure. Tile drains are on very little of this soil, but open ditches cross or border many areas. The ditches permit more rapid removal of surface water and lower the water table slightly where outlets are low enough.

Pastures generally contain a fair proportion of bluegrass and wild white clover, but also include poverty oatgrass, redtop, bentgrass, and large quantities of goldenrod, paintbrush, thistle, and such weeds. Pastures are heavily grazed and are especially valuable in the drier summer months, inasmuch as the moist condition permits growth when the pastures on the well-drained terrace and upland soils have become practically dormant for lack of water.

Average acre yields under common management are corn silage, 9 tons; oats, 25 bushels; and mixed hay, 1.7 tons. An acre of pasture will carry 1 animal unit for about 80 days.

This soil is suited to moderately intensive use, and under conditions in this county it can be efficiently used in 3- to 4-year rotation made up of a row crop, a small grain, and mixed hay. Corn, oats, wheat,
buckwheat, timothy, red clover, alsike clover, Ladino clover, bluegrass, and wild white clover are among the crops fairly well suited. Because of imperfect drainage and the shallow rooting zone, the soil is poorly suited to alfalfa and potatoes. Some difficulty with lodging of small grain may be experienced. Serious damage or total loss of crops by flooding may be expected at infrequent intervals.

Although this soil is fairly high in natural fertility, profitable increases in yields may be expected from applications of amendments. Correction of soil acidity by lime will increase the quantity of legumes and bluegrass in pastures and will result in better success with the seedings of legume hays. Barnyard manure, with superphosphate, may be expected to increase yields of all crops in the rotation when applied to corn and grain. Tile drainage may be useful in improving moisture conditions on some of this soil, thereby permitting more intensive use, but before tiling is attempted, careful consideration should be given to cost in relation to increased returns.

In addition to lime, superphosphate is necessary to obtain and maintain good legume-grass mixtures in pastures. Pastures on this soil can stand continuous moderately heavy grazing, except that during wet periods the stand may be damaged by trampling. The moist condition of the soil encourages rapid growth, and clipping may be necessary as a weed-control measure.

**Middlebury silt loam, high-bottom phase** (0–2 % slopes) (MLB).—This soil differs from Middlebury silt loam primarily in occupying somewhat higher positions that are relatively free from flooding. Because of small acreage it is unimportant in the agriculture of the county as a whole. It is important on the few farms where it occurs, as it is highly productive.

Parent material, vegetation, drainage, and slope are essentially the same as for Middlebury silt loam, but this soil occupies somewhat older bottom lands several feet above the present stream flood plains and is flooded only in times of extremely high water. Several widely separated areas are mapped, as near West Candor, Berkshire, and Lockwood.

The profile of this soil is essentially the same as that of the silt loam, and there are similar variations in acidity and drainage. Internal moisture conditions are also similar.

**Use and management.**—Because of less danger of flooding Middlebury silt loam, high-bottom phase, is used more intensively than Middlebury silt loam. About 75 percent is in crops. Most of the rest is in pasture, although some small patches are in woods. The kind of crops and the rotation, fertilization, and water control practices used are about the same as on silt loam, but yields average slightly higher because of less frequent flooding.

Under the dairy-farming system practiced, this soil is probably best used for a corn, grain, and hay rotation, although it could be used almost continuously for row crops. Requirements for lime, fertilizer, and water control are about the same as those for the silt loam.
Muck (Mu) includes all areas of soil derived from organic material, and variations among the different areas are fairly wide. It is in small very poorly drained shallow depressions, mostly on the glacial outwash terraces and stream bottom lands, but to some extent is in the uplands.

Muck is derived chiefly from the decomposition products of trees and shrubs, although some material from weeds, sedges, cattails, and mosses is included. It is mainly in small areas of a few acres extent, although some tracts of 50 or more acres are mapped. The larger areas are in the broad valleys extending northward from North Spencer. In its present undrained condition Muck is of relatively small agricultural importance because of small acreage and limited suitability. The tree growth includes soft maple, boxelder, elm, blue beech, sycamore, and willows.

Profile description in a woodland area:

0 to 12 inches, dark-brown to black well-decomposed organic material heavily matted with roots of trees and herbaceous plants; generally contains a moderate quantity of sand and silt.
12 to 24 inches, brown partly decomposed woody material.
24 inches +, fibrous peaty material consisting of woody plant remains or reeds, sedges, and other organic material.

STEEP STONY LAND (LORDSTOWN SOIL MATERIAL) (25+% SLOPES)

Steep stony land (Lordstown soil material) (SSL) is a miscellaneous land type occurring in many widely separated narrow areas on slopes flanking the deeper valleys in the uplands. It is closely associated with the hilly and steep phases of Lordstown soils and has the same general environment, but the steep slopes do not have so deep soil material or so distinct a development of soil profile. Representative areas are near Owego, Richford, and Waverly.

The soil material consists largely of flaggy and stony fragments of sandstone and brittle shale. Some grayish to yellowish fine soil material and smaller channers fill the spaces among the large fragments. Bedrock of sandstone with some brittle shale layers is within 2 feet or less of the surface in most places, and outcropping ledges are very common. In places rock cliffs or precipices are included in this unit. On small areas the soil material has accumulated in pockets of sufficient depth to permit the formation of soil profiles with characteristics of members of the Lordstown series on similar slopes.

Use and management.—At present practically all Steep stony land (Lordstown soil material) is in forests of oak, hickory, beech, maple, and pine. Most of these woodlands have been cut over, and the present growth includes a large quantity of weed and cull trees. A few small areas are cleared and used to some extent for pastures that consist largely of poverty oatgrass and various weeds. Because of the steep slopes, stoniness, droughtiness, and shallow depth of material, this type of land is very poorly suited to any use other than forest. The common practices of good forest management, including protection from fires and grazing and systematic harvesting of timber, are needed. The more precipitous rocky slopes will not support any kind of vegetation and are essentially wasteland.
TIoga SERIES

The Tioga soils are in long narrow strips on well-drained bottom lands along the Susquehanna River and some of the larger tributary creeks. The soils are probably the most fertile in the county, but the range of use suitability is somewhat limited by their susceptibility to annual flooding. The series is represented in this county by Tioga gravelly loam and its high-bottom phase, Tioga fine sandy loam, and Tioga silt loam and its high-bottom phase.

About two-thirds of the total area of Tioga soils is in crops. Much of the rest is in pasture, and small patches are idle or in forest. Corn and mixed hay are the important crops and are commonly grown without the use of soil amendments. The soils are only moderately well suited to alfalfa because of flooding and low lime content, and small grains on them are more susceptible to lodging and disease than on the higher lying less fertile soils of the terraces and uplands.

Tioga silt loam (0–3% slopes) (Ts).—This well-drained soil is generally in relatively long and narrow moderately large areas on the bottom lands bordering the larger streams. Representative areas are in the Susquehanna Valley east of Apalachin, near Owego, and along the southern part of Owego Creek. It is one of the most productive soils of the county, and it is very important to agriculture, even though it covers only about 1 percent of the county.

Tioga silt loam, like other members of the series, is on nearly level stream bottom lands. It is derived from recent alluvium washed mainly from acid sandstone and shale material of the adjacent uplands. The bottom lands are well drained but subject to overflow from one to several times each year, mostly in spring. It is a young soil and has less distinctly expressed features than the soils on the adjoining outwash terraces and uplands.

This soil originally supported a very heavy forest of soft maple, sycamore, elm, willow, and in places some white pine and hemlock. This fertile soil was probably one of the first cleared by the Indians.

Profile description in a cultivated field:

0 to 18 inches, pale yellowish-brown to grayish-brown friable silt loam; upper 8 inches—the part stirred by tillage—contains a moderate quantity of well-decomposed organic matter and may be brownish gray.

18 to 36 inches, pale yellowish-brown loam to silt loam that contains somewhat more sand than the layer above and may contain a few indistinct mottlings in the lower part.

36 inches +, stratified sand, silt, and gravel extending to depths of many feet.

Both the upper soil layers and the underlying alluvium are acid. The soil has good internal drainage but retains adequate supplies of moisture for plant growth. Both moisture and air circulate freely, and roots penetrate easily. Most of the soil is free of stone or gravel on the surface and in the upper 3 feet, but narrow gravelly strips are common adjacent to stream channels and inside the river bends. Small sandy areas also occur in a few places.

Use and management.—Tioga silt loam is one of the more intensively used soils in the county. Approximately two-thirds is in cropland, and slightly more than one-fifth, in pasture. Except for a few areas in urban use, the rest is in small patches of woodland and idle land. Mixed hay, corn, and oats are the principal crops and are commonly grown in a rotation of corn, grain, and hay for 3 or 4 years. Potatoes
or vegetables are grown by some farmers. Superphosphate and some manure are applied to the corn and grain crops. Hay is not commonly fertilized, and very little of the soil is limed. Crops are severely damaged or destroyed by summer floods at infrequent intervals, but average acre yields are high. Under current management corn silage yields about 12 tons; grain corn, 40 bushels; oats, 35 bushels; and mixed hay, 1.8 tons.

Level relief, good drainage, and medium texture together permit easy maintenance of good tilth, and these with relatively high natural fertility make the soil suitable for intensive use. Strong acidity, susceptibility to flooding, and at least moderate deficiency in phosphorus limit its use to some extent.

The soil can be conserved if row crops are grown almost continuously and only short periods in hay intervene, but a 3- or 4-year rotation of corn, small grain, and hay is probably better suited to the dairy-farm economy of the county. Where floods late in winter and early in spring last long enough to drown perennial legumes, fall-sown grains, or like crops, the soil is best used for corn, vegetables, spring grains, and other annual crops. Corn for grain or silage, mixed hay, and most vegetable crops are well suited to this soil. The climate is relatively unfavorable for potatoes. Alfalfa in mixtures with grasses is a productive legume when lime is supplied. Oats, wheat, and other small grains will yield rather heavily, but considerable difficulty with lodging may be experienced, and disease is harder to control than on the upland and terrace soils.

The soil is moderately high in natural fertility, but applications of superphosphate and manure will increase the yields of both corn and small grain. The extra nitrogen from the manure may increase lodging of the grain. Lime is necessary to obtain and maintain good stands of clover and alfalfa. Where the soil is used for continuous row crops, requirements for amendments are high, and winter cover crops, as rye or vetch, are needed to maintain organic matter and nitrogen and to protect the soil from scouring by floodwaters. Special practices for water control are not ordinarily necessary, although tree planting for protection of stream banks may be needed in places. The soil warms and dries rapidly after spring floods recede, so that normally prompt and easy tillage is possible and favorable tilth is easily maintained.

The soil produces good pasture, but its suitability for more intensive use precludes its continued use for this purpose. Where it is used for pasture, high productivity should be maintained by applying lime and superphosphate to bluegrass-clover sods. Because of favorable moisture supply and high fertility, the pastures can be grazed heavily throughout the season, although there may be some reduction in carrying capacity late in summer and early in fall. Occasional clipping for weed control may be necessary.

*Tioga silt loam, high-bottom phase* (0–3% slopes) (Tsb).—This soil is very similar to Tioga silt loam but is less subject to flooding. Like the silt loam, it is a very important agricultural soil, even though the area is small.

The environment of this phase is practically the same as that of the silt loam. It is on slightly higher bottom lands a few feet above the
level commonly inundated by present floods, however, and is flooded only by extremely high water. Most of the areas are some distance from the present stream channel and were true first bottom lands when the streams flowed at a level slightly higher than they do now. The soil is in long, narrow strips paralleling some of the larger streams. Representative areas in the Susquehanna River Valley are those near Hiawatha Island, Tioga Center, Barton, and Litchfield, and other small, more widely separated areas are in the valleys of Catatonk and Owego Creeks.

Like the silt loam, this is a very young soil with weakly expressed profile features. In most properties the two are very similar, although this one is somewhat browner. In a cultivated field the upper 18 inches is pale yellowish-brown friable silt loam, the first 3 inches of which is darkened by organic matter. From 18 inches downward the soil is somewhat more sandy, but the material is firmer in place and may be slightly darker in color. Below about 3 feet are stratified sand, silt, and gravel many feet thick. Both the soil and parent material are acid. Moisture and air circulate freely, and roots penetrate all layers easily. No pronounced variations are included in the soil as mapped.

Use and management.—Tioga silt loam, high-bottom phase, is used somewhat more intensively than the silt loam because it is less subject to flooding. Nearly four-fifths of the acreage is in cropland, and about 10 percent is in urban use. Most of the rest is in pasture, but there are a few small patches of idle and wooded land. Corn, oats, and mixed hay grown in 3- to 4-year rotations are the principal crops, although some alfalfa is grown. Manure and superphosphate are applied to corn and grain, and the soil is limed for alfalfa. Yields for any given year may be about the same as for the silt loam, but averages for a period of years are probably slightly higher because of smaller loss from floods.

This soil has all the favorable features of Tioga silt loam and in addition is less subject to floods. It is suited to the same crops, but winter grains and alfalfa will probably do better on it. Needed amendments and other management requirements for both crops and pasture are essentially the same.

Tioga fine sandy loam (0–3% slopes) (Tv).—This soil differs from Tioga silt loam chiefly in being coarser textured. Because of small acreage it is relatively unimportant in the agriculture of the county. The parent material consists mainly of sand, although there is some silt and gravel in places. Other environmental features are the same as for the silt loam. The soil occupies several areas in the larger stream bottoms. Representative areas are near Tioga Center and Lockwood.

Like other Tioga soils, this type has weakly expressed soil profile features. The upper 18 or 20 inches is pale yellowish-brown fine sandy loam, friable to loose in the 6- to 7-inch plow layer but somewhat firm in the remaining depth. Below 20 inches is loose and porous light yellowish-brown fine sandy loam to loamy sand. Below 40 inches the material is more or less stratified and contains layers of gravel and silt. Small quantities of gravel are on the surface and throughout the soil. All the material is acid. Moisture supplies
are probably somewhat less favorable than for the silt loam, because of the coarser texture and more porous nature of the lower layers.

Use and management.—Tioga fine sandy loam is used and managed in essentially the same way as Tioga silt loam. About 60 percent is in rotated crops, and most of the rest is in pasture. Small areas are idle or in urban use. The kinds of crops grown and the rotation, fertilization, and water-control practices now used are the same as on the silt loam, and the two soils are essentially the same in requirements for good management.

Tioga gravelly loam (0–3% slopes) (Tg).—This gravelly soil is confined mainly to the bottom lands of larger streams. It differs from Tioga silt loam in being coarser textured and in containing sufficient gravel to interfere with tillage. It is also somewhat less productive of most crops and less important to agriculture because of its relatively small acreage.

This soil was formed under nearly the same conditions as Tioga silt loam, but the parent material is almost entirely of local origin and consists of gravel, sand, and silt washed from the adjacent uplands. This alluvium contains large quantities of stone fragments, most of which are flat or angular and only a little rounded at the corners by water action. The soil is in small- to medium-sized areas, generally in strips adjacent to stream channels in the Susquehanna River Valley and a few of the larger creek valleys. It is associated with other Tioga soils and members of the Middlebury and Holly series.

The soil profile, except for the content of gravel, is similar to that of Tioga silt loam. Pale yellowish-brown gravelly loam, the first 8 inches of which are darkened by organic matter, extends to a depth of 18 to 20 inches. The plowed part of this layer is loose and friable, but the rest is somewhat firm in place. From 20 to about 40 inches is grayish-yellow to yellowish-brown gravelly loam to loamy sand, definitely more loose and open than the overlying layer. From 40 inches downward for many feet is gravel stratified with sand and some silty layers. Both the soil and parent material are acid. Moisture circulates freely, but because the soil is coarser textured and more porous, supplies for plants are probably somewhat less than in Tioga silt loam.

Use and management.—Because of its coarser texture and less favorable moisture supply, Tioga gravelly loam is used somewhat less intensively than the silt loam. About 60 percent is in rotated crops and about 20 percent is in pasture. Most of the rest is idle land, but one or two small areas are in woodland or in urban use. The kinds of crops grown and the rotation, fertilization, and other management practices used are the same as for the silt loam. The acre yields average slightly less. Under common management corn yields 35 bushels an acre; oats, 35 bushels; and mixed hay, 1.7 tons. Practices required for good management are essentially the same as for Tioga silt loam.

Tioga gravelly loam, high-bottom phase (0–3% slopes) (Tgs).—This soil differs from Tioga gravelly loam primarily in being at a slightly higher elevation, and consequently it is less subject to flooding. From the high-bottom phase of Tioga silt loam it differs in containing a significant quantity of gravel. It is unimportant in the agriculture

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of the county because of small acreage, although it may be important on a few farms.

The conditions under which this soil was formed are similar to those of the high-bottom phase of Tioga silt loam. The parent material, however, contains a large quantity of gravel and is more open and porous. Most of the soil is in the larger valleys. Typical areas are near Nichols, Waverly, and Tioga Center.

The profile of this soil is similar to that of Tioga gravelly loam but in places is somewhat browner, and the material below the plow layer is slightly firmer and has an imperfectly expressed weak nuciform structure. Moisture conditions are similar to those in Tioga gravelly loam, except that this soil is flooded very infrequently, rather than annually.

**Use and management.**—About three-fourths of Tioga gravelly loam, high-bottom phase, is in cropland. Most of the rest is in pasture, but a few small areas are in woodland, idle land, and urban use. Present use and management, use suitability, and requirements for good management are essentially the same as for Tioga silt loam, high-bottom phase. The average yields are probably slightly less because of lower growing-season water supply.

**Unadilla Series**

The Unadilla are well-drained acid soils on smooth low terraces. Most of the soils are in medium-sized roughly rectangular areas in the valley of the Susquehanna River. They are important to agriculture because of suitability to intensive use. Slopes vary from nearly level to sloping; and texture, from fine sandy loam to silt loam. Unadilla fine sandy loam, nearly level phase, and the nearly level and the sloping phases of Unadilla silt loam are mapped in this county.

Nearly all the Unadilla soils are cleared, and more than three-fourths of the total area is cropped. Most of the rest is in pasture, but small areas are idle, and several tracts are in village sites. Corn, wheat, oats, and alfalfa are the important crops. These soils are probably the most productive in the county, but lime, phosphorus, and possibly potash must be supplied in order to obtain continuing high crop yields. The profile of Unadilla soils is similar to that of the Chenango but differs in having a less strongly developed yellowish-brown subsoil.

**Unadilla silt loam, nearly level phase (0–3% slopes) (UNN).**—This yellowish-brown, medium-textured, gravel-free soil is among the most productive in the county. It is excellent for a wide variety of crops. Most of it is in fairly large areas in the Susquehanna River Valley; typical tracts are near Waverly and Lounsberry and on Hiawatha Island. Chenango and Howard soils are on the nearby higher glacial terraces and Tioga, Middlebury, and Holly soils on the lower first bottom land.

This soil is on nearly level well-drained stream terraces well above present overflow. The terraces were built up in the past by flood waters from the present postglacial streams flowing on what were then first bottom lands. Since these materials were deposited, the streams have deepened their channels and no longer overflow the
terraces, thus permitting weathering, leaching, and development of soil layers. The terrace deposits consist mainly of silt and fine sand washed from sandstone and shale. The upper 3 or 4 feet is free of gravel, although some is in the lower parts.

The soil was formed under mixed hardwood forest, including beech, sugar maple, basswood, white ash, black cherry, and white pine; but long use as cropland has modified the effects of this original vegetation.

Profile description in a plowed field:

0 to 8 inches, grayish-brown friable mellow silt loam with a moderate content of well-decomposed organic matter; acid in reaction.
8 to 30 inches, light yellowish-brown friable silt loam; lower few inches slightly lighter in color and firmer in consistence; acid in reaction.
30 inches +, stratified silt and sand with some gravel layers in places; material is light grayish brown, free of mottling, many feet thick, and at depths of 5 or 6 feet may be alkaline; concretions of free lime or limestone gravel are fairly numerous.

This medium-textured soil has a large moisture-holding capacity, and moisture and air move readily through it. Roots penetrate to all depths with ease. Moderate variations in the color of the surface layer occur. The areas low in organic matter are light grayish brown rather than grayish brown. In many areas a gravelly layer is at a depth of about 3 feet, but this is not consistent.

Use and management.—Because of smooth nearly level slopes, medium texture, freedom from stone or gravel, good moisture supply, and moderate fertility, Unadilla silt loam, nearly level phase, is one of the most intensively used soils in Tioga County. Slightly more than four-fifths is cropland; 10 percent, pasture; the rest is in urban use, except for a few small idle and wooded areas. Corn for grain or silage, oats, and mixed hay are the most important crops; but wheat, barley, alfalfa, potatoes, and truck crops are also grown. The dairy-farm rotation of corn, small grain, and mixed hay is used on most of the soil. Fairly heavy applications of manure and some superphosphate are made for the corn and grain. Smooth slopes and medium texture permit easy and rapid accomplishment of needed tillage and easy maintenance of good tilth. The yields on this soil are among the highest in the county. Under common management corn yields 50 bushels an acre; oats, 45; wheat, 25; and mixed hay, 2 tons.

This soil is suited to intensive use and, because of favorable moisture supply, good physical properties, and nearly level relief, crops make efficient use of fertilizer. For this reason it may be profitable to use the soil almost continuously for row crops, if heavy applications of manure, superphosphate, and lime are used to supply the elements of fertility in which the soil is deficient. Winter cover crops, as rye or vetch, are important to help maintain organic matter and to hold plant nutrients that otherwise would be lost by leaching.

In the dairy type of farming prevailing, a 3- or 4-year rotation of corn, grain, and mixed hay is probably better suited to the soil than almost continuous row crops. Manure supplemented with superphosphate is needed for the corn and grain crops, and regular liming is essential to success with legumes. Alfalfa is especially well suited to the soil if longer rotations are desired. The nearly level land permits laying out large rectangular fields, and the only special precaution for
water control ordinarily required is that tillage be across slopes that have any perceptible gradient.

Although this soil will produce excellent pasture, such use is not generally economical because the soil is so well suited to much more intensive use. Pastures should be maintained at a high level of productivity. This can be attained by the use of superphosphate and lime on clover and grass mixtures. Occasional clipping is necessary to control weeds. Heavy grazing should be practiced to obtain maximum returns from this valuable soil, but some reduction in grazing may be necessary in the drier summer months to avoid damage to the stand.

**Unadilla silt loam, sloping phase** (6–15% slopes) (Uns).—This soil differs from the nearly level phase chiefly in that it has stronger slopes. From Chenango soils on similar slopes, it differs in being free of gravel in the upper layers and less intensively leached. It is closely associated with the nearly level phase and is confined largely to the Susquehanna River Valley. It occurs mainly in narrow strips or irregularly shaped areas on the sloping edges of the terraces.

Except for the stronger slopes, the factors involved in the formation of this soil—including parent material, climate, drainage, and vegetation—are the same as for the nearly level phase. The profile is essentially the same as for the nearly level phase, but in places some material has been lost by erosion and organic matter has been dissipated through cropping so that the surface layer is lighter colored or more yellow. A few small areas of soil having slopes of 15 to 25 percent are included.

**Use and management.**—Because of stronger slopes, Unadilla silt loam, sloping phase, has less favorable properties than the level phase, and this is reflected in less intensive use. About 60 percent is in cropland, and except for a small area in urban use, the rest is about equally divided between idle land and woodland. The crops grown and common management practices are about the same as for the nearly level phase, although the average rotation is somewhat longer and average yields are slightly less.

Like the nearly level phase, this soil is suited to all the common crops grown in the county, but management requirements are more exacting because of the stronger slopes. These requirements are similar to those for Chenango gravelly loam, rolling phase. They include mainly the use of lime and fertilizer and some practices for water control, as contour tillage and, in places, strip cropping. Pastures also need about the same management as on the Chenango soil.

**Unadilla fine sandy land, nearly level phase** (0–3% slopes) (Unf).—This soil differs from the silt loam primarily in that it is somewhat coarser textured. It is of considerable importance in a few localities, but the total acreage is small and it is of only moderate importance in the county as a whole. The soil is in the larger valleys. Representative areas are near Barton, Lounsberry, and Catatonk. It was formed under the same environment as the silt loam, except that the quantity of sand in the parent material was higher. Texture is the main basis for differentiating this soil from the silt loam, but it is also somewhat duller in color and looser in consistence in the lower layers.
Remnants of an old orchard on Volusia soil; poor drainage and unfavorable climate are responsible for abandonment of orchards on Volusia soils; forested area on Lordstown soil in background.
Profile of Woostern gravelly silt loam.
Profile description in a plowed field:

0 to 8 inches, grayish-brown friable granular fine sandy loam, fairly well supplied with organic matter and acid in reaction.

8 to 24 inches, light yellowish-brown friable fine sandy loam with no distinct structure; acid in reaction.

24 inches +, loose fine sandy loam to loamy sand, commonly olive gray but yellowish brown in some places; below 3 feet material is stratified and may contain gravel beds; below 6 feet or more are small quantities of limestone gravel and some lime concretions.

The soil profile is readily permeable to air and water, and roots penetrate all layers with ease. Moisture supplies for plants are somewhat less favorable than for the silt loam because of the coarser texture and lower water-holding capacity.

Included are a few small areas of soil with very weakly expressed profile features similar to those of Tioga soils. Several other small areas with slopes of 15 to 25 percent are also included.

Use and management.—The present use of Unadilla fine sandy loam, nearly level phase, is about the same as that of the silt loam. About 70 percent is in cropland, and most of the rest is in pasture. A few small areas are in woodland, idle land, and urban use. The crops grown and practices of management, including rotation and fertilization, are about the same as for the silt loam, and this soil has the same requirements for good management. The yields average somewhat less because of lower moisture supplies. Corn yields 45 bushels an acre; oats, 40; wheat, 22; and mixed hay, 1.8 tons under common management.

**VOLUSIA SERIES**

The Volusia soils are on all parts of the uplands on long, smooth slopes and are exceeded in area only by the Lordstown soils. Because of this large area and wide distribution over the county they are important agriculturally, even though their use is seriously limited by poor drainage. They are associated with members of the Lordstown, Mardin, Bath, Woostern, Canfield, and Chippewa series.

The series is represented in this county by the eroded moderately steep phases, eroded sloping phases, gently sloping phases, moderately steep phases, and sloping phases of Volusia channery and gravelly silt loams.

Slightly more than a fourth of the total area of Volusia soils is in forest, a like part is in pasture, and about 15 percent is idle. The rest is in crops, mostly hay, buckwheat, oats, and wheat. Under good management corn for silage does fairly well, but the growing season is too short for maturing of grain corn in most years. Management practices for maintaining or increasing the supplies of lime, phosphorus, potassium, and nitrogen are needed on all these soils. Some improvement in drainage may be obtained by open ditches, especially those of the diversion type. Tile drainage is of little or no benefit because of the hardpan at a relatively shallow depth.

**Volusia channery and gravelly silt loams, gently sloping phases (0–9% slopes) (Vcl).**—This unit with other members of the Volusia series occurs in many medium to large areas on long smooth poorly drained slopes throughout the uplands (pl. 16). It is by far the most extensive upland soil unit on gentle slopes.
This unit is on poorly drained slopes both in the valley-wall and upland positions. The gravelly types occur in association with Woostern and Canfield soils in valley-wall positions; and the channery soils are associated with members of the Mardin and Lordstown series in the higher uplands. The material is derived from compact to very compact olive to gray acid glacial till 4 to 10 feet thick. The till in the higher uplands consists almost entirely of local sandstone and shale material. The stone fragments are flat channers with some flags. Areas associated with Woostern and Canfield soil, though largely from local material, include moderate quantities of material from granite, red sandstone, and other rocks from distant places, and a part of the rock fragments are rounded.

The till is underlain by level-bedded acid fine-grained gray sandstone, siltstone, and brittle shale. The long smooth slopes, compact till, and impervious character of the underlying rock combine to prevent downward percolation of water and encourage seepage conditions. This combination of conditions accounts for the poor drainage. The soils were formed under hardwood forest of maple, oak, some hickory, beech, and hemlock, and some ironwood, sourwood, dogwood and other small trees in the undergrowth.

Profile description in a cultivated field:

0 to 7 inches, light brownish-gray friable channery silt loam, generally fairly well supplied with organic matter.
7 to 18 inches, pale-yellow firm channery silt loam strongly mottled with shades of gray, brown, and yellow.
18 to 30 inches, a hardpan of dense compact olive-gray channery silt loam to light silty clay loam heavily mottled with gray, yellow, and brown; gradual transition to layer below.
30 inches +, olive to gray compact channery glacial till of silt loam texture; level-bedded sandstone, siltstone, or brittle shale at 4 to 10 feet.

The profile and parent material are strongly acid throughout. Moisture and air circulate poorly in the soil, and roots of most crop plants do not penetrate the hardpan. The soil is characterized by extremes of moisture conditions. It warms and dries very slowly in spring but may become very dry and hard late in summer. While the soil is wet in spring, roots are confined to shallow depths; thus, when the soil becomes dry in summer, they can draw moisture from only a small volume of soil.

The content of rock fragments is sufficient to interfere with most tillage. These fragments are flat channers less than 6 inches across in those areas associated with the Mardin soils in the higher uplands. Where this unit is associated with Woostern and Canfield soils, and about one-third or less of the total area mapped is so associated, the soils have a profile essentially the same as that described, but both the soil and parent material include moderate quantities of rounded granite and red sandstone fragments.

The soil unit, as mapped, includes several other moderate variations. Several small areas, 2 or 3 percent of the total, have large flat stone fragments (flags) on the surface and in the soil in sufficient quantity to make tillage very difficult. A similar acreage has slopes of less than 3 percent, whereas most of this unit is in the 3- to 8-percent slope range. On about 5 percent of this unit most of the original surface layer has been removed by erosion, and the upper part of the original subsoil is now the surface soil, or plowed layer. In addition
to these variations small areas of the very poorly drained Chippewa soils and imperfectly drained Mardin soils and gradations of them are included in mapping, either because they were too small to be delineated separately or because soil boundaries are indistinct.

Use and management.—The many areas of idle or abandoned land are evidence of poor adjustment of use and management to the suitability and needs of the soils of this unit. About 35 percent of the total area is cropland; 15 percent is idle land or wasteland; 25 percent is in pasture; and 25 percent is woodland. The more common crops are oats, buckwheat, and mixed hay, but corn for silage is raised on a moderate acreage. A rotation of corn, oats, and long-term hay is used on some of the better dairy farms, and on others 1 or 2 years in grain alternates with a long period in hay. Buckwheat is most commonly sown as a catch crop when wet weather late in spring prevents seeding oats or planting corn. In some places buckwheat is fitted regularly into the cropping system.

Where corn is grown, it generally receives some barnyard manure and superphosphate. Some farmers apply about 1 ton of lime an acre preceding hay seedings, but many do not use lime. Ordinarily, practices to improve drainage and prevent erosion are not used, but hillside ditches dug roughly on the contour are on some fields. The soil dries so slowly that much of it is tilled when too wet, and poor tilth is a feature of much of the cultivated soil.

Pastures are poor because of the strong acidity and low fertility. They consist mainly of poverty oatgrass, paintbrush, goldenrod, daisy, wild carrot, and similar weedy growth. Some areas not so long in pasture include some red and white clovers, redtop, and colonial bentgrass. The older pastures contain hawthorn, seedling apple, blackberries, and some small forest trees. These brushy growths, together with the poorer grasses and weeds, occupy the idle land that is gradually reverting to forest. Most forests have been cut over two times or more and include many cull and weed trees, but in places good stands of mixed hardwoods occur.

Under prevailing management, average acre yields are corn silage, 5 tons; oats, 20 bushels; buckwheat, 11 bushels; and mixed hay, 1 ton. Pasture will carry one cow an acre for about 35 days, but quality is generally poor.

The mild slopes of the soil would permit intensive use, but poor drainage limits use largely to hay and forage crops, although under good management fairly good results with corn for silage and small grain may be expected. Poor drainage makes the soil poorly suited to potatoes, even though climate is favorable. *Alfalfa* does not produce well, but Ladino, alsike, and wild white clovers are tolerant of the wet condition, and birdsfoot trefoil shows promise as a legume for this and other soils with low lime content and poor drainage.

A rotation in which small grain is followed by 4 years or more of hay is well suited to the soil. A rotation of corn, grain, and long-term hay can be used if corn is needed for silage, but production of corn is somewhat hazardous because of the difficulty of planting sufficiently early in spring. For good yields of corn and grain, manure, superphosphate, and some additional potash are needed. Lime and phosphorus are essential for success with legumes, and good response
will be obtained if top dressings of manure are applied to new seedings or to older stands of grass hay.

Contour tillage is needed on all but the most nearly level areas, and diversion terraces for prevention of erosion and improvement of drainage can be used to advantage in many places. Tile drainage is not effective on these hardpan soils. Diversion terraces intercept seepage above the hardpan and hasten drying of the soil in spring, thus permitting needed earlier tillage and lengthening of the effective growing season.

Ladino, wild white, and alsike clovers, birdsfoot trefoil, bluegrass, redtop, bentgrass, and timothy are among the pasture plants suited to these soils, if needed nutrients are supplied. Lime, superphosphate, probably potash, and available manure are needed on initial seedings, but fertility can probably be maintained with periodic applications of lime and phosphate, if droppings are scattered. The carrying capacity of well-managed pastures is good in spring and fall but is seriously reduced in the drier months, even under good management. Occasional mowing is probably necessary for weed control, although proper fertilization and careful control of grazing aid.

Areas not needed for pasture or crops should be planted to suitable trees, and not left as idle land or wasteland. The common methods of good forest management, including protection from fires and grazing, utilization of cull and weed trees for farm use, and systematic harvest of trees for sale, should be used on the areas now in forest and on new plantings as they come into production.

**Volusia channery and gravelly silt loams, sloping phases (9–15% slopes)** (Vcs).—These poorly drained acid soils, most extensive of any mapped in the county, occupy more than 16 percent of the total area. They are usually in broad areas on smooth slopes in all parts of the uplands and are associated with other Volusia soils and members of the Mardin and Lordstown series. In spite of their large acreage, they are of only moderate agricultural importance because of limited use suitability. Proper utilization of these soils is one of the more serious problems in land use in the county.

Except for slope these soils are similar to the gently sloping phases with which they are associated. They were formed on poorly drained uplands from acid compact glacial till under hardwood forest.

A profile in a cultivated field has 6 to 8 inches of light brownish-gray friable silt loam over a mottled grayish subsoil. A hardpan of compact dense mottled silt loam begins at about 18 inches and grades into the compact olive glacial till parent material at about 30 inches. Level-bedded acid sandstone, shale, and siltstone are at 4 to 10 feet. This unit has the same variation in size and number of stone fragments as the gently sloping phases. Moisture relations in the two units are essentially the same, except that surface runoff is more rapid on this one.

The unit, as mapped, includes a few variations. Several areas, about 5 percent of the total acreage, resemble the Fremont soils and have a brownier surface layer and a slightly less strongly expressed hardpan. Other small areas have rock fragments of large flags rather than the channers or gravel in the typical soils. Like other Volusia soils, this unit includes small areas of the better drained
Mardin and poorer drained Chippewa soil too small to be delineated separately, and areas transitional to those two soils.

Use and management.—As on the gently sloping phases, use and management of Volusia channery and gravelly silt loams, sloping phases, are not well adjusted to needs. About 30 percent is cropland; 30 percent, forest; 25 percent, pasture; and 15 percent, idle. Rotation, fertilization, and other management practices for this unit are essentially the same as for the gently sloping phases. Pastures are of similar composition and are handled in the same way, and the same type of forest prevails. Yields may average slightly higher than on the most nearly level parts of the gently sloping phases, largely because more rapid surface drainage permits the soils to warm and dry earlier in spring and thus increases slightly the effective growing season, and especially the timeliness of spring work.

This soil unit is suited to the same crops as the gently sloping phases, but where the farming system permits, it should remain entirely in close-growing grain and hay crops. Requirements for lime and fertilizer are the same as on the gently sloping phases, but more special practices for water control are necessary. Diversion terraces to improve drainage and retard erosion, contour tillage, and strip cropping are needed on all areas where row crops are grown in the rotation. Selection of suitable times for tillage to insure the most favorable tilth, and thereby the improvement of aeration and moisture conditions, is one of the more essential requirements of good management for this and other Volusia soils. Pasture management similar to that for the gently sloping phases is applicable, and forests need the same kind of management.

Volusia channery and gravelly silt loams, eroded sloping phases (9–15% slopes) (Vcr).—These soils are in small areas closely associated with the sloping phases. They are of slight importance in the agriculture of the county because of small acreage.

The soils were formed under the same conditions as the sloping phases, but the present condition of erosion has developed under use as cropland or unimproved pasture. Most of these eroded areas occupy slopes in the upper part of the 9- to 15-percent range. They are in several widely separated areas throughout the uplands. Originally, they were the same as the sloping phases, but most of the original surface layer has been removed by erosion so that the original subsoil is at the surface.

Profile description in a cultivated field:

0 to 6 inches, pale-gray to light brownish-gray mottled moderately friable channery silt loam.
6 to 10 inches, pale-gray mottled firm channery silt loam.
10 to 24 inches, hardpan consisting of pale-olive compact dense channery silt loam; gradual transition to layer below.
24 inches +, compact olive to gray channery glacial till underlain by level-bedded acid sandstone, shale, and siltstones.

As in other Volusia soils, the profile is strongly acid throughout. Moisture relations are similar to those of the gently sloping phases, except that the storage capacity is less because of shallower depth of material over the hardpan. A few small areas with flaggy rather than channery or gravelly rock fragments are included in mapping.
Use and management.—All the area of Volusia channery and gravelly silt loam, eroded sloping phases, is cleared and slightly more than a third is in cropland. Most of the rest is in pasture, but some small areas are idle. Common management practices for crops and pasture are about the same as for the gently sloping phases, but yields are believed to be somewhat less because of even less favorable moisture conditions, poorer tilth, and poorer aeration than on the gently sloping phases.

The soils are suited to about the same uses as the sloping phases, although where feasible, their use should be restricted to close-growing grass-legume mixtures for hay or pasture. Fertilization, water control, and other management requirements are about the same as for the sloping phases.

Volusia channery and gravelly silt loams, moderately steep phases (16–30% slopes) (VCm).—These soils have the unfavorable drainage characteristic of all the Volusia soils in addition to strong slopes. They are very poorly suited to cropland, relatively poor for pasture, and unimportant in the agriculture of the county. The soils are associated with other phases of Volusia soil and with Mardin, Chipewa, and Lordstown soils.

Except for slope the factors involved in soil formation are the same as for the sloping phases, and the profiles are almost identical. Depth to bedrock probably averages somewhat less than for the Volusia soils on milder slopes. Included in mapping are small areas of Fremont-like soil with brownert surface layers and less compact hardpans. About 15 percent of this unit has large flaggy stone fragments on the surface and through the profile and parent material. A few small tracts have slopes of 30 to 60 percent.

Use and management.—Areas of Volusia channery and gravelly silt loams, moderately steep phases, are used less intensively than the Volusia soils on milder slopes. About 10 percent is cropland; 45 percent, pasture; 20 percent, idle; and 25 percent, woodland. The cropped and pastured lands are managed about the same as the sloping phases, but average yields are somewhat less.

Because of the strong slopes these soils are very poorly suited to crops, and permanent pasture is the most intensive use for which they are even moderately well suited. Pasture management requirements are similar to those for the Volusia soils on milder slopes. Use of lime and superphosphate on suitable grass-legume mixtures, occasional clipping to control weeds, and control of grazing are the more important requirements. Areas not needed for pasture can well be reforested. Natural reproduction from adjacent forested areas will eventually accomplish this, but artificial plantings insure better stands of desirable species. The common practices of good forest management, including protection from fire and grazing and systematic harvesting of timber, should be applied.

Volusia channery and gravelly silt loams, eroded moderately steep phases (16–30% slopes) (VCd).—From the moderately steep phases these soils differ primarily in having lost most of the original surface layer through accelerated erosion, and from the eroded sloping phases in having steeper slopes. These soils are unimportant to agriculture because of their small area and limited use suitability. They occupy
several small widely separated areas in the uplands and are associated with the moderately steep phases of Volusia soils.

Except for stronger slopes, these soils were formed under the same conditions as the eroded sloping phases, and profile features of the two units are practically the same. Variations include some small areas—about 10 percent of the total—with slopes in excess of 30 percent, and other small areas with large rock fragments (flags) on the surface and in the soil. Small areas of Mardin and Chippewa soils are included.

Use and management.—At present about half the area of Volusia channery and gravelly silt loams, eroded moderately steep phases, is in pasture, a third in crops, and most of the rest in idle land. Crop and pasture management are about the same as for the eroded sloping phases, but yields are slightly lower because of the less favorable moisture conditions.

The combination of poor drainage, strong relief, and serious erosion makes these soils very poor for agriculture. Pasture is the most intensive use to which they are suited, and where they are not definitely needed for pasture, reforestation should be considered. Pastures and forests need the same general types of management as Volusia soils on milder slopes, possibly with some additional practices for erosion control.

WOOSTERN SERIES

The Woostern soils, like those of the Lordstown and Bath series, occupy fairly large areas of the uplands in the southeastern part of the county. They are typically in long narrow strips on the slopes of the deeper valleys at somewhat lower elevations than the Lordstown and Bath soils.

The underlying glacial till is deeper and generally somewhat less compact than under the Bath soils, and the stone fragments are rounded rather than angular (pl. 17). Associated soils are members of the Canfield and Volusia series. The Woostern series is represented by the hilly, rolling, undulating, and steep phases of Woostern gravelly silt loam.

Less than 25 percent of the Woostern soils are in woodland. Corn, small grain, hay, and pasture are the important crops and, as with most other soils of the upland, many fields are idle. These soils are better suited to corn than the Lordstown and Bath because of the somewhat longer growing season. Favorable moisture supplies for crops are assured because the deep friable medium-textured soils favor good drainage but absorb a moderate quantity of water.

The steep phase of Woostern gravelly silt loam is probably best used for forest, but the three others can be utilized for crops and pasture. The supplies of lime and phosphorus are very low, and under heavy cropping the relatively small supplies of organic matter, potassium, and nitrogen are rapidly depleted. Management requirements are concerned chiefly with increasing or maintaining the supplies of these materials by use of lime, fertilizer, manure, and cover crops.

Woostern gravelly silt loam, rolling phase (6–15% slopes) (WR).—This brown well-drained friable deep soil is one of the more important agricultural soils in the uplands, even though its acreage is not large. It is suited to a wide variety of crops, but moderately careful manage-
ment is required to obtain high yields. It differs from the associated Canfield soils primarily in having better drainage, and from Bath and Lordstown soils in having developed from a deeper less compact till in which there is more foreign rock material.

This soil commonly occurs in relatively long narrow strips and is associated with Canfield, other Woosten, and Volusia soils. Like others of the Woostern series, it is on the lower slopes of the uplands in valley-wall positions and occurs below the higher lying Lordstown, Mardin, and Volusia soils and above the Chenango and Howard soils of the glacial terraces in the valleys proper. Many of its areas border the deeper and broader valleys.

The soil is derived from deep acid moderately compact gray to olive glacial till composed of local gray sandstone and shale material and foreign material from granite, quartzite, and red sandstone. The till contains large numbers of rock fragments; those of local origin are channers with imperfectly rounded corners, and those from distant places are well-rounded gravel. The slope pattern is moderately irregular and complex.

The soil was originally covered with heavy mixed hardwood forests of beech, sugar maple, white ash, and white pine. Because of relatively easy access from the adjacent valleys, it was probably some of the first upland soil cleared.

Profile description in a plowed field:

0 to 8 inches, grayish-brown mellow friable gravelly silt loam with a moderate supply of organic matter.
8 to 30 inches, yellowish-brown friable gravelly silt loam; lower part slightly duller in color and somewhat more firm in place; gradual transition to layer below.
30 inches +, unaltered glacial till consisting of olive to gray acid gravelly silt loam; material moderately compact but less so than that underlying Mardin and Bath soils; till is many feet thick and underlain by the level-bedded gray acid sandstone and brittle shale of the region.

The soil is strongly acid throughout. Moisture and air circulate freely, but adequate moisture for plants is retained by the medium-textured soil. Roots of the common crop plants and forest trees penetrate the subsoil with ease.

Several moderate variations are included with the soil as mapped. In places with a relatively high humus content the plow layer is dark grayish brown rather than grayish brown. A few areas about 2 miles east of Owego have a subsoil more distinctly brown. Several small bodies, making up about 5 percent of the total area, are characterized by large flaggy rock fragments on the surface and in the soil. A few small areas have been severely eroded so that most of the original surface layer is missing and the upper original subsoil is now the plow layer. Small tracts of Canfield soil and areas transitional to Canfield soil are included where they are too small to be delineated separately or where boundaries are not distinct.

Use and management.—Present use of Woostern gravelly silt loam, rolling phase, is fairly well adjusted to its physical suitability, but management is commonly at a somewhat lower level than that required for high production. About 55 percent is in cropland; 20 percent, in pasture; and 15 percent, idle. The remaining 10 percent is chiefly in woodland, but a few small areas are in urban use. Corn, oats, and
mixed hay are the most important crops; but wheat, buckwheat, alfalfa, and potatoes are important on some farms.

The common rotation of corn, small grain, and 2 years or more of hay is used on most of the cropland. Barnyard manure is the principal source of fertilizer and is applied to both corn and small grain. Some farmers use superphosphate in addition on these crops, and many apply lime prior to the hay seedings. Pastures, as on most other upland soils, consist largely of poverty oatgrass and various kinds of weeds. They do not generally receive amendments or other special management practices.

Under common management corn silage yields an average of 8.4 tons an acre; grain corn, 25 bushels; oats, 25 bushels; and mixed hay, 1.2 tons.

The deep friable soil, good moisture relations, and moderate slope make this phase good for intensive use as cropland, but strong acidity and low natural fertility necessitate careful management for high crop yields. Under good management practically all the common crops, including corn for grain and silage, oats, wheat, various clovers, alfalfa, timothy, and many tame grasses will do well. The deep friable soil is favorable for potatoes, although climate is less favorable than on higher lying Bath or Lordstown soils on similar slopes. Most vegetable crops can be expected to do well.

Because of the moderate slopes a 4-year rotation of a row crop, small grain, and hay is the most intensive use that can be safely employed. At least 1 ton of ground limestone, applied prior to hay seedings, is essential for success with legumes and increases yields of many other crops. Barnyard manure, supplemented by superphosphate, is needed on corn. Lime, phosphorus, and, under heavy cropping, potash should be applied to small grains used as companion crops. Legume hay seeded with adequately fertilized small grains does not need additional fertilizer unless the stand remains for long periods; then potash may be required.

Tillage should be on the contour where feasible, but the somewhat irregular slopes interfere with that practice. Strip cropping and diversion terraces for water control are good practices on the stronger, longer slopes, but they are impractical on the areas of complex slopes. Tillage can be accomplished over a fairly wide range of moisture conditions, and good tith is rather easily maintained.

Ladino clover-grass mixtures are good for pastures on this soil. Lime and superphosphate, applied with initial seedings and at regular intervals, are important for pasture maintenance. Clipping to remove weeds and careful control of grazing are the other good management practices. As on other well-drained soils of the uplands, the carrying capacity of the pastures will be greatly reduced during the drier summer months, and this necessitates use of supplemental pastures on soils with higher summer moisture content or of temporary pastures on some of the cropland in rotation.

**Woostern gravelly silt loam, undulating phase (0–5% slopes)** (Wu).—This deep friable well-drained brownish-colored soil on gentle slopes is the best soil for crops in the uplands of the county. It is the least extensive of the Woostern soils and, because of the small acreage, is
of relatively small agricultural importance, even though it may be very important on a few farms.

Except for the milder slopes this soil has formed under the same conditions as the rolling phase. It is in a relatively few widely separated areas on smooth gentle slopes in valley-wall positions. Some of the larger areas are near West Candor, Catatonk, and Glenn School.

The profile is essentially the same as that of the rolling phase, except that depth of weathered soil material over glacial till may be slightly greater because of less erosion. Variations consist of small areas of flaggy rather than gravelly soil, and areas of Canfield soil too small to be delineated separately on the map are included.

Use and management.—The present use of Wooster gravelly silt loam, undulating phase, is about the same as that of the rolling phase. More than half is in cropland, and a fourth is in pasture. The remaining area is in idle or wooded land. The kinds of crops grown and the rotation, fertilization, and other management practices used are similar to those for the rolling phase, and yields are about the same or slightly higher.

Gentle slopes, favorable moisture conditions, and friability to considerable depth make this soil good for intensive use. Practically all the crops common to the county will do well under good management, and a short 3- to 4-year rotation of a row crop, grain, and hay can be used. Requirements for fertilizer and other amendments are about the same as for the rolling phase. Fewer practices for soil and water conservation are required. Contour tillage is the only special practice needed where a suitable rotation and adequate amendments are used. Methods for pasture management are similar to those for the rolling phase, but the suitability of this soil to more intensive use largely precludes its use for pasture under good farm management.

Wooster gravelly silt loam, hilly phase (16–25% slopes) (Wh).—This soil has the brownish color and deep friable profile characteristic of all Wooster soils, but its favorable features are offset to some extent by strong slopes. It is in many small- to medium-sized areas on valley slopes throughout the county and is associated with other Wooster soils and those of the Canfield and Volusia series. This is the most extensive of the Wooster soils and is important to agriculture, though less so than those on milder slopes that are suited to more intensive use.

The stronger and somewhat more irregular, or complex, slope is the only environmental factor of this phase differing from those of the rolling phase. This hilly phase, like other Wooster soils, is derived from deep gravelly moderately compact acid glacial till, occupies parts of well-drained uplands, and is developed under mixed hardwood forests.

The soil profile is essentially the same as that of the rolling phase. It consists of a 6- to 8-inch grayish-brown friable gravelly silt loam plow layer overlying a yellowish-brown friable silt loam subsoil. The subsoil grades at 28 or 30 inches into moderately compact gray to olive acid gravelly glacial till. The entire profile is acid. Surface runoff is moderately rapid. Otherwise, moisture conditions are the same as in the rolling phase. The kind and quantity of stone fragments on the two soils are the same.
A few moderate variations are included in the mapping unit. Several small areas, about 5 percent of the total, are eroded to the extent that most of the original surface soil is missing, and in these places the present plow layer is in the upper part of the original subsoil. Other small areas have more flags and angular rock fragments on the surface and in the soil. Small areas of Canfield soils are included, as in other Woostern soils.

Use and management.—Woostern gravelly silt loam, hilly phase, is used less intensively than the rolling phase because of its stronger slopes. About 35 percent is in rotated crops, 30 percent in pasture, 25 percent in woodland, and 10 percent in idle land. Rotations of corn, oats, and mixed hay 4 to 6 years long are most frequently used. Other crops of some importance are alfalfa, wheat, and buckwheat. Fertilizer, in the form of barnyard manure supplemented with superphosphate, is applied by some farmers to corn and grain crops, and some farmers apply lime preceding the hay. Others till the land approximately on the contour, but other special methods for conserving soil and water are not commonly used. The weedy poverty oat-grass sward common to most upland soils is on most permanently pastured areas of this soil, and it ordinarily receives no fertilizer or other special management. Under common management average acre yields obtained are corn, 20 bushels; oats, 20 bushels; and mixed hay, 1 ton.

The deep friable soil and good moisture conditions favor intensive use of this phase, but strong slopes limit its use mainly to close-growing grain and hay crops. Row crops, however, can be safely grown at 4- to 6-year intervals under good management. The soil is suited to the same crops as the rolling phase and has similar requirements for lime and fertilizer. More care in water control is necessary. Strip cropping, contour tillage, and diversion terraces are needed on many fields, but the complexity of the slope pattern may make these practices impractical in many places. Such areas should be used entirely for close-growing grain and forage crops. Pasture management requirements are similar to those for other well-drained upland soils with similar slopes. Regular applications of lime and superphosphate to suitable grass-legume mixtures, clipping to eradicate weeds, and careful control of grazing are the most commonly needed practices.

**Woostern gravelly silt loam, steep phase** (26–45% slopes) (Wt).—This soil differs from Lordstown soils on similar slopes principally in having a deeper profile and from Bath soils in having a more friable substratum and in containing a moderate quantity of rounded gravel. Because of its steep slopes it is the least suited to agriculture of all the Woostern soils.

This soil is like the rolling phase, except it has steeper slopes that permit somewhat more rapid surface runoff. It occurs chiefly in long narrow strips on steep slopes of valley walls and is associated with other Woostern soils. Some of the larger areas are near Richford, Berkshire, and Nichols.

The soil profile in a cleared field is the same as that of the rolling phase. In relatively undisturbed forested areas the surface is covered with 1 to 2 inches of leaf litter, and the upper inch or two is black
almost pure organic matter held in a mat of fine roots. This breaks sharply to brownish-gray friable gravelly silt loam, which at 3 to 4 inches grades to yellowish-brown gravelly silt loam. Below 7 or 8 inches the profile is very similar to that in the cultivated fields.

Variations include small areas of flaggy rather than gravelly soil and several areas, about 15 percent of the total, on which accelerated erosion has removed most of the original surface layer. Several areas with very steep slopes exceeding 45 percent are included.

Use and management.—Woostern gravelly silt loam, steep phase, is used much less intensively than the other Woostern soils. Nearly half is in woodland, and slightly more than a third is in pasture. The rest is in idle land and wasteland or in meadows cut for hay. Pastures are mainly poverty oatgrass mixed with large quantities of weeds, including goldenrod, paintbrush, and wild carrot. In places some redtop, colonial bentgrass, and small quantities of clover are in the mixture. Hawthorn, seedling apple, blackberry briers, and some small forest trees are on most pastured fields. As on other upland pastures, soil amendments are not applied, and measures for weed control are not used. It is estimated that 5 acres of average pasture will carry one cow during a 5-month grazing season.

The fields mowed regularly for hay are relatively free of brush and trees and not so weedy. These areas may include some timothy and a little clover, but redtop and poverty oatgrass are dominant. Hay yields average 0.8 ton or less an acre. The vegetation on the idle fields is about the same as on the pastures, though there is somewhat more bushy growth. Forested areas have been heavily cut over and are covered with a second growth of red oak, maple, white ash, and some white pine.

The strong slopes of this soil almost eliminate it from use as cropland. It is fairly well suited to pasture if proper liming and fertilization can be accomplished on such steep land. Pasture mixtures of grass and legumes require regular applications of lime and superphosphate, clipping for weed eradication, and careful control of grazing for proper maintenance. On some areas it may not be economical to apply the intensity of management required to produce high-quality pastures, and grazing of the less nutritious natural growth may be best. Areas not actually needed for pasture or meadow can well be reforested, rather than permitted to remain idle or as wasteland. Prevention of fires, protection from grazing, and systematic harvest of timber are the important practices in good forest management.

PHYSICAL LAND CLASSIFICATION, USE AND MANAGEMENT, AND ESTIMATED YIELDS

The soils as they are listed and shown on a soil map are classified largely on the basis of physical properties that can be observed in the field. Some of these properties, including color, structure, and texture, are considered internal ones; whereas others, as erosion, slope, and stoniness are external. All these properties have some significance in determining the use suitability of the soil unit. Readjustment of land use on the farms of the county requires a knowledge of the use suitability of the soils.
LAND CLASSIFICATION

In the scheme of physical land classification for Tioga County, the soils are divided into five physical land classes, or use suitability groups (A, B, C, D, and E), according to properties that will affect their workability, productivity, ease of conservation, and consequently their suitability. This grouping is very similar to, but not identical with, the capability classification of the Soil Conservation Service.

The first three of these groups are made up of soils suited to use as rotation cropland; the fourth group, of those poorly suited to crops but at least fair for pasture; and the fifth group, of those poorly suited to either crops or pasture and therefore limited to forest use. The group to which each soil belongs is given in Table 6.

Data collected by soil surveyors during the progress of the survey, and information from county agents, farmers, and others who work with and are familiar with the soils were used in arriving at the classification. The limits between the five land classes are of course approximate, and soils near the limits are marginal between the two classes on either side of the limit.

These groupings should not be confused with the management groups in the section on Use and Management. Neither should the method of grouping be confused with the land classification scheme used by the Agricultural Economics Department of Cornell University, for the basis for grouping is quite different. The grouping here discussed is based on physical land conditions, whereas that used by the Agricultural Economics Department is based largely on present intensity of land use and other economic factors.

The grouping is not to be taken as a recommendation for use of the soils, for factors other than physical land conditions must also be considered in making specific recommendations for land use. It is likely, however, that over a long period the soils of the county will yield the greatest return and be better conserved if used for the purposes which this grouping indicates. The classification may be considered as an ideal toward which an improved land-use program can strive.

Group A in this scheme of classification is composed of soils excellent for agriculture in Tioga County. They are excellent to good soils for both crops that require tillage and pasture; they are easy to work and conserve and compared with most other Tioga County soils are fairly productive. Slopes are nearly level, and though many of the soils are gravelly, the quantity of gravel is not ordinarily sufficient to interfere materially with tillage. The soils are well drained, but they are deep and retain adequate moisture for crop growth. They have no strongly developed adverse features that cannot be corrected. They are generally not naturally fertile, but they respond well to good management and are not highly exacting in management requirements. Under even relatively low levels of management moderate yields of crops can be obtained.

Group B is made up of good soils for agriculture. They are good to fair for crops that require tillage and excellent to fair for pasture. Soils of this group are at least moderately easy to work. Soil moisture and soil material are moderately easy to conserve, and the soils are
at least moderately productive of crops. Most of the soils are deficient in lime and have relatively low supplies of phosphorus. Some of them have restricted drainage, a few are relatively shallow over rock, and most have moderate to rolling slopes. Moisture supplies for crops are normally adequate, however, and medium texture and moderate slopes permit fairly easy accomplishment of all tillage. Under good management these soils will produce well and can be conserved, but under poor management yields will be low and the soils will be rapidly depleted. Soils within this group have a fairly wide diversity of management requirements because of differences in lime content, slope, and drainage conditions.

Group C soils are fair for agriculture. They are fair to poor for crops requiring tillage and good to fair for pasture. Each of the soils has unfavorable factors of workability and productivity or presents problems in conservation. One or a combination of these factors definitely limit the suitability of the soils for crops. Low content of lime, of plant nutrients, or of organic matter; fairly strong slope; restricted drainage; or shallow depth to rock limit the soils of group C in suitability for tilled crops, but under good management fair yields of crops, especially hay and small grain, can be obtained. Because of a diversity of physical properties, these soils have a fairly wide range of management requirements. The best use of the soils of this group, the largest of the five groups, is one of the serious agricultural problems of Tioga County.

Group D consists of soils that are poor for the agriculture of this county. They are very poor for crops that require tillage and good to fair for pasture. Each of these soils is so difficult to work, difficult to conserve, or both, that its use for cropland is ordinarily not feasible, although lack of suitable cropland may justify the intensity of management necessary for successful crop production on some farms. Moderately steep or hilly slopes, shallow depth to rock, severe erosion, and restricted drainage, alone or in combination, are the adverse features of these soils. Moisture supplies are sufficiently favorable, however, to permit fair pasture production when adequate lime and superphosphate are used. Because of the diversity of properties, these soils vary somewhat in management requirements, even when used for pasture.

Group E soils are very poor for agriculture. They are very poor for crops that require tillage and very poor to poor for pasture. Each soil of this group is so difficult to work and to conserve, so low in productivity, or so unsatisfactory because of a combination of these conditions that application of the intensity of management necessary for successful growing of tilled crops is generally not feasible. Each soil is sufficiently low in content of plant nutrients or poor in moisture relations, or both, that common pasture plants produce very little feed. These soils are apparently best suited to forest under present conditions, even though they are likely less productive of forest than the soils of the other groups.

**USE AND MANAGEMENT**

The principles of use and management for soils in this county are explained in this section, and the major requirements of good management for different soils are summarized. The term “soil use” refers to
three broad uses—for crops that require tillage, permanent pasture, and forest. Soil management refers to such practices as choice and rotation of crops; application of lime, commercial fertilizer, manure, and crop residues; tillage practices; and engineering operations for the control of water on the land.

**PRINCIPLES OF SOIL MANAGEMENT**

Crops grow by using mainly carbon dioxide from the air and water in the soil. In the process of growing they use nitrogen and various minerals from the soil, which, although used in small quantities, are essential parts of the plant tissue formed. To absorb these nutrients the roots need air as well as water. If any one of the requirements of growth is deficient, whether it be sunlight, water, air, or any one of the nutrients, growth is governed mainly by the quantity of that one least available to the plant.

A farmer has little or no control over the amount of sunlight or carbon dioxide; they are free gifts of nature. If he is wise, he will do those things that will enable the plant to make the most efficient use of these free factors. He can control the supply of water and of available soil minerals and the physical conditions that will favor their absorption, and in so doing encourage the best growth of plants.

Lime, nitrogen, phosphorus, and potassium are the nutrients most likely to be lacking in Tioga County soils. Lime, phosphorus, and potassium must be purchased largely from commercial sources. Nitrogen can also be purchased as commercial fertilizer, but it is expensive, and there is another source on the farm itself. Much of the nitrogen contained in plants fed to animals remains in the manure. By using manure made from grass, small grain, corn, and similar crops, a farmer is merely conserving the nitrogen originally in the soil that was taken up by plants. Certain plants, however, such as alfalfa and the clovers, have bacteria on their roots that can take nitrogen from the air and add it to the soil. These plants are legumes, and by using them the farmer can obtain, as a byproduct, much if not all of the nitrogen he needs for good crop production on his own farm. In an agriculture such as that of this county, proper use of legumes in crops rotations and the application of adequate fertilizer for their growth is the key to successful soil management.

Good soil management involves (1) the control of water on the land, (2) maintaining the supply of mineral plant nutrients, and (3) keeping the soil in good tilth. These three factors are discussed in the following.

Water on the land must be controlled. If it runs off too rapidly it washes off the most fertile parts of the soil and little moisture sinks into the soil for use by crops. Even in as humid an area as this county, lack of water during part of the growing season is one of the principal factors that limit crop growth. On many soils, however, too much water stands in the subsoil during the normally wet spring. The water drives out air and prevents roots from absorbing the needed plant nutrients and from extending into the soil where they can get the water needed for growth when the ground becomes dry in midsummer. As a consequence, plants on these poorly drained soils are injured by too much water in spring and too little in mid-
summer. Removal of excess water in periods of wet weather is an important part of water control on the land.

The supply of mineral plant nutrients must be maintained. Crops cannot use the water, carbon dioxide, and sunlight for growth unless these nutrients are available. Nitrogen is generally the most deficient and is also one of the most expensive. Its storehouse is principally the organic matter in the soil. Under intensive cropping nitrogen becomes deficient as the supply of organic matter is depleted. Crops therefore become yellow and make poor growth. If the system of farming permits, the use of legumes is usually the most economical way to get nitrogen. Otherwise, it must be bought as commercial fertilizer.

After nitrogen, lime is most apt to be lacking. Lime must be purchased, but it is relatively cheap in the form of ground limestone. Next to lime, phosphorus is most likely to be limiting. It too must be purchased as commercial fertilizer, and one of the cheapest sources is superphosphate. Phosphorus does not leach readily from the soil, but it may be fixed in forms that the plant cannot get. As a result of this fact phosphorus should be applied in relatively large applications spaced several years apart. Finally, under intensive cropping, potassium may become limiting unless it can be returned in the form of manure. Potassium must also be purchased as commercial fertilizer in some cases. Unlike phosphorus, potassium is likely to be leached from the soil and used to excess by the plants themselves. Light applications of potassium made annually or at 2-year intervals are therefore preferable to heavy applications at longer intervals.

The soil must be kept in good tilth, which is best promoted by growing crops that have fibrous root systems. Such crops leave organic matter in the soil and cause it to granulate. This granulation permits roots to penetrate easily and allows them to exploit a large volume of soil for needed water and plant nutrients. In the agriculture of this county, the growth of sod-forming crops for hay or pasture provides an excellent opportunity to maintain the good physical condition of the soil.

A farmer can think of his soil management practices in three main groups—rotations, fertilization, practices to control runoff and erosion. He should think of his rotation first, because through it he is able to accomplish a very large part of the needed soil management practices. The benefits of a good rotation can be considered a byproduct in the production of needed crops. After rotations, he should think of fertilization. Fertilization should not be considered only for a specific crop in any given year, but for all crops in the entire rotation, and particularly for the sod-forming leguminous crops, as those are the ones that add so much in the way of good physical condition and needed nitrogen. By fertilizing crops adequately in a good rotation suited to the land the farmer can maintain fertility, control the water that runs off the land, and to a large extent control erosion. The things he needs to add are mainly lime and phosphorus. These are the cheaper materials he has to buy. After fertilization, the farmer should think of contour cultivation, strip cropping, diversion ditching, and use of winter cover crops and similar supporting practices to control runoff and erosion. These should be designed to suit the
particular kind of rotation used on the land and the needs of the land itself.

**ROTTATIONS**

Crops vary in the drain they put upon the soil. Generally, row crops take the most out of the soil, return the least, and subject the soil to most serious washing. Next in order of drain on the soil are close-growing crops that do not form a sod. These are crops such as small grains and Sudan grass. Their drain upon the soil is moderate; they return little in the way of fertility but do protect the soil from washing while they are growing. They leave the soil bare in fall and in spring. Sod-forming crops are sometimes called soil-improving crops. They form a sod that binds the soil in place and prevents washing. Their fibrous root systems make the soil porous and add organic matter. In addition the sod-forming crop adds nitrogen if it contains alfalfa, clover, or other legumes. Legumes add the most nitrogen the first year they are grown. They add less each succeeding year as the nitrogen and organic-matter level of the soil is built up, and finally a point is reached at which the quantity of nitrogen removed in the crop is about equal to that added by the legume.

To grow grasses with legumes is profitable, because grasses draw upon the soil nitrogen made by the legume and cause the legume to fix more nitrogen. On many fields it is best to plow sod at relatively frequent intervals in order to benefit from the fertility stored by the legume. By growing legumes with cash crops in relatively short rotations on land suited to them, a farmer makes the most efficient use of the legume. On some fields, however, it is not advisable to plow frequently because this exposes the soil to erosion. On such fields it is better to leave the sod-forming crops down for as long periods as the legume remains in the stand. Harvest the hay or pasture crop, feed it to animals, and spread the manure on more nearly level-lying land where row crops needed may be grown for several years in succession. In this way the benefits of the legume grown on one field may be applied to the cash crop grown on another.

The most intensive rotation is one in which row crops are grown continuously. Such a rotation exposes the soil to washing and is adapted only to the least erosive soils in the county. A rotation of two successive years of a row crop followed by a close-growing crop and two or more years of a sod-forming crop is considered the next most intensive rotation. A rotation of a row crop followed by 1 year of small grains and 2 years of hay is still less intensive, because the soil is exposed to washing for a shorter period and the land receives the benefits of sod-forming crops a longer time. The adapted rotations for various soils of the county are listed in table 6.

**FERTILIZATION**

If the rotation itself is to maintain productivity of the soil to the greatest extent possible, the crops must grow vigorously. This means that needed minerals must be supplied if they are not available in the soil. It is especially important that lime and phosphorus be supplied in the rotation to insure vigorous growth of legumes. The legume must make good growth so it will take large quantities of
nitrogen from the air and fix it in the soil for use of succeeding crops in the rotation.

On most soils of the county a ton of lime an acre applied every 4 or 5 years will be adequate if a liming program is already established. If lime has not been applied previously, all the soils except the Howard will require 2 tons of lime an acre for one or two rotations. The Howard soils do not require this heavier initial application, because they naturally contain more lime than the others.

Applications of 20-percent superphosphate at a rate equivalent to 150 pounds a year will usually supply adequate phosphorus. Generally adequate for soils used for rotated crops on dairy farms is 600 pounds of 20-percent superphosphate every 4 or 5 years. Phosphorus does not leach from the soil, and therefore a soil heavily fertilized for vegetables may supply all the phosphorus row crops will need for several years.

Lime and phosphate should be applied to the corn or the small-grain crop in the rotation; that is, preceding the leguminous sod-forming crop. Both nutrients may be applied at one time for an entire 4- or 5-year rotation.

Potassium may become deficient unless manure is returned to the land relatively frequently. Under intensive cropping and little manuring, crops on most soils of the county respond to potassium fertilizer. Potassium is leached from the soil and therefore should be applied in small quantities yearly or every 2 years rather than in a large quantity once during the rotation.

Lime, superphosphate, and potassium applied in quantities and ways just described will meet soil needs on most dairy farms, but if vegetable or other high-value crops are grown, it is generally economical to make relatively large applications of a complete commercial fertilizer for the specific crop in question. If that crop is in a rotation with sod-forming crops, the application may be adequate to carry the entire rotation. In some instances the addition of nitrogen in the form of commercial fertilizer may be justified for old meadows in which the legume has run out, but the farmer should rely first on legumes and manure for his nitrogen.

PRACTICES TO CONTROL RUNOFF AND EROSION

After choosing a rotation suited to the land and applying lime and fertilizer for this rotation as a unit, additional supporting practices may be needed to slow the runoff of water and to control erosion. The need for such practices will depend upon how much of the time the rotation leaves the soil barren of vegetation as well as on the erodibility of the soil. Needed supporting practices for the most intensive rotations to which the soils are adapted are listed in table 6. If a rotation that leaves the soil bare less of the time than the one indicated in table 6 is used, correspondingly less intensive supporting practices will be needed. Generally a rotation that keeps a sod-forming crop on the land 5 out of 6 years requires little in the way of supporting practices, even though the soil is on relatively strong slopes.

MANAGEMENT GROUPS

The soils of the county are arranged in 11 management groups in table 6. Characteristics affecting the use and management of each
group are listed and some of the requirements for good management are shown.

On this page and pages following the groups are described more fully, and the requirements of the soils, when used either as cropland or pasture, are discussed. Several groups have similar requirements. For example, the soils of the uplands are placed in several groups but generally require about the same fertilization. Pastures on all soil groups of the better drained uplands require similar management, although the response to that management may differ.

Only the broad principles of management are discussed. These principles are based on a knowledge of the more important deficiencies of the soils as derived from limited experimental data. The recommendations made are not specific for the soils of a particular farm. Specific recommendations would take into account the circumstances peculiar to that farm, as past treatment of the soil, type of farm enterprise, and interest of the farm operator. The information given for the various management groups can be helpful to a farmer in showing what uses and what management practices are generally suitable to his soils. It can also be useful to farm advisors when they are helping farmers choose systems of farming suited to their particular farms.6

**GROUP 1**

Group 1 is composed of well and imperfectly drained soils of the first bottoms. These soils are subject to overflow and receive annual additions of soil material, and for this reason are the most fertile soils of the county. They are, however, generally somewhat deficient in lime and phosphorus. Nearly level slopes, medium texture, deep friable soil, and good moisture supplies are other favorable features. The soils are easy to work, easy to conserve, and under good management are highly productive.

All the soils of group 1 are suited to intensive use. Corn will do very well, and most vegetables produce heavily. Climate is less favorable for potatoes than on the higher uplands, but large yields are obtained by some growers. Difficulty with lodging of small grains may be expected. Most legumes and grass hays will do well, although alfalfa may not be suited to some soils of the group if floodwaters stand on the land for long periods. With proper fertilization and use of green-manure crops, these soils can be conserved in continuous row crops, but in many places in the county where dairying is dominant a 3- or 4-year rotation of corn, small grain, and hay is best. These soils produce excellent pastures throughout the growing season, but more intensive use commonly has first priority.

Natural fertility is relatively high, but the soils respond to use of amendments. Row crops and grain need regular applications of phosphorus, and lime is essential for success with legumes. Areas in continuous row crops need liberal applications of barnyard manure, and rye, vetch, or other green-manure crops will help maintain good tilth and plant nutrients. The supply of potassium is believed to be sufficient, but a deficiency may develop under intensive use, and potash fertilizer may then be necessary.

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6 For additional information on soil management see publications (5), (6) and (7) in Literature Cited, p. 133.
Because of the gentle slopes, erosion is not a serious problem on these soils. In places stream-bank erosion requires control. Natural drainage is adequate for nearly all crops, except on the Middlebury soils. On these tile drains and open ditches can be used to improve drainage if good outlets can be found. If drainage is accomplished the effective growing season is extended and a wider variety of crops can be grown.

These level soils of group 1 can well be used intensively for row crops on dairy farms where there are sloping upland soils. The sloping soils can then be kept in long-term mixtures of legumes and grass, and the manure produced from the forage can be used on the soils of group 1.

GROUP 2

In group 2 are nearly level well-drained soils of uplands and terraces. These soils resemble those of group 1 in having gentle slopes, deep friable material, and favorable moisture supply. They are not subject to overflow, however, and have a more distinct soil profile because they are older. They have been leached for a relatively long time and are lower in natural fertility than soils of group 1. The gentle slopes, good moisture supply, freedom from flooding, favorable texture, and low susceptibility to erosion combine to make them some of the best agricultural soils of the county.

Like the soils of group 1, these soils are suited to intensive use. A 3- or 4-year rotation of a row crop, a small grain, and hay is probably best suited, but more intensive use in continuous row crops can be practiced under good management. Corn and most intensive cash crops are exceptionally well suited to these soils occurring in the valleys, and potatoes to those at high elevations. All small grains produce well, but wheat generally produces more to the acre than oats. If adequately limed, alfalfa in mixtures with grass gives the highest yield of hay. Red clover, Ladino clover, and bird'sfoot trefoil are also suited. Good pastures are obtained under proper management.

Most of these soils occur on farms that include areas of sloping more erodible soil. On these farms the soils of group 2 should be used intensively for row crops, as that permits long-term growing of legume-grass mixtures for hay or pasture on the sloping soils. In this system the legume-grass hay is fed to livestock, and the manure produced is applied to the row crops. The supply of nitrogen produced by legumes grown on the sloping soils is in this way used to maintain the fertility of the level soils of group 2, and as a further advantage, erosion is controlled on the entire farm.

The soils of group 2 respond readily to applications of amendments. In rotations 8 to 10 tons of manure applied to corn, 600 pounds of 20-percent superphosphate divided between the corn and grain, and about 1 ton of lime preceding the hay will meet crop needs. In more intensive cropping these quantities of lime, phosphorus, and manure are applied during a 4-year period and in addition, some potash fertilizer. Heavier applications of fertilizer are made on high-value vegetable crops and potatoes. Winter cover crops, as rye or vetch, should be grown where continuous row cropping is practiced. On potato farms, small quantities of lime mixed with the seed can be applied locally to aid in establishing good stands of clover for green
manure. Such liming will not introduce a serious potato-scab problem.

These soils are not susceptible to serious erosion. Erosion control is accomplished largely by the use of good rotations and needed amendments, but contour tillage is a supporting practice needed on some areas with long slopes.

Where the soils are used for pasture, applications of lime and superphosphate are needed to obtain and maintain good grass-legume mixtures. Control of grazing during dry periods to avoid damage to the stand, scattering of droppings, and occasional clipping for weed eradication are important in good management of pastures on these soils. Permanent pasture is not the best use of these soils on most farms; they are suitable for more intensive use.

GROUP 3

Sloping and rolling well-drained soils of uplands and terraces make up group 3. They have a deep friable profile, medium texture, and favorable moisture supply like the soils of group 2, and like them they are deficient in lime and phosphorous. They have stronger slopes (6 to 15 percent) than soils of group 2, and for this reason are more susceptible to erosion and loss of moisture unless carefully managed.

In general, use suitability and management requirements of these soils are similar to those of group 2, but more care in conserving soil material and moisture is necessary. These soils cannot be conserved under continuous row crops, and a 4- to 5-year rotation made up of a row crop, grain, and hay is the shortest that can be safely used under most conditions. Corn, small grain, alfalfa, clover, and timothy are suited to these soils, and potatoes and vegetables do well under good management. As on other well-drained deep soils, an alfalfa-grass mixture gives the highest yield of hay, and wheat is the most productive small grain.

Needed amendments for each 4- or 5-year rotation include 600 pounds of superphosphate and 8 to 10 tons of manure. Small applications of muriate of potash totaling about 150 pounds for the rotation are also needed. About 1 ton of lime applied before each hay seeding, or as soil tests indicate need, is essential to success with legumes. The lime also increases the yield of other crops by correcting soil acidity, supplying calcium, and increasing the quantity of nitrogen fixed by the leguminous crop preceding.

Contour tillage is needed on these soils, and where length and shape of slope will permit, strip cropping is advisable to conserve moisture and soil material. Diversion terraces may also be useful for these purposes under some conditions.

Ladino clover, wild white clover, birdsfoot trefoil, Kentucky bluegrass, and timothy are among the better pasture plants. Seeding and any other tillage should be done on the contour, and in places contour furrows may be useful for conserving moisture. About 600 pounds of superphosphate every 4 years and 1 ton of lime at 4-year intervals, or as tests indicate the need, are required for maintenance of good pasture. Lime requirements are likely to be somewhat lower on the Howard soils, which have alkaline to calcareous subsoil, than on the rest of the group.
The carrying capacity of pastures on this group of soils is greatly reduced during the drier summer months, and supplemental temporary summer pasture is necessary for most efficient grazing. Scattering of droppings and clipping for weed eradication are other pasture management requirements.

GROUP 4

In group 4 are moderately steep and hilly soils of uplands and terraces. They have the same favorable internal features—deep friable profile, medium texture, and good moisture relations—as the soils of groups 2 and 3. The strong slopes favor rapid runoff, however, and make the conservation of soil material and moisture difficult. The slopes also interfere with the use of the heavier modern farm implements.

Continuous sod crops for meadow or pasture are generally desirable for good soil conservation, although under careful management row crops can be grown safely once in 6 years or more. Alfalfa-grass or clover-grass mixtures are well suited if 1 ton of lime an acre is applied at 4- or 5-year intervals and about 600 pounds of 20-percent superphosphate is added every 4 years. Some potash fertilizer in addition may be needed.

When the legumes in a pasture run out, the land should be reseeded. Small grain can be used as a companion crop in reseeding. Birdsfoot trefoil may be used as the legume. Seeding should be done on the contour. Diversion terraces may be useful for water conservation on some of the slopes. If possible, row crops should be grown on less erodible land that is heavily manured to maintain fertility.

Where need for cropland makes necessary the use of these soils for rotated crops, contour tillage, strip cropping, diversion terraces, and such supporting practices are needed to conserve soil and water so that most efficient use of fertilizer may be made. Manure and superphosphate on corn and grain, and lime preceding the sod crop, are needed amendments. Old stands of hay will respond to application of manure or nitrogen fertilizer. Additional potassium from commercial fertilizer is necessary when available quantities of manure are small.

GROUP 5

Undulating and gently sloping moderately drained soils of upland and outwash terraces constitute group 5. These soils have the same gentle slopes as those of group 2, but a compact or hardpan layer at a depth of 18 to 20 inches impedes water movement so that the lower subsoil is waterlogged periodically. The rooting of crop plants is confined to the upper 12 or 15 inches of the soil, and the effective reservoir of moisture and plant nutrients is limited to this rather shallow zone. Control of runoff is a more serious problem than on well-drained soils with similar slopes because the moisture-absorbing capacity is lower and runoff is correspondingly greater.

The soils of this group are suited to fewer crops than most soils of the preceding groups. Corn, small grains, and mixed hay are suited to these soils. Corn for grain may not mature during many seasons on the Mardin soils, because they have a short effective growing season, but silage corn can be successfully grown in most places. Beans and potatoes are row crops that produce fairly well. Wet
weather may delay seeding of spring grain enough to reduce yields seriously. Wheat will ordinarily yield more than oats in terms of total feed, even though winter wheat may be damaged to some extent by frost heaving during winter months.

Ladino, red, and alsike clovers are the best suited legumes now available for these soils, although birdsfoot trefoil shows promise as a legume tolerant of their acidity and poor drainage. Alfalfa is rather poorly suited, but small quantities can be used in seeding mixtures for long-term hay. Whatever legume is used, lime and phosphorus are needed for efficient production. If management is good these soils can be conserved under a row crop-grain-hay rotation lasting 4 years.

Amendments required are about the same as for groups 2 and 3, although response is less because of the poorer moisture conditions. About 10 tons of manure, 600 pounds of 20-percent superphosphate, and 1 ton of lime are needed in each rotation. Corn and grain crops will probably respond to potash, in addition. Potash fertilizer is essential if little manure is applied.

Contour tillage is necessary for control of runoff, and strip cropping is needed on the longer, more sloping areas. Diversion terraces can be used to advantage in many places both to improve drainage and to reduce erosion.

These soils are good for pasture and, even though they have some limitations as cropland, they are better for crops than most soils of the uplands. Ladino clover, wild white clover, alsike clover, birdsfoot trefoil, and such legumes in mixtures with grasses are suited to these soils. The principal amendments needed on pastures are lime at the rate of 1 ton an acre and 600 pounds of 20-percent superphosphate. The lime should be applied every 4 years, or as soil tests indicate need, and the superphosphate once every 4 years. A response may be expected from potash, but if light top dressings of manure are applied periodically, potash fertilizer may not be necessary. Control of grazing and clipping for weed control are also needed.

GROUP 6

Group 6 consists of sloping and rolling moderately drained soils of the uplands. These soils have restricted drainage and other unfavorable features related to the hardpan and, in addition, stronger slopes of 9 to 16 percent. These slopes and the low infiltration favor heavy and rapid runoff so that conservation of soil material and moisture are difficult.

The same crops as for group 5, including corn, small grains, mixed hay, and dry beans, are suited to these soils. Their susceptibility to erosion and restricted internal drainage makes them only fair for potatoes. A rotation of a row crop, small grain, and mixed hay lasting 5 years or longer may be used safely if proper supporting practices are employed. Needs for amendments are the same as for group 5.

Supporting practices for control of erosion are essential if row crops are used in the rotation. Contour tillage and strip cropping are needed for control of runoff. Diversion terraces serve the same purpose, aid in improving internal soil drainage as well, and thereby increase the growing season by warming and drying the soil earlier in spring.
Where these soils are used for permanent pastures, requirements for fertilization and other management are about the same as for those of group 5. Old pastures likely can be rejuvenated most effectively by plowing and reseeding a grass-legume mixture with a nurse crop of small grain.

**GROUP 7**

Group 7 is made up of hilly and moderately steep, moderately drained soils of the uplands. These soils, like those of groups 5 and 6, have restricted internal drainage and associated features due to a hardpan, or compact layer, at 18 to 20 inches, but they occupy strong slopes of 16 to 30 percent. Surface runoff is rapid, and under cultivated crops, loss of water and soil material is serious. The strong slopes prevent efficient use of the heavier types of modern farm machinery.

These soils are poorly suited to crops and should remain in grass-legume mixtures for hay or pasture as long as the legume remains in the stand. On farms where soils suited to crops are scarce, however, these soils can be conserved under a 6-year or longer rotation of corn, small grain, and hay if carefully managed. Requirements for amendments and other management practices on pastures are similar to those of groups 5 and 6.

When used as cropland with a row crop in the rotation, special practices for water control are essential to conservation. Strip cropping and contour tillage are needed wherever length and shape of slope will permit. Diversion terraces both for runoff control and improvement of internal drainage are needed on most fields. Lime applied at the rate of 1 ton an acre every 4 or 5 years is necessary for success with legumes and for increased yields of other crops. Other needed amendments are about 600 pounds of 20-percent superphosphate and 10 tons of manure applied to the corn and grain crops every 4 or 5 years. Manure or nitrogen fertilizer is needed on old stands of hay. Some response may be expected from light applications of potash fertilizer to the corn and grain crop, although this may not be necessary where heavy manure applications are used.

**GROUP 8**

Gently sloping to sloping poorly drained soils of the uplands are in group 8. These are hardpan soils saturated with water to within a few inches of the surface until late spring and periodically during the growing season. This waterlogged condition and poor aeration are unfavorable for root development of most crop plants. Runoff is large on the more sloping soils because of the low infiltration of rainwater into the already wet soil. During prolonged dry spells the upper part of the soil may become very dry and hard, and the hardpan layer effectively prevents most root development in lower layers. These soils have the additional unfavorable features of strong acidity and relatively low supplies of available plant nutrients. As a group they are poor for crops but fair for pasture or meadow. They are important because their area totals more than a fourth of the county.

The proper adjustment of use and management to the suitability and needs of these soils is an important problem in the agriculture of the county. Because of their poor drainage, grass-legume mixtures for hay or pasture are best suited to these soils, but where need for
land justifies, they can be used for other crops if carefully managed. Ladino clover-grass mixtures are suitable. Birdsfoot trefoil is tolerant of the wet conditions and acidity and shows promise as a well-suited legume crop. Planting sod crops for hay and grazing the stand after the hay is harvested is believed to be one of the most efficient uses of these soils.

A ton of lime and about 600 pounds of superphosphate applied every 4 or 5 years are the main amendments required, but some potash and top dressings of manure or nitrogen fertilizer may bring profitable increases in yields. Erosion is not a serious problem, but diversion terraces may be used to improve drainage.

Where these soils are used for cropland, a 4- to 6-year rotation made up of a row crop, grain, and hay can be practiced. Corn for grain may not mature, because of the short growing season, but silage corn produces fair yields. The planting of corn and spring grains may be delayed in wet years, and buckwheat is a catch crop useful in management of these soils. Wheat has consistently produced more feed than oats, but some frost damage may occur. Potatoes, alfalfa, and most vegetable crops are poorly suited to these soils. The main amendments required are 1 ton an acre of lime and 600 pounds of 20-percent superphosphate every 4 or 5 years.

Water control involves both improving drainage and reducing erosion. Diversion terraces are useful for improving internal drainage, as they collect and divert the excessive runoff and seepage. Tile drainage is not effective, because the hardpan interferes with movement of water. Strip cropping and contour tillage are other special water-control measures needed where the more sloping soils are used as cropland.

**GROUP 9**

Group 9 is composed of moderately steep poorly drained soils of the uplands. They have the hardpan layer, poor drainage, and other unfavorable features of the soils of group 8, and in addition have slopes of 15 to 30 percent. Runoff is rapid, and erosion is a serious problem. Modern farm machinery is difficult to use. These limitations, with those described for group 8, make these soils very poor for most crops. They are probably best used for long-term hay or pasture.

Ladino clover-grass mixtures produce good yields of high-quality hay or pasture if 1 ton of limestone and 500 to 600 pounds of superphosphate are applied once in 4 or 5 years. Potash may also be needed. Birdsfoot trefoil may replace the Ladino clover. These soils can be used to advantage by harvesting an early cutting of hay and then grazing the stand to help in carrying the livestock through the midsummer pasture slump. Available evidence indicates that these soils are more efficiently used in this way than they are if kept in permanent pasture. They should be plowed only to reestablish the stand of legumes, and all tillage should be on the contour. Diversion ditches may be valuable to intercept seepage water and improve drainage.

Where need for land requires the use of these soils for crops, the rotation should last 6 years or longer. They are suited to the same
crops and, except for the longer rotations, have the same management requirements as the soils of group 8.

GROUP 10

Very poorly drained soils of the uplands, terraces, and bottom lands constitute group 10. These soils are saturated throughout the profile for most of the year and are gray and mottled to the surface. Most of them are characterized by a nearly black accumulation of organic matter in the upper few inches of soil. Muck is a relatively deep organic deposit. Low or depressed positions and seepage from higher slopes are responsible for the high water table in muck.

Pasture is the most intensive use to which most of these soils are suited, but the native plants, including reeds, sedges, ferns, sweetflag, and cattail, furnish very little feed. Moderate improvement in drainage, which can be accomplished by straightening and deepening natural channels and constructing open ditches or furrows, will stimulate the growth of more nutritious tame grasses and legumes on the better sites. Lime and superphosphate may be profitably used in such places. Reed canary grass will do well on these very poorly drained soils if the fertility level is raised.

On a part of these soils the cost of improving drainage and increasing fertility levels to improve pastures may exceed the return that will be obtained, and in other places drainage may not be feasible from an engineering standpoint.

Small areas of Alluvial soils, undifferentiated, in group 10 have characteristics similar to those of the soils of group 1 and have similar use suitability and management requirements. Some of the larger muck areas may be suitable for drainage and for crops, as vegetables, corn, grains, and potatoes. Management requirements for such muck areas are about as described for group 1. Copper sulfate may be needed for onions and other special vegetable crops.

GROUP 11

Group 11 is composed of well to excessively drained soils of steep to very steep uplands and terraces. In profile features they are similar to those of group 4, except total depth of soil material over bedrock is less. Slopes are stronger (26 to 46 percent or more), favor rapid runoff, and make the use of heavy farm machinery almost impossible.

Forest is the best use for these soils, but some pasture can be obtained under good management. At present about two-thirds of the total acreage is in forest or woodland, and most of the areas should remain in that use. The common practices of good woodland management, including protection from fires and grazing, utilization of cull trees and inferior species for fuel or other farm use, and selective cutting of timber for sustained yield, are needed on woodlands on these soils.
On slopes of 26 to 35 percent permanent pastures will produce well in the spring flush period if adequate lime and phosphorus are applied. Such pastures generally produce little feed from the middle of July or August to the end of the season, no matter what treatment is applied.

An acreage of these soils sufficient to graze the cows during the flush period of pasture production and before aftermath pasture on hay land is available can be kept if needed, but these soils are relatively less efficient producers of pasture than those with gentler slopes and more favorable moisture supplies. For this reason cleared areas of these soils not actually needed for pasture should be returned to forest. Reforestation can be attained in places by natural seeding from adjacent forested areas, but plantings of suitable species result in more rapid reforestation and a more uniform cover.

**SUITABILITY OF SOILS FOR POTATOES**

In recent years interest in commercial potato production has been manifest in Tioga County, and consideration of soil areas suited to potatoes is important. Past management, location with respect to roads and markets, size of soil area, and type of soil are important in determining the use of a particular tract for potatoes.

The following tabulation shows the suitability of the soils of Tioga County for potato production:

<table>
<thead>
<tr>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well-drained level to undulating soils of uplands; summers cooler and potato blight less serious than in valleys. Soils acid, with little scab problem, and absorb and hold water well. Runoff not rapid; slopes less than 8 percent. Erosion and loss of water not serious; water relations make use of fertilizer effective.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP 1. Good soils (good climate):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lordstown channery silt loam, gently sloping phase.</td>
</tr>
<tr>
<td>Woestern gravelly silt loam, undulating phase.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUP 2. Good soils (fair climate):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chenango silt loam, nearly level phase.</td>
</tr>
<tr>
<td>Chenango gravelly silt loam, nearly level phase.</td>
</tr>
<tr>
<td>Chenango gravelly loam, alluvial-fan phase.</td>
</tr>
<tr>
<td>Chenango fine sandy loam, nearly level phase.</td>
</tr>
<tr>
<td>Howard gravelly silt loam, nearly level phase.</td>
</tr>
<tr>
<td>Howard gravelly loam, nearly level phase.</td>
</tr>
<tr>
<td>Howard loam, nearly level phase.</td>
</tr>
<tr>
<td>Tioga silt loam, high-bottom phase.</td>
</tr>
<tr>
<td>Tioga gravelly loam, high-bottom phase.</td>
</tr>
<tr>
<td>Unadilla silt loam, nearly level phase.</td>
</tr>
<tr>
<td>Unadilla fine sandy loam, nearly level phase.</td>
</tr>
</tbody>
</table>

| Well-drained level to undulating deep soils similar to those of group 1. Slopes less than 8 percent. Potato scab not a serious problem. Soils acid; absorb and hold water well; runoff not rapid. Erosion and loss of water not serious; water relations make use of fertilizer effective. Unlike those of group 1 these soils occur in valleys where summer days and nights are warmer, fog is more common, and potato blight is a greater problem. |
### Group 3. Fair soils:

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bath channery silt loam, sloping phase</td>
<td>Some one or some combination of characteristics makes each soil of this group less well-suited physically to potatoes than the soils of groups 1 or 2. Imperfect drainage, heavy texture, rolling relief, shallow soil, and danger of flooding are unfavorable characteristics. No soil of the group poorly suited to potatoes, however; and with good management reasonably good yields may be expected on all. Management requirements generally more exacting than on soils of groups 1 and 2.</td>
</tr>
<tr>
<td>Braceville gravelly silt loam</td>
<td></td>
</tr>
<tr>
<td>Canfield gravelly silt loam:</td>
<td></td>
</tr>
<tr>
<td>Undulating phase</td>
<td></td>
</tr>
<tr>
<td>Rolling phase</td>
<td></td>
</tr>
<tr>
<td>Chenango gravelly loam, rolling phase</td>
<td></td>
</tr>
<tr>
<td>Howard gravelly loam, rolling phase</td>
<td></td>
</tr>
<tr>
<td>Lordstown channery silt loam, sloping phase</td>
<td></td>
</tr>
<tr>
<td>Mardin channery silt loam:</td>
<td></td>
</tr>
<tr>
<td>Undulating phase</td>
<td></td>
</tr>
<tr>
<td>Sloping phase</td>
<td></td>
</tr>
<tr>
<td>Tioga silt loam</td>
<td></td>
</tr>
<tr>
<td>Tioga gravelly loam</td>
<td></td>
</tr>
<tr>
<td>Tioga fine sandy loam</td>
<td></td>
</tr>
<tr>
<td>Uradilla silt loam, sloping phase</td>
<td></td>
</tr>
<tr>
<td>Woostern gravelly silt loam, rolling phase</td>
<td></td>
</tr>
</tbody>
</table>

### Group 4. Poor soils:

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bath channery silt loam, moderately steep phase</td>
<td>These are the soils on which mistakes are most commonly made. On some, poor drainage or frequent flooding make crop failures or near crop failures common; on others, hilly topography, susceptibility to erosion, and difficulty of using machinery make the soil poor for potatoes; still others are strongly eroded, though on moderate slopes, and are unproductive.</td>
</tr>
<tr>
<td>Canfield gravelly silt loam:</td>
<td></td>
</tr>
<tr>
<td>Hilly phase</td>
<td></td>
</tr>
<tr>
<td>Eroded rolling phase</td>
<td></td>
</tr>
<tr>
<td>Fremont and Volusia channery silt loams, gently sloping phases</td>
<td></td>
</tr>
<tr>
<td>Lordstown channery silt loam, moderately steep phase</td>
<td></td>
</tr>
<tr>
<td>Mardin channery silt loam:</td>
<td></td>
</tr>
<tr>
<td>Eroded sloping phase</td>
<td></td>
</tr>
<tr>
<td>Moderately steep phase</td>
<td></td>
</tr>
<tr>
<td>Gently sloping shallow phase</td>
<td></td>
</tr>
<tr>
<td>Sloping shallow phase</td>
<td></td>
</tr>
<tr>
<td>Middlebury silt loam, high-bottom phase</td>
<td></td>
</tr>
<tr>
<td>Volusia channery and gravelly silt loams:</td>
<td></td>
</tr>
<tr>
<td>Gently sloping phases</td>
<td></td>
</tr>
<tr>
<td>Sloping phases</td>
<td></td>
</tr>
<tr>
<td>Eroded sloping phases</td>
<td></td>
</tr>
<tr>
<td>Woostern gravelly silt loam, hilly phase</td>
<td></td>
</tr>
</tbody>
</table>
Beaver dam across a narrow valley east of Willseyville. Some of the more rugged tracts in the county are suitable for forest and wildlife preserves.
Small sawmill near Candor. Most original forest stands have been cut, but the supply of good timber has increased recently because management of forested land has improved.
### GROUP 5. Very poor soils:

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allis channery silt loam, gently sloping phase</td>
<td></td>
</tr>
<tr>
<td>Alluvial soils, undifferentiated</td>
<td></td>
</tr>
<tr>
<td>Atherton silt loam</td>
<td></td>
</tr>
<tr>
<td>Canfield gravelly silt loam, eroded hilly phase</td>
<td></td>
</tr>
<tr>
<td>Chenango gravelly loam:</td>
<td></td>
</tr>
<tr>
<td>Hilly phase</td>
<td></td>
</tr>
<tr>
<td>Steep phase</td>
<td></td>
</tr>
<tr>
<td>Chippewa channery silt loam</td>
<td></td>
</tr>
<tr>
<td>Chippewa stony silt loam</td>
<td></td>
</tr>
<tr>
<td>Holly silt loam</td>
<td></td>
</tr>
<tr>
<td>Howard gravelly loam:</td>
<td></td>
</tr>
<tr>
<td>Hilly phase</td>
<td></td>
</tr>
<tr>
<td>Steep phase</td>
<td></td>
</tr>
<tr>
<td>Lordstown channery silt loam, eroded</td>
<td></td>
</tr>
<tr>
<td>moderately steep phase</td>
<td></td>
</tr>
<tr>
<td>Lordstown flaggy silt loam</td>
<td></td>
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<tr>
<td>Steep phase</td>
<td></td>
</tr>
<tr>
<td>Very steep phase</td>
<td></td>
</tr>
<tr>
<td>Mardin channery silt loam, eroded moderately steep phase</td>
<td></td>
</tr>
<tr>
<td>Middlebury silt loam</td>
<td></td>
</tr>
<tr>
<td>Muck</td>
<td></td>
</tr>
<tr>
<td>Steep stony land (Lordstown soil material)</td>
<td></td>
</tr>
<tr>
<td>Volusia channery and gravelly silt loams:</td>
<td></td>
</tr>
<tr>
<td>Moderately steep phases</td>
<td></td>
</tr>
<tr>
<td>Eroded moderately steep phases</td>
<td></td>
</tr>
<tr>
<td>Woostern gravelly silt loam, steep phase</td>
<td></td>
</tr>
</tbody>
</table>

These soils are, for the most part, so obviously poor for commercial potato production that few mistakes are made on them. Some soils of the group are permanently wet; others, so steep machinery can hardly be used; others, hilly but severely eroded.

### ESTIMATED YIELDS

Estimated acre yields of principal crops to be expected under two levels of management are given in table 7 for each soil in the county. In columns A are estimated yields without special practices; in columns B, yields to be expected under current practices of management. The practices followed in current management are described in the section on Use and Management.

### FORESTS

The last remnants of the virgin forests in the county disappeared about 50 years ago. The original growth consisted of much white pine and hemlock mixed with various hardwoods, as white and red oaks, chestnut, hard maple, and beech. The present timber is composed of second and third growths, mostly hardwoods. In places, hemlock is fairly plentiful with lesser stands of white pine. Chestnut has disappeared because of the ravages of the chestnut blight.

Forested areas are more generally confined to the steeper lands flanking the main valleys and the areas of more rugged relief not suited to cultivation (pls. 18 and 19). These areas are fairly well distributed over the county, and most of them have remained permanently forested. Forested land is somewhat more extensive in the northern parts of the county than in the southern.

Most of the lands retired from agricultural use and purchased by the State have been planted to trees that give promise of substantial...
<table>
<thead>
<tr>
<th>Soil</th>
<th>Corn (silage)</th>
<th>Corn (grain)</th>
<th>Oats</th>
<th>Wheat</th>
<th>Buckwheat</th>
<th>Legume-grass hay</th>
<th>Potatoes</th>
<th>Permanent pasture</th>
<th>Physical land classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allis channery silt loam, gently sloping phase</td>
<td>4.2</td>
<td>60</td>
<td>20</td>
<td>35</td>
<td>11</td>
<td>15</td>
<td>11</td>
<td>15</td>
<td>0.8</td>
</tr>
<tr>
<td>Alluvial soils, undifferentiated</td>
<td>6.0</td>
<td>9.0</td>
<td>25</td>
<td>40</td>
<td>13</td>
<td>20</td>
<td>11</td>
<td>20</td>
<td>1.0</td>
</tr>
<tr>
<td>Bath channery silt loam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sloping phase</td>
<td>7.2</td>
<td>10.0</td>
<td>30</td>
<td>50</td>
<td>18</td>
<td>25</td>
<td>18</td>
<td>23</td>
<td>1.2</td>
</tr>
<tr>
<td>Moderately steep phase</td>
<td>8.0</td>
<td>11.0</td>
<td>25</td>
<td>40</td>
<td>13</td>
<td>20</td>
<td>11</td>
<td>23</td>
<td>1.3</td>
</tr>
<tr>
<td>Canfield gravelly silt loam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undulating phase</td>
<td>8.0</td>
<td>11.0</td>
<td>25</td>
<td>40</td>
<td>13</td>
<td>20</td>
<td>11</td>
<td>23</td>
<td>1.3</td>
</tr>
<tr>
<td>Rolling phase</td>
<td>10.0</td>
<td>13.0</td>
<td>35</td>
<td>45</td>
<td>15</td>
<td>23</td>
<td>15</td>
<td>23</td>
<td>1.5</td>
</tr>
<tr>
<td>Eroded rolling phase</td>
<td>11.0</td>
<td>14.0</td>
<td>40</td>
<td>50</td>
<td>15</td>
<td>23</td>
<td>15</td>
<td>23</td>
<td>1.7</td>
</tr>
<tr>
<td>Chenango gravelly silt loam, nearly level phase</td>
<td>10.0</td>
<td>13.0</td>
<td>35</td>
<td>45</td>
<td>15</td>
<td>23</td>
<td>15</td>
<td>23</td>
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1 Corn for grain frequently does not completely mature. Yields indicated are in terms of dry corn equivalent at the time of harvest.
2 Yields from one cutting the first year of harvest. Legumes are usually grown in mixtures with grasses, and most such mixtures include more than one legume. The legume dominant in the stand depends not only on the seeding mixtures used, but also on soil conditions.
3 Cow-acres-days is a term used to express the carrying capacity of pasture land. It is the product of the number of animal units carried per acre multiplied by the number of days that animals can be grazed without injury to pasture, for example, a soil that supports 1 animal unit per acre for 360 days rates 360; a soil supporting 1 animal unit on 2 acres for 180 days rates 360; and a soil supporting 1 animal unit on 4 acres for 100 days rates 35
4 The use of letters to indicate classes of soils is explained in text, p. 97 A=excellent for agriculture—excellent to good for crops and pasture; B=good for agriculture—good to fair for crops, excellent to fair for pasture; C=fair for agriculture—fair to poor for crops, good to fair for pasture; D=fair for agriculture—very poor for crops, good to fair for pasture; E=very poor for agriculture—very poor for crops and pasture, fair to poor for forests.
future value. These are mostly red, Scotch, and white pines, spruce, and larch. Additional forest plantings are planned as the State may acquire submarginal land. Some farmers have established small plantings on their lands not suitable for other purposes.

The 1945 census gives a total of 61,392 acres in farm woodland, or an average of about 30 acres a farm. Of this acreage, 46,261 acres were not pastured, and 15,131 acres were used as woodland pasture. Somewhat larger farm acreages are timbered on the uplands than in the valleys, as the valley land has a higher crop value. The use of woodland as range for livestock is disapproved (2) as a practice harmful to tree growth, especially to young growth. Trampling of stock destroys the mat of leafy litter that catches and holds rainwater, packs the soil, and injures roots of both mature and young trees. The quantity of grass available is trifling, and the leafy browse afforded does not compensate for the harm done to the forest stand.

In this county increasing interest is being taken in farm woodland as a source of cash return. Interested timber owners have formed marketing cooperatives through which selective cuttings are marketed.

MORPHOLOGY, GENESIS, AND CLASSIFICATION OF SOILS

Soils are defined as the natural medium for the growth of plants (9, 10). They are formed principally from disintegrated rock fragments through the action of living organisms and climatic agencies. The functioning of these active agencies is conditioned by the relief, or lay of the land, and by the length of time that the soil-forming process has been acting.

Tioga County is in south-central New York in the southern tier of counties bordering Pennsylvania and is on the glaciated Allegheny Plateau (3). Here podzolization is the normal soil-forming process, and formerly the area was considered to be in the Gray-Brown Podzolic soil region. Nearly all the zonal soils of the county, however, are now classified in the Podzol group. The higher elevation, as compared to the areas to the north and west, and the more acid parent material are believed to have contributed largely to the formation of Podzol rather than Gray-Brown Podzolic soils in the area.

The county is in the extreme northern part of the Appalachian Plateaus physiographic province (3), which extends from southern New York to central Alabama. The large province is divided into several sections on the basis of differences in underlying rock, elevation, degree of dissection, and the presence or absence of glaciation. The section designated as the glaciated Allegheny Plateau covers southern New York and northern Pennsylvania and includes all of Tioga County. Except for glaciation this section is very similar to the larger unglaciated section that extends from northern Pennsylvania south to eastern Kentucky and west to central Ohio.

The glaciated Allegheny Plateau is maturely dissected and has a typical dendritic drainage pattern. The general pattern was altered very little by glaciation, but the larger valleys were deepened and straightened by ice action, and spurs and drainage divides were obliterated in many places. The underlying rocks are Devonian sandstone and brittle shale of the Chemung formation. They are nearly level-bedded but dip very gently to the south. The floors of the deep
valley are 800 to 1,000 feet in elevation, and the plateau surface is
between 1,500 and 1,600 feet. An exception is a small area in the
northeastern part that is 2,000 feet above sea level. The county
drains to the southwest through the Susquehanna River and its
tributaries, except for a very small area in the north end of Spencer
Valley that drains to the north into Cayuga Lake.

Differences in the composition of the parent material and the
manner of its disposition are the major bases for differentiating many
of the important soil series of the county. In general, however, differ-
ences in parent material cannot account for differences between the
soils of this county and those of other regions. The low supply of
bases, however, may have been a factor in the development of Podzol
soils in the area rather than the Gray-Brown Podzolic soils developed
in comparable latitudes in the States farther west and in the limestone
belt of central New York. The parent material of practically all soils
in this county has been transported by ice or water, or both, and has
been altered and in some cases sorted by this movement. The impor-
tant classes of parent material are glacial till, glacial outwash, young
terrace deposits, recent alluvium, and organic material.

Glacial till is by far the most important class, as it covers about
85 percent of the county. On the higher uplands where glacial action
was relatively feeble, the existing soil and the weathered rock material
were stirred and mixed, but the underlying rocks were only slightly
disturbed. On these higher areas the advance and retreat of the ice
was rather rapid, and no significant deposition of rock material from
distant places occurred. Here the till mantle is thin (2 feet to less
than 10 feet) and consists almost entirely of angular sandstone and
brittle shale fragments in a matrix of sand, silt, and some clay. This
material is gray, strongly acid, and very compact. The compaction
is probably caused by the weight of the ice sheet. This till is the
parent material for the Lordstown, Mardin, Fremont, and part of the
Volusia and Chippewa soils. Bath soils are on some of the deeper
pockets. Where the till is very thin or entirely missing and brittle
shale is at shallow depth, the Allison soil is formed.

On the lower upland slopes, especially those bordering many of the
narrower valleys, the ice sheet was thicker, remained longer, and
retreated more slowly. In these places a thicker and somewhat less
compact till was deposited. As on the higher uplands, it consisted
largely of local gray acid sandstone and shale material, but it also
included some crystalline rock, as granite, and red sandstone from
distant places. Small quantities of limestone were likely present also,
but they have been removed by leaching, and the till is now strongly
acid. Rock fragments were moved farther by the ice and are more
rounded. This class of till covers about 10 percent of the county and
is the parent material for the Wooster, Canfield, and associated areas
of the Volusia and Chippewa soils.

As the melting glaciers retreated northward in the deeper and
broader valleys, large volumes of water poured from the front of the
melting ice. These waters carried large quantities of rock material
and deposited them in the valleys as low fans or outwash aprons. The
material was mainly from sandstone, but also from granite, quartzite,
and in places limestone. The deposits are stratified and are friable
to great depth. Where the materials are strongly acid throughout,
they give rise to the Chenango, Braceville, and Atherton soils, and where they contain lime in the upper stratum, Howard soils are formed.

Since the glaciers retreated from Tioga County, the larger streams have continued to deepen their valleys. As this deepening has gone forward the original flood plains have been left as terraces, or benches, well above overflow. Such terraces are found in the Susquehanna River Valley and in the valleys of one or two of the larger creeks. These terrace deposits consist mainly of sand and silt with gravel beds at moderate depths. The upper layers are acid, but the substratum is alkaline or calcareous. This class of parent material covers only 1 percent of the county and gives rise to the Unadilla soils.

Deep deposits of recent alluvium cover the present flood plains. This material consists mainly of silt and sand with some clay and gravel. It is deep, friable, and acid. Tioga, Middlebury, and Holly soils are formed in this class of material.

Organic deposits have accumulated in depressed pockets or small ponds or lakes on uplands, terraces, and bottom lands. These deposits consist of decomposed remains of plants and are the parent material for Muck.

Relief and drainage are as important in determining local soil differences as parent material and, within any given class of parent material, the differences among the various soil series are largely the result of differences in drainage. As with parent material, however, major differences between the soils of this county and those of other regions cannot be accounted for by drainage differences.

All the upland areas are thoroughly dissected and have strong relief; the ridge crests are 300 feet higher than the adjoining valleys. In spite of this, the uplands of the county are characterized by broad areas with imperfect to very poor drainage. This restricted drainage may be due to one or a combination of several factors. The shallow depth of unconsolidated weathered rock material over rock, the compactness of this material caused by ice packing, and the imperviousness of the underlying level-bededd sandstone or shale are important on all the smoother slopes. On the slopes below the ridge crests large quantities of seepage water from higher slopes contribute to poor drainage. About 60 percent of the upland soils, including the Mardin, Canfield, Volusia, Fremont, and Chippewa, have moderately to severely restricted drainage caused by one or several of these factors. Only on the stronger slopes and on the deeper and more friable tills are the well-drained Lordstown, Woostern, and Bath soils.

In contrast to the uplands, the glacial outwash terraces and the younger terraces generally have nearly level slope and slight relief. Exceptions are narrow strips of hilly and steep slope on the terrace edges and in a few small kamy areas. Even though relief is gentle, the terraces are dominantly well drained, principally because of the deep friable gravelly material on which the Chenango, Howard, and Unadilla soils form. The imperfectly and poorly drained Braceville and Atherton soils are on flats or depressions, generally where there is a local pocket of fine soil material, and in many places where seepage water is received from adjacent upland slopes.

The bottom lands are characterized by level slopes and high groundwater level and are subject to frequent overflow. About two-thirds
of the bottom-land soils have restricted drainage. The well-drained Tioga soils are confined mainly to the higher elevations and are on the coarser textured materials.

Parent material, relief, and drainage vary widely in different parts of the county, but the climate is essentially uniform over the entire area. This uniform climate is largely responsible for the characteristics common to the mature soils, and is also one of the main causes of differences between Tioga County soils and those of distant regions. The county has a cool temperate continental type of climate with long cold winters and warm summers. Total annual precipitation ranges from about 35 to 38 inches, and the heavier rainfall is in the higher upland areas. The average annual temperature is about 45°F, and the mean relative humidity averages about 80 percent with only slight variation from month to month (11, 16).

These climatic factors have in several ways affected the formation of soils in this county. One-half or more of the precipitation falls during the growing season when the soil is not frozen, and leaching of bases as calcium and magnesium proceeds at a relatively rapid rate. This process is slowed by winter freezing, although not entirely so, inasmuch as cold spells alternate with warm periods during which the soil thaws completely. Iron and aluminum compounds are also translocated in solution, or mechanically by the percolating waters, but are normally reprecipitated, or dropped, in the subsoil layers. Active as this leaching process is, it proceeds at a slower rate in this county than in areas farther south on the Appalachian Plateaus where rainfall is heavier and the soil is not frozen during the winter months. The alternate freezing and thawing are important in mechanical weathering of the larger rock fragments in the soil and of the underlying bedrock. Freezing and thawing break up the material so that chemical and biologic agencies can more easily attack it. The functioning of biologic agencies in the formation of soils is closely related to climate, inasmuch as moisture and temperature conditions determine to a large extent the kind of plants and animals that can live.

The original forests of Tioga County varied because of local variations in moisture and soil conditions, but they were dominantly of the mixed hardwood type with some white pine and hemlock in places (1, 14). All these trees are deep feeders and return moderate quantities of bases to the surface in their litter. These bases are not sufficient to replenish the materials lost by leaching, however, and consequently the soils are acid, though somewhat less so than soils that develop under cooler climate. Windfalls of forest trees are likely more important in stirring and mixing soil materials than is commonly recognized.

The burrows of small animals, insects, and earthworms, as well as the root channels of plants, increase the ease of absorption and percolation of water and encourage leaching. The insects and worms are also very active in mixing soil material and in incorporating organic matter in the upper layers. Bacteria and fungi are also important in the soil-forming process. Most soils of the county have the mor, or matted, type of humus layer, which is formed largely by the activities of fungi and to little extent by the activity of earthworms, burrowing insects, and bacteria (12, 15). The predominance of fungi is said to be caused by the low supply of bases in the parent material,
so that this feature of the soils is partly a function of the kind of parent material.

As for climate, the biologic agencies are relatively uniform over the entire county and are not major factors in differences among the soils. Nonetheless, as is true for climate, they have been important in determining differences between soils of the area and those of distant places.

The active soil-forming agencies, as climate and living organisms, work slowly, and a long period of time is required for establishment of an equilibrium between the soil and its environment (9). The last retreat of the glacial ice sheet from the area now in this county was recent in geologic time and occurred between 10,000 and 25,000 years ago according to estimates by geologists. The climate since that time probably has been essentially as it is now, and vegetation likely has not changed significantly during the past 10,000 years.

Although much younger in years than the soils farther south on the unglaciated Allegheny Plateaus, the soils of this county on the uplands and terraces underlain by glacial drift and outwash have distinctly developed fairly mature Podzol and Gray-Brown Podzolic profiles. In general, however, their profile features are less strongly expressed than those of soils in glaciated northern Indiana and southern Michigan where climate and vegetation are very similar. The Tioga County soils have less textural difference between the surface and subsoil layers, and do not have the well-expressed nuciform structure of the subsoil that characterizes many of the mature soils of the glaciated regions farther west. These differences may be caused in part by more recent deglaciation of Tioga County, although differences in parent material may be an important factor.

On the bottom lands the soil materials consist of recently deposited alluvium, and frequent increments are added by floodwaters. This is also true on many of the low alluvial fans bordering the valleys. The continuing renewal of soil material does not permit the active soil-forming agencies to function long enough to alter seriously the soil material. For this reason, soils in these positions have very weakly expressed profile features and are considered to be young.

The normal mature soil of Tioga County in well-drained positions has a Podzol type of profile. Under forest, the surface is covered with a thin layer of leaf litter, the lower part of which is actively decomposing. This rests on a matted humus layer, which is in turn underlain by a very thin ashy-gray $A_2$ horizon. The $B$ horizon is strong yellowish brown but has very weakly expressed structure and is relatively uniform in texture throughout the total depth. The unaltered acid glacial till or outwash is at a depth of about 30 inches.

Closely associated with these soils, but on slopes with moderately restricted drainage, are other Podzol soils similar in profile features to the normal ones except that a compact hardpan begins at 20 to 24 inches and extends downward to the parent material. The "Low-Humic Gley" soils are in poorly drained positions associated with the zonal soils. They have a mull humus layer that is grayish brown, are mottled within 8 to 10 inches of the surface, and have the compact layer more strongly developed and at shallower depth. The associated "Humic Gley" soils have a gray surface layer darkened with organic
matter, and the mottles are very near the surface. The Bog soils consist of deep organic deposits.

CLASSIFICATION OF SOILS

The soil series of Tioga County are grouped in higher categories according to their profile characteristics in table 8, and some of the important factors that have contributed to their formation are listed. The highest category of classification is the order, and three orders—zonal, intrazonal, and azonal—are recognized.

Zonal soils are defined as having well-developed soil characteristics that reflect the influence of the active factors of soil genesis—climate and vegetation; intrazonal soils as having more or less well-expressed soil features that reflect the dominating influence of some local factor of relief, parent material, or age over the normal effect of the climate and vegetation; and azonal soils as those without well-expressed soil characteristics. The orders are divided into suborders, each of which in turn includes several great soil groups.

The principal soil series are arranged to show their catenary relations in table 9. A soil catena is defined as a group of soils within one zonal region developed from similar parent material but differing in characteristics of the solum because of differences in relief or drainage (16). The soil series listed in a horizontal line in table 9 have essentially the same kind of parent material but differ in profile characteristics, whereas those in vertical columns have the same kind of profile but are derived from different kinds of material.

Tioga County is in the region of Podzol and Gray-Brown Podzolic soils. The zonal order is represented by soils of both these great soil groups; the intrazonal order by soils of the Bog, "Humic Gley," and "Low-Humic Gley"; and the azonal order by soils of the Alluvial great soil group. These great soil groups are defined, and representative profiles are described as follows.

PODZOL SOILS

Nearly all the zonal soils of the county are classified as Podzol, which are zonal soils having a thin mat of partly decayed leaves over a very thin dark grayish-brown humus mineral soil and a trace of pale-gray leached A₂ horizon over a brown or yellowish brown B horizon slightly heavier in texture than the surface soil. They are developed under deciduous or mixed deciduous and coniferous forest in temperate or cool-temperate humid regions. All the Podzol soils of this county are developed from acid glacial till or outwash. Soils of the Bath, Lordstown, Woostern, Chenango, Unadilla, Mardin, Canfield, Fremont, and Braceville series are in this great soil group.¹

BATH SERIES

The Bath soils are representative of the Podzol soils of the county. They occur on sloping to moderately steep well-drained slopes in the higher uplands and are derived from a moderately deep acid glacial till that is in turn derived from the underlying level-beded

¹ Cline, M. G. Tentative catena key for New York soils, 1947. [Processed.]
### Table 8. Classification of the soil series of Tioga County, N. Y., in higher categories and some of the factors that have contributed to their morphology

**Zonal Soils—Light-Colored Podzolized Soils of the Timbered Regions**

<table>
<thead>
<tr>
<th>Great soil group and soil series</th>
<th>Topographic position</th>
<th>Parent material</th>
<th>Relief</th>
<th>Drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Podzol: Bath</td>
<td>Deeply dissected uplands (plateaus)</td>
<td>Compact deep glacial till derived from acid sandstone and shale, largely of local origin.</td>
<td>Sloping to moderately steep.</td>
<td>Good.</td>
</tr>
<tr>
<td>Lordstown</td>
<td>do</td>
<td>Relatively shallow compact stony or flaggy glacial till derived from acid sandstone and shale, largely of local origin.</td>
<td>Gently sloping to very steep, commonly high elevations.</td>
<td>Good to excessive.</td>
</tr>
<tr>
<td>Mardin (shallow phases)¹</td>
<td>do</td>
<td>do</td>
<td>Gently sloping to sloping...</td>
<td>Moderately good. Do.</td>
</tr>
<tr>
<td>Mardin ¹</td>
<td>do</td>
<td>Moderately deep compact stony or flaggy glacial till derived from acid sandstone and shale.</td>
<td>Undulating to moderately steep.</td>
<td>Do.</td>
</tr>
<tr>
<td>Chenango</td>
<td>Old glacial outwash terraces.</td>
<td>Gravelly glacial outwash, chiefly from acid sandstone and shale.</td>
<td>Nearly level to steep.</td>
<td>Good.</td>
</tr>
<tr>
<td>Unadilla</td>
<td>Stream terraces</td>
<td>Gravelly old stream alluvium, chiefly from sandstone and shale.</td>
<td>Nearly level to sloping.</td>
<td>Good.</td>
</tr>
<tr>
<td>Woostern ²</td>
<td>Valley walls in deeply dissected uplands (plateaus).</td>
<td>Deep slightly to moderately compact glacial till, mainly from local acid sandstone and shale; contains some crystalline rock and sandstone from distant places; stone fragments are rounded.</td>
<td>Undulating to steep.</td>
<td>Do.</td>
</tr>
<tr>
<td>Canfield ¹²</td>
<td>do</td>
<td>Same as Lordstown, Woostern, and Bath.</td>
<td>Undulating to hilly.</td>
<td>Moderately good. Imperfect.</td>
</tr>
</tbody>
</table>
| Fremont                         | Smooth slopes of dissected uplands. | | Gently sloping to moderately steep. | }
<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Description</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray-Brown Podzolic soil: Howard</td>
<td>Old glacial outwash terraces.</td>
<td>Nearly level to steep</td>
</tr>
<tr>
<td></td>
<td>Gravelly glacial outwash, mainly from sandstone and shale but includes some limestone and crystalline rock.</td>
<td></td>
</tr>
</tbody>
</table>

**Intrazonal Soils—Hydromorphic Soils of Marshes, Swamps, Seep Areas, and Flats**

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Description</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bog soil: Muck</td>
<td>Depressions in uplands and outwash terraces.</td>
<td>Level</td>
</tr>
<tr>
<td>&quot;Humic Gley&quot; soils: Chippewa</td>
<td>Broad smooth slopes of dissected uplands.</td>
<td>Level to gently sloping</td>
</tr>
<tr>
<td>Atherton</td>
<td>Low stream and old glacial outwash terraces.</td>
<td>Nearly level</td>
</tr>
<tr>
<td>&quot;Low Humic Gley&quot; soils: Volusia</td>
<td>Smooth slopes of dissected uplands.</td>
<td>Gently sloping to moderately steep</td>
</tr>
<tr>
<td>Allis</td>
<td>do</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Decomposed plant residues over mineral soils.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Same as Lordstown, Mardin, and Volusia.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Glacial outwash of sand and gravel largely from sandstone and shale.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Same as Lordstown, Woostern, and Bath. Thin acid glacial till from acid soft to brittle shale; bedrock at less than 3 feet.</td>
<td></td>
</tr>
</tbody>
</table>

**Azonal Soils**

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Description</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvial soils: Tioga</td>
<td>Level bottom lands of larger streams.</td>
<td>Nearly level</td>
</tr>
<tr>
<td>Middlebury</td>
<td>do</td>
<td>do</td>
</tr>
<tr>
<td>Holly</td>
<td>do</td>
<td>do</td>
</tr>
</tbody>
</table>

1 Soils with a distinct hardpan layer are formed under slightly to moderately hydromorphic conditions. They are transitional between the Podzol and the Gray-Brown Podzolic soils and the Planosols and have characteristics common to each group.

2 Locally includes soils transitional to Gray-Brown Podzolic soils.
<table>
<thead>
<tr>
<th>Parent material</th>
<th>Drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excessive</td>
</tr>
<tr>
<td>Glacial till:</td>
<td></td>
</tr>
<tr>
<td>Compact deep till from acid sandstone and shale, chiefly of local origin; stone fragments are chiefly angular channers and flags.</td>
<td>Lordstown</td>
</tr>
<tr>
<td>Do</td>
<td></td>
</tr>
<tr>
<td>Steep stony land (Lordstown soil material).</td>
<td>Lordstown</td>
</tr>
<tr>
<td>Slightly to moderately compact till, largely from acid sandstone and shale; includes some material not of local origin; stone fragments rounded. Thin acid till from soft to brittle acid shale; bedrock generally at less than 3 feet, but depth is variable.</td>
<td>Woostern</td>
</tr>
<tr>
<td>Manlius ¹</td>
<td></td>
</tr>
<tr>
<td>Glacial outwash: Sand and gravel chiefly from sandstone and shale; small quantity of limestone at great depth. Sand and gravel from sandstone, shale, and a moderate quantity of limestone.</td>
<td>Chenango</td>
</tr>
<tr>
<td>Howard ²</td>
<td></td>
</tr>
<tr>
<td>Stream terraces (old alluvium):</td>
<td>Unadilla</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Sand and gravel largely from sandstone and shale deposited by post-glacial streams.</td>
<td></td>
</tr>
<tr>
<td>Stream bottom lands (young alluvium):</td>
<td>Tioga</td>
</tr>
<tr>
<td>Recently deposited sand and gravel mostly from sandstone and shale.</td>
<td></td>
</tr>
<tr>
<td>Organic deposits:</td>
<td></td>
</tr>
<tr>
<td>Well-decomposed residue of woody and herbaceous plants.</td>
<td></td>
</tr>
</tbody>
</table>

¹ Not mapped in Tioga County but included to show relations of soils of this county to those of adjoining areas.
² Classified as a Gray-Brown Podzolic soil.
gray Devonian sandstone and brittle acid shale. They were formed under a mixed forest of maple, oak, chestnut, and beech, with some hemlock and white pine on some sites. A mor, or matted, type of humus layer has developed under this vegetation influenced also by the strongly acid parent material. Although these soils are from glacial deposits that are considered to be young from a geologic standpoint, they have been exposed to their present environment for thousands of years and are probably in equilibrium with it.

A profile of Bath channery silt loam under mixed second-growth forest on the gently sloping to sloping crest or upper slope of the higher ridges has the following characteristics:

A₀. Undecomposed leaf litter 1 to 2 inches thick.
A₀. Black mor layer heavily matted with fine tree rootlets and about 2 to 3 inches thick.
A₂. 0 to ¾ inch, light-gray to nearly white friable silt loam; material generally has a slightly to moderately expressed fine platy structure but when removed crumbles to very fine granular aggregates with a soft floury feel; layer filled with fine tree rootlets; by way of root channels and worm and insect burrows thin streamers of this material extend downward 2 to 3 inches into the layer below; pH, about 4.0.
B₂. ½ to 10 inches, strong yellowish-brown silt loam without well-expressed structure; material breaks into irregular angular-shaped fragments that crumble easily to a loose friable granular mass and contains many tree roots; pH, about 4.5.
B₃. 10 to 18 inches, yellowish-brown friable loam generally slightly firmer than the layer above; in places material may have a weakly expressed nuciform structure, but the aggregates crumble easily to a friable granular mass; gradual transition to layer below; pH, about 5.0.
C. 18 to 30 inches +, olive loam to silt loam; material compact in place but breaks into irregular angular firm fragments that shatter under pressure to smaller angular fragments; layer more gray and compact with increasing depth. Material extends downward 10 feet or more in most places and rests on level-bedded gray fine-grained sandstone that contains some beds of brittle gray acid shale; larger tree roots extend down into this layer; pH, about 5.5.

The entire soil profile contains a large quantity of flat angular gray sandstone fragments.

The other well-drained Podsol soils differ from the Bath soils mainly in characteristics associated with differences in kind, depth, and manner of deposition of parent material.

**LORDSTOWN SERIES**

The Lordstown soils were formed under conditions practically identical to those of the Bath series, except the depth to bedrock is less, ordinarily 2 to 3 feet. The upper soil layers are essentially the same as those of the Bath profile, but the C layer is missing, or where present, is generally more loose and open than for the Bath soil. Level-bedded acid gray somewhat massive sandstone is at 3 feet or less, and stone fragments in the soil profile are larger and more numerous.

**WOOSTERN SERIES**

The Woostern soils are at somewhat lower elevations than either the Bath or Lordstown and are derived from a deeper glacial till. This till consists largely of local rock material similar to that underlying the Bath and Lordstown soils, but includes some crystalline rock
material and reddish sandstone that have been transported from areas farther north. Generally the rock fragments, especially those from distant areas, are fairly well rounded, but some flat channers and flags persist. This till is many feet thick and commonly is somewhat less compact than that of Bath soils on the uplands.

Climate is essentially the same as for the Bath soils, although total precipitation may be slightly less and the growing season slightly longer. The forest cover is similar to that on the higher uplands, but may contain more hard maple and less oak and beech than the higher areas on shallow till.

The profile layers of the Wooster soils are essentially the same in kind, sequence, structure, consistence, and reaction as those of the Bath soils, but the parent material is deeper and slightly more open. The Wooster soils of this county differ somewhat from the Wooster soils of eastern Ohio, which have a grayish-brown A horizon several inches thick and a yellowish-brown B horizon with a well-expressed nuciform texture. The Wooster are heavier textured in the B horizon and are less stony throughout.

CHENANGO SERIES

The Chenango soils are similar to the Bath and Wooster soils in general profile features, but are derived from glacial outwash of stratified acid sand, gravel, and some silty material. These materials are open and porous in contrast to the compactness of the upland tills, but they are similar in containing much siliceous material and in lacking lime. Climate is essentially the same as that of the Wooster soils, but there is possibly slightly less precipitation and a slightly longer growing season than in the higher uplands. Forest growth may have been somewhat more vigorous on these deeper more friable materials, but there was the same general association of trees. Generally the A2 horizon is thinner than on the Bath soils, and the total depth of solum is slightly greater. The profile of the Chenango soils contains a large quantity of well-rounded gravel.

UNADILLA SERIES

The Unadilla soils are closely associated with the Chenango soils in the broader valleys. They are on lower and younger postglacial terraces that are derived from the same general type of material as the Chenango and have about the same chemical composition as the glacial outwash, except that small quantities of lime are at depths of 5 or 6 feet. Climate and vegetation are the same as for the Chenango soils. The profile of the Unadilla soils is similar to that of the Chenango but the upper 3 feet is free of gravel, and the horizon differentiation may be less well expressed because the Unadilla are younger soils.

MARDIN SERIES

The Mardin soils are developed from parent material similar to that of the Bath soils, and under similar vegetation and climate. Slopes have about the same range but are commonly longer and smoother, and internal drainage is definitely impeded. This restricted drainage is largely responsible for differences between the Mardin and Bath soils. Compactness of the till, smooth slopes, and seepage
from adjacent higher slopes contribute to the impeded drainage of the Mardin soils.

A profile of Mardin channery silt loam on a mild slope of about 4 percent under second-growth forest of sugar maple and red oak has the following properties:

A0. Leaf litter 1 to 2 inches thick.
A. A mor or matted, humus layer about 2 inches thick; layer has a very thin fermentation zone at the top and is very heavily matted with tree rootlets; pH, 4.0 or less.
A1. 0 to ½ inch, light-gray to nearly white silt loam of weak fine platy structure; material crumbles readily to a smooth soft floury mass and contains many small tree rootlets; pH, about 4.0. In many places this layer is lacking entirely.
B1. ½ to 10 inches, brownish-yellow silt loam of no distinct structure; material breaks into soft irregular fragments that crumble readily to a smooth friable granular mass and contains many roots; pH, about 4.0.
B2. 10 to 19 inches, light brownish-yellow to olive silt loam with a moderately expressed nucleiiform structure; aggregates, 1 to 1½ inches in size, crush or crumble to a friable granular mass; structure particles have grayish to yellowish coatings; fairly strong mottles apparent in lower part of layer; pH, about 4.5.
B3m. 19 to 26 inches, light-gray to olive silt loam streaked with shades of brown and yellowish brown; material very compact in place, extremely difficult to penetrate with a digging tool when dry, and breaks into irregular angular fragments that shatter under strong pressure to a fine floury mass; small pebbles or angular stone fragments are a common constituent of this layer; few roots penetrate beyond the topmost 1 or 2 inches; pH, about 5.0.
C. 26 to 41 inches +, olive loam to olive silt loam with a distinct blocky structure; aggregates darkened by a thin coating, and brownish and yellowish mottles are fairly common in the upper part; both mottles and coatings disappear below the upper 6 or 8 inches; material compact in place but less so than the B3m layer, and compaction decreases with depth. Material extends downward to a minimum of 4 feet and may reach to 10 feet or more; underlying is acid sandstone and shale similar to that under the Bath soils; pH, about 5.0.

Both the soil profile and the parent material contain large quantities of flat sandstone and shale channers.

CANFIELD SERIES

The Canfield soils occur on the lower uplands in association with Woostern soils and have the same kind of profile as the Mardin. They differ from the Mardin mainly in having gravelly till parent material similar to that of the Woostern, and bear the same relation to the Woostern soils as the Mardin soils do to the Bath. Some areas of Canfield soils are more grayish in the surface and less yellow and more brown in the subsoil than the Mardin soils, and in this respect approach the Gray-Brown Podzolic soils in general profile features.

BRACEVILLE SERIES

The Braceville soils are also similar in general profile characteristics to the Mardin soil and are the imperfectly drained analog of the Chenango soils. Some of the younger soils of this series may have less distinctly expressed profiles.
FREMONT SERIES

The typical Fremont soils have much the same kind of profile as the Mardin but have more motting. The surface layers of the Fremont are more brown than those of the Volusia, and the mottled layer is less compact. The Fremont soils are, however, at higher elevations, mainly on the smooth crests of the highest ridges. Because of the high elevation these soils do not receive seepage water as do the Volusia, and the restricted drainage is caused entirely by the compaction of the till and the imperviousness of the underlying rock. The Fremont series is intermediate in drainage between the Mardin and Volusia soils and has some properties of both Podzol and "Low-Humic Gley" soils.

GRAY-BROWN PODZOLIC SOILS

The Gray-Brown Podzolic soils are the other zonal great soil group represented in Tioga County. They are defined as a zonal group of soils having a comparatively thin organic covering and organic mineral layers over a grayish-brown leached layer that rests on an illuvial brown horizon developed under a deciduous forest in a temperate moist climate.

HOWARD SERIES

The Howard soils are the only recognized members of the Gray-Brown Podzolic group in the county. These soils were formed under the same environment of cool humid climate and mixed hardwood forests as the Podzol Chenango soils and are also on well-drained glacial outwash terraces. The parent material of the Howard soils differs, however, in containing moderate quantities of lime at depths of 4 to 5 feet, and this difference in lime content is apparently the main factor responsible for soil profile differences. The Howard soils do not have so strongly expressed profile features as the more typical Gray-Brown Podzolic soils of the Middle West, northern Indiana, or southern Michigan.

A profile of Howard gravelly loam in a cultivated field has the following characteristics:

A. 0 to 8 inches, grayish-brown friable gravelly loam that contains a moderate supply of well-incorporated organic matter; normally acid in reaction.

A. 8 to 18 inches, yellowish-brown loam, moderately firm in place; material may have a weakly expressed subangular nut structure but it crumbles readily to a friable mass; acid in reaction.

B. 18 to 36 inches, strong yellowish-brown or brown loam to silt loam, heavier in texture than the layer above and firmer in place; weak nucliform structure characterizes layer; aggregates crumble easily to a friable mass when moist but material is slightly sticky when wet; pH, 6.5 to 7.5 or possibly higher.

C. 36 to 50 inches +, grayish to brownish loose gravel and sand; gravel fragments mainly sandstone but some of quartz, granite, and limestone are included; lime concretions and coatings on other gravel particles fairly common; material, with moderate variations, extends to depths of many feet.

In places the structure is very weakly expressed or lacking, as in the Chenango soils, and the soil differs only in having an alkaline lower subsoil and calcareous parent material.
In virgin areas the upper 18 inches of the solum resembles a Podzol soil, although the $A_1$ horizon is more strongly expressed. The $B_2$ horizon resembles the $B_2$ of a typical Gray-Brown Podzolic soil. It has been noted that soil in nearby counties developed on materials higher in lime has the horizon equivalent to the $B_2$ nearer the surface, or directly under a grayish $A_2$. This leads to the speculation that soils in a Podzol region derived from material high in lime pass through a stage comparable to Gray-Brown Podzolic soils until the $A$ horizon becomes deep and strongly acid. At that point, perhaps, a Podzol soil may be impinged on the old $A_2$ horizon. If that is the case, the Howard series represents the last stage before development of a Podzol soil.

"LOW-HUMIC GLEY" SOILS

The "Low-Humic Gley" soils are intrazonal soils with dark grayish $A_1$ horizons underlain by a thin light-gray reduced horizon that in turn overlies a highly mottled horizon extending to the parent material. "Low-Humic Gley" has not been accepted as official nomenclature and is used pending final naming of this important group of soils. The Volusia and Allis series are included in this great soil group in Tioga County.

VOLUSIA SERIES

The Volusia soils are the most extensive of the "Low-Humic Gley" group. Volusia soils were formed under an environment much like that of such associated Podzol soils as the Bath, Mardin, Woostern, and Canfield. Parent material is compact acid gravelly or channery glacial till underlain by level-bedded sandstone and brittle shale. The soils were formed under a comparable kind of mixed forest and under the same cool humid climate as the associated zonal soils. Slopes are smoother, longer, and on the average less steep, however; and these characteristics combined with the compactness of the till, the imperviousness of the underlying rock, and the seepage of water from higher slopes, are responsible for poor drainage conditions. Drainage is the major cause of differences between the Volusia soils and the associated Podzol soils.

A profile of Volusia channery and gravelly silt loams on a long smooth gentle slope under cut-over forest of mixed red oak and sugar maple has the following characteristics:

$A_{20}$. Leaf litter 1 to 2 inches thick.

$A_{2}$. Thin black mor, or matted, humus layer; fine tree rootlets heavily mat layer; very thin mat at the top is actively decomposing. This horizon may be absent.

$A$. 0 to 6 inches, dark grayish-brown silt loam that breaks into a mass of loose fragments easily crushed to a smooth granular mass; layer contains many roots; pH, about 4.5.

$B_{1}$. 6 to 7 inches, gray friable silt loam; pH, about 4.5.

$B_{2}$. 7 to 10 inches, grayish-brown silt loam with brown and gray mottles; material breaks into irregular fragments that crumble readily to a fine granular mass; pH, about 4.5.

$B_{3}$. 10 to 14 inches, grayish-brown strongly mottled with light-gray and yellowish-brown heavy silt loam; weakly expressed blocky structure; material breaks into aggregates with highly mottled gray surfaces; layer contains many roots; pH, about 4.5 to 5.0.

$B_{3}$. 14 to 26 inches, very compact gray silt loam to light silty clay loam strongly mottled with browns and yellows; material breaks into
large angular blocks that shatter to finer fragments when dry but are somewhat plastic when wet; aggregates are gray on the surface and yellow streaked with brown and gray on the inside; few roots in layer; pH, 4.5 to 5.0.

C. 26 to 42 inches, compact olive-gray silt loam to clay loam mottled or mingled with yellow, brown, and gray; material breaks into large angular blocks that may have black to gray streaks or film on the surface; aggregates crush or shatter to a granular mass; few roots in layer.

The C layer with moderate variations extends to depths of 4 to 10 feet or more. Both the soil profile and parent material contain large quantities of angular channers or gravel; more gravelly material is in areas associated with the Canfield and Woostern soils.

ALLIS SERIES

The Allis soil, like the others in the “Low-Humic Gley” group, is on poorly drained smooth upland slopes and was formed under mixed hardwood forest. It differs, however, in having parent material that consists almost entirely of acid brittle shale broken and mixed by glacial action. Shale bedrock is at a depth of 36 inches or less in most places. Smooth gentle slopes and shallow depth to the dense impervious shale bedrock are chiefly responsible for the poor drainage of Allis soil. The upper profile layers are similar to those of the Volusia soils, although they are commonly more grayish. The lower compact layers are even tighter than in the Volusia soils, but are more brittle and shatter to a soft silty mass rather easily. Stone fragments consist of flakes and small blocks of brittle shale or siltstone.

“HUMIC-GLEY” SOILS

“Humic-Gley” soils are an intrazonal group of soils with very dark or peaty surface soil underlain by gray mineral soil. In Tioga County, the soils of only two series, the Chippewa and Atherton, are in this group.

CHIPPENWA SERIES

Soils of the Chippewa series are in the uplands and closely associated with such zonal soils as the Mardin and Lordstown and the intrazonal Volusia soils. Like those soils they are derived from acid compact glacial till, mainly from local acid sandstone and shale. The Chippewa soils occupy very poorly drained situations, either on broad flats or shallow depressions. The compact parent material, impervious underlying rock, and large quantities of seepage and runoff water combine to keep these soils saturated most of the year. The original vegetation, like that on the associated zonal soils, was forest; but the tree species were somewhat different. Moisture-tolerant trees, as elm, soft maple, ash, blue beech, and some willow and hemlock, made up the original forest.

A profile of Chippewa channya silt loam in a pastured area under a cover of willow shrubs, native sedges, and reeds has the following characteristics:

A. 0 to 4 inches, dark-gray to black loam consisting largely of well-decomposed organic matter; material relatively friable, even when wet, and strongly acid in reaction; in some places layer is very thin or entirely missing.
G. 4 to 18 inches, light-gray to gray silt loam with strong mottling of brown and yellow; material has no well-expressed structure but is relatively friable; strongly acid.

C. 18 inches +, light-gray to olive compact silt loam to light silty clay loam; material heavily mottled in upper part but lightcolored and less compact with increasing depth; level-bedded gray sandstone at depths of 4 feet or more.

**ATHERTON SERIES**

The Atherton soil has profile features essentially the same as the Chippewa soils and was formed on similar relief and under the same type of vegetation. It occurs on the glacial outwash terraces in association with the Chenango and Braceville soils and is derived mainly from stratified sand and gravel but generally includes some local alluvium or colluvium.

**BOG SOILS**

Bog soils are defined as an intrazonal group of soils with muck or peaty surface soil underlain by peat, developed under swamp or marsh types of vegetation, mostly in a humid or subhumid climate. The Muck of Tioga County falls in this category. It is formed in very poorly drained depressed positions, mainly on the outwash terraces. Some areas do occur in the uplands and others on the bottom lands. The native vegetation is sedges, reeds, grasses, cattails, sweetflag, and other marsh plants. The muck deposit consists of a layer of dark-brown well-decomposed organic material overlying a lighter brown fibrous peaty organic deposit. Mineral soil material is at depths of 3 to many feet.

**ALLUVIAL SOILS**

Alluvial soils are an azonal group of soils developed from transported and relatively recently deposited alluvial material characterized by a weak modification or none of the original material by soil-forming processes (15). The Tioga, Midelebury, and Holly soils belong to this group. All are on the level stream bottom lands, are subject to annual overflow, and receive annual increments of soil material. Parent material consists of recently deposited sand, silt, and clay. These soils were originally covered with heavy hardwood forests; all are very young and have weakly expressed profile features.

Typical Tioga soil consists of 2 to 3 feet of uniform yellowish-brown friable acid silt loam, except where the surface soil or plow layer is darkened by organic matter. This overlies yellow to gray stratified acid sand, silt, and gravel many feet thick. The associated Middlebury soils are similar to the Tioga in the upper 12 to 18 inches but are strongly mottled below those depths because the lower layers are waterlogged. The Holly soils occupy the lowest or depressed positions in the bottom lands. They are gray and mottled up to the surface and in places may have a very dark organic surface layer 3 to 4 inches thick.
TIOGA COUNTY, NEW YORK

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