Soil Survey
of
Ottawa County, Ohio

By
A. H. PASCHALL, in Charge, J. G. STEELE
and G. W. CONREY
Ohio Agricultural Experiment Station
and
S. W. PHILLIPS
United States Department of Agriculture

Bureau of Chemistry and Soils
In cooperation with the
Ohio Agricultural Experiment Station

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SOIL SURVEY OF OTTAWA COUNTY, OHIO

By A. H. PASCHALL, in Charge, J. G. STEELE, and G. W. CONREY, Ohio Agricultural Experiment Station, and S. W. PHILLIPS, United States Department of Agriculture

COUNTY SURVEYED

Ottawa County is in the northern part of Ohio. (Fig. 1.) The mainland borders Lake Erie, and several islands in Lake Erie and in Sandusky Bay are included within the county boundaries. North Bass, the most distant island, is 9 miles from the mainland. The county comprises an area of 262 square miles, or 167,680 acres.

The surface relief of the county as a whole ranges from nearly level to gently rolling. West of Port Clinton the surface is very flat and but little elevated above Lake Erie. Shallow stream valleys, cut to a depth ranging from 15 to 25 feet, and low limestone ridges or knolls, rising from 5 to 15 feet above the general level, break the monotony of the landscape. In the eastern part of the county, east of Port Clinton, the relief is undulating or gently rolling, being, in general, level along the lake front and rising gently inland, except in Catawba Island Township and in the eastern end of Marblehead Peninsula, where large masses of limestone rise above the surrounding level. It is probable that at one time these masses were islands similar to the present islands in Lake Erie, and even now Catawba Island Township is separated from the mainland by a narrow swamp heading in section 33 of Portage Township and extending in a northeasterly direction for a distance of 5 miles and from there north to the lake through West Harbor. This swamp occupies the old Portage River channel. East Harbor and Middle Harbor were probably formed by Portage River at some earlier stage in its history, and are now lake-border marshes.

The surface relief of North Bass, South Bass, and Middle Bass Islands is undulating or gently rolling. In places, especially on the western edges, limestone cliffs rise from the shores of these islands, but the eastern parts slope gently to the water’s edge. The smaller islands are limestone masses projecting from 10 to 40 feet above the lake level.

The highest point in the county is just southeast of Lakeside at the Marblehead village line where the elevation is 670 feet above sea level. Other elevations are 642 feet at the high point on South Bass Island, 581 feet at Oak Harbor, 616 feet at Elmore, and 596 feet at Curtice. The mean level of Lake Erie is 672 feet above sea level.¹

Although several streams pass through the county, the slope of the land is not sufficient to provide adequate run-off of surface water, and drainage, in general, is poor. Portage and Toussaint Rivers and Turtle and Crane Creeks cross the county through shallow valleys in an easterly direction. These streams have developed narrow flood plains throughout a part of their courses, but in Salem and Carroll Townships are on a level with the lake and are bordered by large areas of marshland.

Parts of Carroll, Erie, and Benton Townships lie in the "pump lands" which are in close proximity to Lake Erie. Here, dikes and ditches have been constructed, and during periods when the lake is at a high level and during periods of heavy rainfall, water is removed by pumping.

Underdrainage is poor in all parts of the county, with the exception of a few of the more undulating areas and areas in which the underlying limestone lies near the surface.

Ottawa County was organized in 1840 from parts of Lucas, Erie, and Sandusky Counties. The earliest settlers were French Canadians who were attracted by the wealth of fur to be obtained around East, West, and Middle Harbors and along the rivers. The eastern end of the county, which was a part of the Connecticut Western Reserve, lies in the "fire lands" and was settled about 1809 by people from Danbury, Conn. Among the early settlers near Port Clinton were some Scotch people who were left there after a shipwreck. After 1849 the influx of Germans was heavy, and to-day a large proportion of the population is of German origin.

Previous to 1910 the population of the county was all classed as rural. In 1910 the county had an urban population of 3,007 and a rural population of 19,363. The density of the rural population was 71.7 persons a square mile. By 1920 the rural population had decreased to 18,266 or 67.6 persons a square mile, and the urban population had increased to a total of 3,928. The 1930 census reports the population of the county as 24,109, of which 19,701 is classed as rural. The density of the rural population is 73 persons a square mile.

No large cities are in the county, and the outside markets are at some distance. Cleveland, which is 100 miles east of Oak Harbor, affords a market for most of the farm produce, and Toledo, which is 25 miles distant, is an important market. Small shipments are made to Buffalo, Pittsburgh, and Cincinnati.

Railroad transportation facilities are excellent. The Lake Shore division of the New York Central Railroad passes through the county from Danbury to Millbury, Wood County; the Wheeling & Lake Erie Railway and the Norwalk division of the New York Central cross the western part of the county; and the Lakeside & Marblehead Railroad connects Danbury and Marblehead. An interurban electric line runs from Toledo through Curtice, Elmore, Oak Harbor, and Port Clinton to Lakeside.

Good roads connect most parts of the county, and the completion of a bridge across Sandusky Bay facilitates motor transportation to the east. Several State highways cross the county. These roads are built of brick, concrete, or bituminous macadam. County roads are being improved and are maintained in good condition. A few sec-

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9 Soil survey reports are dated as of the year in which the field work was completed. Later census figures are given when available.
tions are as yet untouched by improved roads, but an attempt is being made to change this situation as rapidly as possible.

CLIMATE

The climate of Ottawa County is temperate and free from sudden changes. The mean annual temperature at Danbury, in the eastern part of the county, is 50.7°F. A maximum of 108°F and a minimum of -18°F have been reported. The average annual rainfall is 29.67 inches. Lake Erie very markedly modifies the climate of the areas bordering it. This is shown by a comparison of the climatic data taken at Danbury and at Rocky Ridge. Rocky Ridge is in the western part of the county and is an inland town. The average date of the last killing frost at Danbury is April 23 and at Rocky Ridge is May 1; the average date of the first killing frost is October 25 at Danbury and October 12 at Rocky Ridge. This gives Danbury an average frost-free season of 185 days and Rocky Ridge, 165 days, both of which are long enough for maturing most crops commonly grown in this county. The long growing season characteristic of the eastern part of the county is an important factor in fruit growing which is the chief type of agriculture in that part.

The distribution of rainfall is fairly uniform, the spring season showing a slightly higher rainfall than the other seasons.

Tables 1 and 2 give the more important climatic data for Ottawa County. The data in Table 1 is taken from the records of the United States Weather Bureau at Danbury, and the data in Table 2 is taken from Bulletin No. 26, published by the Engineering Experiment Station of Ohio State University, and gives climatic data from records kept at Rocky Ridge for the years 1894 to 1909, inclusive.

**Table 1.—Normal monthly, seasonal, and annual temperature and precipitation at Danbury, Ottawa County, Ohio**

(Elevation, 550 feet)

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature</th>
<th>Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean °F.</td>
<td>Absolute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>maximum °F.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>30.4</td>
<td>50</td>
</tr>
<tr>
<td>January</td>
<td>32.8</td>
<td>62</td>
</tr>
<tr>
<td>February</td>
<td>27.6</td>
<td>54</td>
</tr>
<tr>
<td>Winter</td>
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<tr>
<td>March</td>
<td>38.3</td>
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</tr>
<tr>
<td>April</td>
<td>45.3</td>
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<tr>
<td>May</td>
<td>59.2</td>
<td>92</td>
</tr>
<tr>
<td>Spring</td>
<td>48.3</td>
<td>92</td>
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<tr>
<td>June</td>
<td>70.8</td>
<td>96</td>
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<tr>
<td>July</td>
<td>74.6</td>
<td>103</td>
</tr>
<tr>
<td>August</td>
<td>72.3</td>
<td>108</td>
</tr>
<tr>
<td>Summer</td>
<td>72.9</td>
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<tr>
<td>September</td>
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<td>October</td>
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<td>Fall</td>
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<td>97</td>
</tr>
<tr>
<td>Year</td>
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TABLE 2.—Normal monthly, seasonal, and annual temperature and precipitation at Rocky Ridge, Ottawa County, Ohio

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<tr>
<td></td>
<td>Mean</td>
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</tr>
<tr>
<td>December</td>
<td>29.4</td>
<td>68</td>
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<tr>
<td>January</td>
<td>26.6</td>
<td>73</td>
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<td>February</td>
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Winter

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</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Absolute maximum</td>
</tr>
<tr>
<td></td>
<td>26.7</td>
<td>73</td>
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March

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<th>Precipitation</th>
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<td>Mean</td>
<td>Absolute maximum</td>
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April

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<td>47.8</td>
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</tr>
<tr>
<td>May</td>
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Spring

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<tbody>
<tr>
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<td>Absolute maximum</td>
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Summer

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September

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<td>Absolute maximum</td>
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November

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Fall

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Year

AGRICULTURE

The first settlers in Ottawa County were occupied with trapping, as many fur-bearing animals inhabited the lake marshes. The heavy forests served as a basis for two industries. The sugar maples were tapped and the sap used in making sugar; the other industry was the making of "black salts," or lye. In clearing the land the logs were cut, piled, and burned, the ashes leached, and the resulting lye boiled down into "black salts" which was marketable at the country stores.

Fishing became an important industry at an early date, and today Port Clinton is one of the important fishing centers along Lake Erie.

As the land was cleared, wheat and corn were sown among the tree stumps. Wheat was grown largely for home consumption, but corn of a white flint variety was much in demand by the Hudson Bay Co. With the settling of Canada the demand for flint corn lessened and dent corn took its place. General farming is now followed in the central and western parts of the county.

East of Port Clinton the soil and climate are particularly suitable for fruit growing. About 1850 the growing of grapes began and continued until the black rot became very severe. In 1885 vineyards gave way to peach orchards, and peaches now constitute the leading fruit crop. In 1854 an attempt was made to start a sheep ranch on South Bass Island, but this venture was unsuccessful. Four
years later grape growing began and is now the chief agricultural industry on the islands.

A study of the agricultural statistics for the county brings out a number of interesting features in the development of agriculture. In 1890, 157,510 acres were in farms, and the average size of farms was 75 acres. The proportion of improved land on the farms has steadily increased.

The acreage devoted to the different crops has varied considerably during the last 25 years, with the exception of corn which is the only crop that has maintained a fairly constant acreage. In 1929 this crop occupied 14.4 per cent of the total farm land. Wheat and oats are the crops which vary most in acreage. In 1929 these two grain crops together occupied 22.8 per cent of the farm land. An increase in the acreage of one of these two crops is usually marked by a corresponding decrease in the acreage of the other. At present there seems to be a tendency to decrease the acreage in wheat and to increase the oat acreage. Some barley, rye, and buckwheat are grown, but their acreages are decreasing.

Timothy has been an important hay crop, but at present it is losing favor. The acreage in clover and alfalfa is increasing, alfalfa showing the greatest rate of increase.

Table 3, compiled from data taken from the Federal census reports, shows the average acre yields of different crops for the different census years.

<table>
<thead>
<tr>
<th>Crop</th>
<th>1879</th>
<th>1889</th>
<th>1899</th>
<th>1909</th>
<th>1919</th>
<th>1929</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Bushels</td>
<td>Bushels</td>
<td>Bushels</td>
<td>Bushels</td>
<td>Bushels</td>
<td>Bushels</td>
</tr>
<tr>
<td>Corn</td>
<td>39</td>
<td>30</td>
<td>43</td>
<td>36</td>
<td>39</td>
<td>35.2</td>
</tr>
<tr>
<td>Oats</td>
<td>30</td>
<td>35</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>38.0</td>
</tr>
<tr>
<td>Wheat</td>
<td>21</td>
<td>18</td>
<td>12</td>
<td>17</td>
<td>18</td>
<td>18.5</td>
</tr>
<tr>
<td>Rye</td>
<td>17</td>
<td>22</td>
<td>21</td>
<td>14</td>
<td>14</td>
<td>14.4</td>
</tr>
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<td>Barley</td>
<td>25</td>
<td>27</td>
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<td>22</td>
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<td>24.4</td>
</tr>
<tr>
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<td>67.4</td>
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<tr>
<td>Beets</td>
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<td>9.3</td>
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</table>

The number of horses, cattle, sheep, and swine is on the decrease. The number of milk cows has remained fairly constant, and poultry shows an increase in numbers.

The value of farm land steadily increased until 1920 when it was $120 an acre. By 1930 land values had declined and farm land was worth about $82 an acre. The selling price of the better land for general farming in this county ranges between $100 and $200 an acre. Orchard land is much more valuable and, in some locations has brought as much as $1,000 an acre.

The farms are operated largely by owners, but there has been a steady though slow increase in the number of tenant-operated farms, especially in the general-farming sections of the county. In 1880 only 17 per cent of the farms were operated by tenants, but in 1930 the proportion had increased to 22.5 per cent.

Agriculture at the present time consists of general farming, combined with some dairying and livestock raising, and of fruit growing. The principal farm crops are corn, oats, wheat, alfalfa, and clover.
Sugar beets are an important special crop, and tomatoes, potatoes, and cucumbers are grown on a small scale. The fruit crops are peaches, apples, pears, and grapes. The livestock consists mainly of hogs, cattle, and poultry.

Wheat is the chief cash crop in the general-farming sections. The leading variety is Trumbull. The average yield for the county is about 18 bushels an acre, but the range is from 12 to 45 bushels.

Other cash crops are sugar beets, cucumbers, and tomatoes. These crops are grown under contract. The companies furnish the plants or seed and some labor at a reasonable charge, the cost of which is deducted at the time of harvesting and settlement.

Corn, oats, and hay are both subsistence and cash crops. Most of the corn is harvested for grain. Of the 20,699 acres of corn grown in 1929, only 703 acres were cut for silage.

Hogs are the most important kind of livestock. In 1930 there were 7,999 hogs distributed over the county, mostly in small lots. Chester White and Duroc-Jersey are the chief breeds. Cattle feeding is carried on in a small way in the general-farming section of the county. Sheep raising is of little importance.

Dairying is carried on in a small way on most farms. Most of the cows are good-quality grades, and there are a few registered herds in the county. Holstein-Friesian, Jersey, and Guernsey are the leading breeds, with smaller numbers of Ayrshire and Brown Swiss. Milk, cream, and some butter are produced. The milk and cream are collected by trucks and taken to Toledo, Fremont, Oak Harbor, and Port Clinton. A few dairymen retail their milk in the towns.

Poultry raising is increasing. Most of the increase is in the size of farm flocks, but a few men are operating commercial poultry farms. Chickens suitable for both egg and meat production are favored.

Musk rat farming is a new industry in the county. It is particularly suited to the marshes along the lake and rivers. The animals are sold either for breeding stock or for their fur.

Fruit growing is important in certain sections of the county, especially on the islands, Marblehead Peninsula, and in the vicinity of Oak Harbor. Peaches, apples, pears, grapes, and some cherries and plums are grown. Peaches have been the leading fruit for some time, but present indications are that they will be replaced to a considerable extent by apples.

Cooperative marketing has been extensively developed in this county. The county farm bureau has organized a livestock shippers' association. This organization handles all forms of livestock at a central shipping point located in Oak Harbor. Any member is entitled to ship his livestock through the association without cost other than the actual shipping cost. Nonmembers of the association may ship by paying 10 cents a hundred pounds.

For the handling of grain, feeds, coal, and fertilizers, farmers' elevator companies have been organized. These are incorporated by local groups of farmers and are located at Curtice, Elliston, Genoa, Graytown, Oak Harbor, and Rocky Ridge.

The marketing of fruit, the largest marketing problem in the county, is handled by 5 cooperative associations, 2 located at Gypsum, 1 at Danbury, 1 at Oak Harbor, and 1 in Bay Township. The
organization of each of these companies is about the same. The oldest company, the Island Gypsum Fruit Co., was organized in 1889. Each member of the company must take two shares of stock, which entitles the member to sell 3,000 bushels of fruit. All fruit grown by the members must be sold through the company. The fruit is repacked and graded at the company packing house and sold under the house brand and grade. The sales are posted and averaged every day. The expenses for the season are prorated and deducted at time of settlement. All the companies, with the exception of the Bay Fruit Co., ship most of their fruit by rail. The Bay Fruit Co. is small and does most of its shipping by truck.

It is generally recognized that the light-colored soils are better for grapes, peaches, and apples. Pears and plums are grown on the dark-colored soils. The dark-colored soils, when adequately drained, are best for all general farm crops and for sugar beets, tomatoes, and cucumbers. During favorable seasons the light-colored soils are about equal to the dark-colored ones for wheat and oats. The light-textured soils—loams and fine sandy loams—are recognized as best for potatoes and other truck crops.

The heavy soils of the county require careful handling. Moisture conditions must be just right at plowing time or the soil will be cloddy. So far as possible fall plowing is practiced. For corn the land is plowed to a depth of 6 or 8 inches, and the seed bed is well prepared before planting. Subsequent cultivation of the crop varies with the individual farmer and with the season. Oats ordinarily follow corn in the rotation. In the past the corn stubble has been disked down and the oats drilled without further preparation. The presence of the European corn borer is now making it imperative that the cornstalks be plowed under or destroyed in the fall. Wheat is sometimes planted in the corn stubble by drilling between the rows. Here again the corn borer is causing the farmer to change his practice. Clover, sweetclover, or alfalfa is seeded in oats or wheat in early spring.

The rotation most in favor is corn, oats, wheat, and hay. Some farmers use a rotation including a special crop, as corn, beets, oats, and alfalfa, or they may use a 3-year rotation of corn, oats, and clover or alfalfa.

For grapes the land is kept very thoroughly cultivated. Peaches receive clean cultivation, but the frequency of cultivation depends on the season. In a wet season grass and weeds are allowed to grow, but during a dry season the ground is cultivated frequently. In the replacement of a peach orchard the trees are pulled and sweetclover is planted. During the second year the sweetclover is disked into the ground. The third year the trees are planted and the ground near the trees cultivated.

Fertilizers are being used in increasing amounts. In 1919 about $56 a farm was spent on fertilizers, and in 1929 about $62. Wheatland receives the most fertilizer, a complete fertilizer, such as 2–12–2, or 20 per cent superphosphate (acid phosphate) being used at the rate of 200 pounds to the acre. Oats and corn are fertilized to less extent than wheat. Beets are fertilized heavily, the usual applica-

*Percentages, respectively, of nitrogen, phosphoric acid, and potash.
tion being from 250 to 350 pounds of a 2-12-6 mixture or of 20 per cent superphosphate. Tomatoes receive from 250 to 350 pounds of 20 per cent superphosphate or a complete fertilizer, such as 2-12-6. In orchards, sulphate of ammonia or nitrate of soda is used at the rate of one-fourth pound to each tree for each year of age up to a total of 3 or 4 pounds. Lime is not in general use.

Manure is usually applied on the “clay spots” (Fulton silty clay loam) for corn or wheat, and occasionally it is used around fruit trees instead of a nitrogenous fertilizer.

Most of the farms of the county are well equipped. Houses, barns, and fences are well constructed and kept in good repair. Machinery is modern, and tractors, corn binders, and corn huskers are numerous. A number of farmers have their buildings equipped with electricity.

The farm laborers are mainly native whites. During the last few years the extra laborers required in the beet fields have been Mexicans. Most farmers do not plant an acreage larger than can be worked by the farmer himself and his family.

About one-fourth of the tenant farmers operate on a strictly cash basis and the rest on a share basis under contracts for periods ranging from one to five years. The owner furnishes the land, buildings, fences, and in addition a certain percentage of the implements, work animals, and seed, depending on the agreement, and in return receives one-half or two-thirds of the crop.

Certain soils in the county are outstanding in their productive capacity over a period of years. Toledo silty clay, Toledo clay loam, Toledo loam, Brookston clay, and Brookston clay loam, closely followed by the Danbury soils, are the best for general farm crops. These soils will produce from 60 to 80 bushels of corn, from 25 to 35 bushels of wheat, and from 50 to 60 bushels of oats an acre. The light-colored soils (Fulton, Nappanee, Lucas, and Catawba) return from 30 to 45 bushels of corn, from 15 to 30 bushels of wheat, and from 30 to 45 bushels of oats an acre. Sugar beets, tomatoes, and cucumbers yield nearly twice as much on the dark-colored soils as on the light-colored soils. For fruit growing the order is reversed, the light-colored soils being favored, except for pears and plums. Although the fruit may grow as well and yield as much on the dark-colored soils as on the light-colored soils, the quality is much better on the light-colored soils and the length of life of the trees is longer.

**SOIL SERIES AND TYPES**

In soil classification soils are differentiated into soil series which are further divided into soil types. A soil series is a group of soils having common characteristics of profile, that is, they resemble each other in color, structure, and chemical composition, and in sequence, number, and degree of development of the soil layers, or soil horizons. The soils of a series occur under similar general conditions of relief and drainage and usually have a common or similar origin and mode of formation. The soil type corresponds in all respects to the soil series of which it is a member and is separated on the basis of the texture of the surface soil, that is, the proportions of sand, silt, and clay particles of which it is composed. Important variations in a soil type are designated as phases.
The soils of Ottawa County are classified in 16 soil series, including 30 types and 4 phases of types. In addition, five classes of miscellaneous soil materials have been recognized and mapped.

The most extensive soils of the county are dark and have very poor natural drainage. They are included in the Toledo, Brookston, Wauseon, Bono, and Maumee series. All of these soils were at one time heavily timbered. The Danbury soils, which are also dark and occupy undulating areas where natural drainage was somewhat better than that of the other dark-colored soils, apparently were developed under prairie conditions.

Where bedrock (limestone) occurs within 2 or 3 feet of the surface the soils have been correlated either as Randolph soils, which are light, or as the associated Millsdale soils, which are dark.

The soils of the Toledo series are the predominating soils of Ottawa County. They have very dark gray or very dark grayish-brown surface soils overlying mottled gray and yellowish-brown subsoils. These soils are derived from laminated fine-textured materials and are free from gravel or pebbles throughout the soil profile. They occupy nearly level or flat areas and hence have very poor natural drainage.

The Fulton soils occur as low knolls 1 or 2 feet high within areas of the Toledo soils and along stream valleys. They have yellowish-brown or grayish-brown surface soils and mottled gray and yellowish-brown subsoils. The parent material is laminated silt and clay, consequently the soil is free from boulders and gravel.

The Lucas soils occur on ridges 10 or 12 feet high and along stream banks. They have brown surface soils underlain by yellowish-brown tight but not impervious subsoils which are free from mottling to a depth of about 20 inches. The substratum consists of laminated silt and clay. These soils are developed under better drainage than either the Fulton or the Toledo soils.

The Bono soils have grayish-black or black surface soils overlying mottled bluish-gray and yellow heavy subsoils. They are developed from laminated fine-textured material similar to the Toledo soils. Drainage is very poor.

Soils of the Maumee series have black or very dark gray surface soils underlain by olive-gray or dark olive-gray subsoils mottled with yellow and gray. The substratum is olive-gray or grayish-yellow calcareous material. Drainage of these soils is very poor.

The Danbury soils have very dark brown or almost black surface soils overlying yellowish-brown subsoils. They are derived from laminated silt and clay, similar to the parent material of the Toledo, Fulton, and Lucas soils, but apparently they have developed under a grass or prairie vegetation.

The Brookston soils have very dark grayish-brown surface soils and mottled gray and yellowish-brown subsoils which contain some gravel. The substratum is a clay or clay loam till, which contains considerable limestone gravel. These soils occur in the western and eastern parts of the county. They occupy level areas and have poor natural drainage.

Soils of the Wauseon series have developed from fine sandy material deposited over heavy calcareous clays, either till or lacustrine deposits. Weathering and eluviation have since developed three
distinct horizons. The surface soil is gray friable material, the subsoil is brownish-yellow or grayish-yellow heavier material containing yellow and gray mottlings, and the substratum is calcareous heavy olive-gray clay.

The Nappanee soils bear the same relation to the Brookston soils as the Fulton do to the Toledo. They occupy very gently undulating areas within areas of the Brookston soils. The distinguishing characteristics are a light brownish-gray surface soil over a mottled gray and yellowish-brown very tight and impervious subsoil. The substratum is heavy glacial till.

The Catawba soils have grayish-brown surface soils, reddish-brown or brown subsoils, and a glacial till substratum which in most places is mottled yellowish brown and gray. These soils occur in Danbury and Catawba Island Townships and on the islands in Lake Erie.

The Randolph soils have developed under conditions of fair drainage and have brownish-gray surface soils overlying mottled gray and yellowish-brown subsoils. Limestone bedrock lies within 3 feet of the surface. These soils are neutral or slightly acid in the surface layer and neutral in the subsoils.

The Millsdale soils are poorly drained soils. They have grayishbrown surface soils and darker-gray subsoils containing soft darkbrown concretions. Limestone bedrock underlies these soils.

The alluvial first-bottom soils have been included in two series. The better-drained soils with dark-brown surface soils underlain by slightly lighter colored subsoils showing little change with increasing depth, are classified in the Genesee series. The poorly drained soils are placed in the Eel series. They have dark grayish-brown surface soils overlying, at a depth of 15 inches, mottled brown and grayish-brown subsoils which are slightly heavier in texture.

Soils of the Fox series have a 2 or 3 inch grayish-brown friable surface layer underlain by brown material, the color of which changes to grayish yellow at a depth of about 10 inches. Calcareous brown gravel occurs between depths of 26 and 36 inches. In Ottawa County these soils occur on long narrow ridges, and drainage ranges from good to excessive.

The Rodman series is represented in Ottawa County only by a beach-ridge phase of Rodman gravel which is described in detail on a subsequent page of this report.

Beach sand, muck, marsh, stone quarries, mines, pits, and dumps, and made land are miscellaneous soil classifications which, with the exception of muck, have little or no agricultural value.

In the following pages of this report the different soils of Ottawa County are described in detail and their agricultural relationships are discussed, the accompanying soil map shows their location and distribution, and Table 4 gives their total acreage and proportionate extent in the county.
### Table 4.—Acreage and proportionate extent of soils mapped in Ottawa County, Ohio

<table>
<thead>
<tr>
<th>Type of soil</th>
<th>Acres</th>
<th>Per cent</th>
<th>Type of soil</th>
<th>Acres</th>
<th>Per cent</th>
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<tr>
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<td>Fox gravelly sandy loam</td>
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</table>

**TOLEDO SILTY CLAY**

Toledo silty clay is the most extensive soil in Ottawa County. It occurs in all parts of the county but is best developed in the central and western parts. The natural forest growth is of the swamp-forest type, with elm, soft maple, and black ash predominating. This soil is known locally as "elm land."

The surface soil to a depth of 6 or 8 inches is very dark grayish-brown silty clay. Under good tilth and optimum moisture conditions the topmost surface soil consists of granules about three-sixteenths inch in diameter. The subsurface soil to a depth of 14 inches is mottled dull-gray and yellowish-brown silty clay which when dry is very hard and breaks into irregular granules ranging from one-fourth to three-fourths inch in diameter. The subsoil, extending from a depth of 14 to a depth of 40 inches, is mottled gray and yellowish-brown silty clay which is somewhat lighter in color than the subsurface soil and contains some soft dark-brown concretions in the lower part. The substratum below a depth of 40 inches consists of gray laminated silt and clay, with faint yellowish-brown mottlings. The surface soil in most places is neutral in reaction, but it may be slightly acid, and the subsoil is neutral, in places calcareous below a depth of 36 inches. In the better-drained areas a 3 or 4 inch layer, which is usually pink and lies just above the substratum, contains considerable calcareous or limy material.

Some areas included with Toledo silty clay near the marshes along Sandusky Bay in Bay Township and the marshes and "pump lands" in Carroll Township vary from typical. These areas have only recently been separated from the marshes by ditching and draining and are subject to inundation in the spring. The natural vegetation is a broad-leaved grass which grows in small tussocks. The surface soil is gray and may contain some brown spots which disappear when the land is cultivated. The subsoil is slightly mottled with bluish gray and pale yellowish brown.
Owing to the level surface relief, both surface drainage and underdrainage of this soil are very poor, and artificial drainage is necessary. Open ditches and dead furrows have been used, but tile drainage has proved to be much more satisfactory. Tile draining has greatly increased in recent years through the introduction of modern ditching machinery and the maintenance of township ditches.

This soil occupies 119.8 square miles or 45.7 per cent of the county. About 90 per cent of the land is cleared and used largely for general farm crops. The permanent pasture on this soil occurs almost wholly in the open wood lots which support a good growth of grass. Corn, oats, and wheat, in the order named, are the leading crops. Alfalfa and sweetclover are increasing in popularity and occupy a larger acreage each year. The soil is very fertile and is well adapted to the production of sugar beets. Pears and plums do well on this soil, but peaches suffer winter injury, and although apples grow well they lack the quality of apples produced on light-colored soils.

Corn yields range from 35 to 80 bushels and average about 45 bushels an acre. Oats average 45 bushels, wheat 20 bushels, and hay yields range from 1 to 3 tons an acre. Sugar-beet yields are subject to seasonal variations and range from 7 to 14 tons an acre.

In the improvement of crop yields on this soil probably first attention should be given to adequate drainage. In many places where in past years the tile have been laid from 6 to 8 rods apart it will be desirable to lay additional lines between the old lines. Where the land is adequately drained it is possible to grow such legumes as red clover, sweetclover, and alfalfa in the rotation. In some places it may be necessary to use lime before planting alfalfa or sweetclover. Ordinarily Toledo silty clay is not acid, or "sour," but where the land has been heavily farmed it may need some lime, hence tests for soil acidity or lime requirement should be made on each field. For corn, manure should be used at a rate of 6 or 8 tons an acre, supplemented by an application ranging from 200 to 300 pounds of 20 per cent superphosphate. If manure is scarce, from 125 to 150 pounds of complete fertilizer, such as a 4-10-6 mixture, can be applied in the hill or row, and an equal amount of an 0-14-6 fertilizer can be distributed broadcast. With new types of fertilizer distributors, which separate the fertilizer from the seed, from 125 to 150 pounds of a complete fertilizer, such as a 4-10-6, can be applied with safety. For wheat or oats 200 pounds of 16 per cent or 20 per cent superphosphate or a mixed fertilizer, such as 2-14-4 or 0-14-4, is desirable. When a hay crop, such as alfalfa, is to be seeded in the grain, it pays to use an extra 100 or 150 pounds of superphosphate, which will tend to strengthen the stand and lessen winter killing. For sugar beets the use of 250 or 300 pounds of a 2-12-6 fertilizer is recommended. For tomatoes grown on this land, heavy applications ranging from 300 to 400 pounds of superphosphate are desirable as an aid in ripening the crop.

Table 5 gives the results of mechanical analyses of samples of the surface soil, subsurface soil, and several layers of the subsoil of Toledo silty clay.
TOLEDO CLAY LOAM

Toledo clay loam closely resembles Toledo silty clay. The main difference between the two soils is in texture, the clay loam containing more sand and less clay than the silty clay and hence being more easily drained. The colors of the different horizons of the clay loam are somewhat similar to those of the silty clay, but the subsoil of the clay loam shows more yellow, and the upper inch or two of the laminated silt and clay substratum contains some soft gray calcareous material.

Included with this soil as mapped are areas of Toledo silty clay loam which because of small extent were not shown separately. These areas are near Danbury and on the northern part of Middle Bass Island. The silty clay loam is intermediate in texture between the silty clay and the clay loam, but in color and other characteristics it is similar to the clay loam.

Toledo clay loam occupies level areas, commonly occurring in depressions between sand or loam knolls. Both surface drainage and underdrainage are poor, but underdrainage is somewhat better than in the silty clay. Lines of tile placed from 4 to 5 rods apart should supply adequate drainage.

The total area of Toledo clay loam is 7.3 square miles. About 90 per cent of the land is cleared and used for general farm crops. Crop yields, especially of sugar beets, average slightly higher than yields of the same crops on Toledo silty clay. The fertilizer recommendations given for Toledo silty clay apply to this soil.

TOLEDO LOAM

The surface soil of Toledo loam consists of a 6 or 8 inch layer of very dark grayish-brown loam underlain by an 8-inch layer of mottled gray and light yellowish-brown loam that is somewhat loose but more compact than the upper layer. The upper part of the subsoil, between depths of 16 and 24 inches, is yellowish-brown and gray mottled clay which breaks into lumps that crumble readily under pressure. The lower part of the subsoil, to a depth of 40 inches, is clay loam, in most places having more gray coloring than the layer above. The laminated silt and clay, which occurs below a depth of 40 inches, is gray, slightly mottled with brown, and contains some soft calcareous concretions. This soil in places contains layers of sand interstratified with the silt and clay.
Toledo loam occupies level land or low knolls of small extent that rise a foot or two above the general level. Natural drainage is fair but not adequate, and artificial drainage is desirable. The tile lines should be placed 5 or 6 rods apart.

This soil occurs chiefly in the vicinity of Elmore. It occupies a total area of 2.9 square miles, practically all of which is cleared and used for general farm crops. Corn, oats, and wheat grow well and yield more than on Toledo silty clay. The soil is well adapted to root and tuber crops, such as sugar beets and potatoes. It is a fair soil for fruit, and vegetables do very well.

The fertilizer requirements are similar to those for Toledo silty clay. The soil in few places is acid enough to require liming for growing alfalfa or sweetclover.

**TOLEDO VERY FINE SANDY LOAM**

Toledo very fine sandy loam occurs chiefly in the vicinity of Elmore. The surface soil to a depth of 8 inches is dark brownish-gray very fine sandy loam, and the subsurface soil between depths of 8 and 12 inches is mottled yellowish-brown and gray very fine sand. Between depths of 12 and 17 inches the subsoil is yellowish-brown, brown, and gray mottled fine sand or very fine sandy loam. In place, the material in this layer appears to be hard and firm, but it breaks and crumbles readily when moved. The lower subsoil layer, extending to a depth of 44 inches, is mottled gray and yellow fine sand which shows some stratification. Laminated silt and clay occur below this depth. A thin layer of clay or silty clay occurs in places in the subsoil, and where this layer is below a depth of 20 inches it is usually calcareous.

This soil occurs as level land and as low knolls 1 or 2 feet above the general level. Surface drainage is poor, but, owing to the abundance of sand in the subsoil, underdrainage is fair. In places where the silt and clay layer lies within 2 feet of the surface, underdrainage is fair or poor and artificial drainage is very desirable.

The total area of Toledo very fine sandy loam is 4.1 square miles, and about 95 per cent of the land is cleared and used largely for general farm crops. A small acreage is used for growing fruit, chiefly apples, and for vegetables. The crops grown and the yields produced are similar to the crops and yields on Toledo silty clay. Fertilizer recommendations are much the same, but in general larger quantities of fertilizer should be used on Toledo very fine sandy loam than on the silty clay. Liming is not necessary except where the stands of clover or alfalfa have been unsatisfactory, when it is advisable to have the individual fields tested and to apply the quantity of lime required. For fruit trees some nitrogenous fertilizer, such as nitrate of soda or sulphate of ammonia, should be used at the rate of one-fourth pound to each tree for each year of age of the tree, until a limit of 3 or 4 pounds is reached. For vegetables, an acre application ranging from 500 to 700 pounds of a complete fertilizer, such as a 4-10-6 or a 4-12-4, should be used.

**FULTON SILTY CLAY LOAM**

The surface soil of Fulton silty clay loam consists of a 6 or 8 inch layer of brown or grayish-brown silty clay loam overlying a sub-
surface layer of mottled gray and yellowish-brown clay which is very tight and impervious and becomes very hard on drying. The subsurface layer gives this soil its local name of "clay soil" or "clay spots." Below a depth of 20 inches the soil is mottled gray and yellowish-brown heavy and impervious silty clay which passes at a depth of about 26 inches into silty clay loam containing some calcareous concretions. The substratum at a depth of 36 inches is mottled light-gray, gray, and yellowish-brown slightly calcareous laminated silty clay.

In reaction this soil is acid in the surface and subsurface layers, the acidity decreasing with depth and the reaction becoming neutral or alkaline in the lower part of the subsoil at a depth of about 26 inches.

The color of the surface soil, as mapped in this county, varies. The better-drained areas are brown, but the more poorly drained areas are somewhat grayish brown.

Fulton silty clay loam occupies very gently undulating areas, occurring as small knolls a few acres in extent, rising from 6 inches to 2 feet above the general level of the land. Surface drainage is fair, but underdrainage is very poor on account of the heavy impervious character of the subsoil, and artificial drainage is necessary.

This soil occupies 27.8 square miles in Ottawa County. About 85 per cent of the land is cleared and is usually farmed in conjunction with areas of Toledo silty clay. It is not a productive soil. It is more difficult to drain than the Toledo soils, is low in organic matter, and in most places acid. On farms where this soil occurs, it usually receives most of the manure. A few farmers have used lime, but the practice is not so general as it might be. Corn is only a fair crop, rarely yielding more than 30 bushels an acre. In a favorable season wheat and oats yields are nearly equal to the yields obtained on Toledo silty clay. This soil is very suitable for growing all orchard fruits, with the possible exception of plums and pears, and for growing small fruits, such as raspberries and grapes.

In the improvement of crop yields on Fulton silty clay loam it is highly essential to provide adequate drainage. The heavy tight impervious subsoil is extremely hard to drain, and tile lines should be spaced not more than 2 or 3 rods apart. With adequate drainage, the next step is to increase the supply of organic matter, which can best be done by growing and plowing under legumes, such as clover, alfalfa, and sweetclover. These crops will not grow satisfactorily on this soil unless lime, at a rate ranging from 1 to 2 tons of ground limestone an acre, has been applied. In the fertilization of corn it is desirable to use from 8 to 10 tons of manure an acre and to supplement this with 125 or 160 pounds of complete fertilizer, such as 4–10–6, in the hill. Where but little manure is available, a complete fertilizer, such as 4–10–6, should be applied in the hill or row at a rate of 125 or 150 pounds an acre, together with a broadcast application, at the same rate, of an 0–14–6 fertilizer. For oats or wheat from 250 to 300 pounds of 20 per cent superphosphate or a 2–14–4 mixed fertilizer is desirable. When grass is to be seeded in the wheat the amount of fertilizer should be increased by one-half. For fruit the application of some nitrogenous fertilizer at the rate of one-fourth pound a tree for each year of age, to a limit of 4 or 5 pounds, is satisfactory.
FULTON SILT LOAM

The surface soil of Fulton silt loam to a depth of 6 or 7 inches is grayish-brown or brown silt loam. It overlies a 7-inch mottled yellowish-brown and gray silty clay subsurface layer. The upper part of the subsoil between depths of 15 and 20 inches, is mottled gray and yellowish-brown clay containing numerous black or very dark brown concretions. Between depths of 20 and 34 inches the soil material is mottled gray, yellow, and rust-brown clay or silty clay, which is heavier in the upper part of the layer than in the lower part. Below a depth of 34 inches is the mottled gray and yellowish-brown laminated silt and clay substratum which contains some calcareous concretions in the upper 3 or 4 inches. This soil is acid in the surface and subsurface layers, slightly acid in the upper subsoil layer, and neutral in the lower subsoil layer.

This soil is mapped east of Port Clinton where it occurs in small areas. The most extensive development is between East Harbor and West Harbor.

The surface relief is gently undulating, and the land has sufficient slope to supply adequate surface drainage. Underdrainage is very poor, owing to the heavy and impervious subsoil.

This soil occupies 0.8 square mile, and all the land is cleared. It occurs in a fruit-growing section and is used chiefly for growing fruit, to which it is well adapted. Peaches, apples, and some cherries are the principal fruits grown.

This soil requires thorough drainage and careful fertilization. Recommendations given for Fulton silty clay loam will apply for Fulton silt loam also.

FULTON LOAM

The surface soil of Fulton loam consists of 6 or 8 inches of brown or grayish-brown loam overlying a 5-inch layer of mottled gray and grayish-brown loam. Below this and extending to a depth of 30 inches is mottled grayish-brown and gray clay loam having some dark-brown stains on the breakage faces. Where undisturbed the material in this layer is firm, but when broken out it crumbles readily. The substratum below a depth of 30 inches consists of mottled gray and yellowish-brown laminated silt and clay, and in places sand is interstratified with the silt and clay. The soil is acid to a depth of about 25 inches, below which it is neutral, and it becomes calcareous at a depth of 36 inches.

Small areas of this soil are distributed over the southern part of the county. The largest bodies are in sections 15 and 16 of Harris Township.

The surface relief is very gently undulating, and the slope is sufficient to provide fair surface drainage. Underdrainage is poor, and artificial drainage is necessary. Tile lines should be placed from 3 to 4 rods apart.

Fulton loam occupies a total area of 2 square miles. Practically all the land is cleared and used largely for general farm crops. This is not a very productive soil, being similar in this respect to Fulton silty clay loam, and it has the same fertilizer requirements as that
soil. The soil is better adapted to fruit production than to general farm crops.

**FULTON VERY FINE SANDY LOAM**

The surface soil of Fulton very fine sandy loam to a depth of 10 inches is brownish-gray very fine sandy loam. Below this to a depth of 20 or 22 inches is mottled yellowish-brown and gray very fine sand which is firm and coherent in place but which loses its cohesion when removed. Between depths of 20 and 30 inches is mottled gray and brown clay. Below this the substratum consists of stratified fine sand and very fine sand, overlying stratified silt and clay. In places the stratified silt and clay layer is within 30 inches of the surface, especially in the areas occurring along the eastern edge of the sand belt which extends across parts of Harris and Clay Townships.

The surface relief is level or very gently undulating. Surface drainage is fair, as is underdrainage except where the heavy subsoil lies within 30 inches of the surface. In such places artificial drainage is desirable, and the tile lines should be placed from 3 to 4 rods apart.

Nearly all the land is cleared and is used largely for general farm crops and for peaches. In the production of general farm crops it is necessary to apply large quantities of fertilizer and lime, similar to the applications recommended for Fulton silty clay loam. The soil is well adapted to fruits.

**LUCAS SILT LOAM**

Lucas silt loam to a depth of 6 or 8 inches is brown silt loam. Between depths of 8 and 20 inches the material is yellowish-brown silty clay which is firm and breaks into irregular particles from one-fourth to one-half inch in diameter. Between depths of 20 and 40 inches is gray and yellowish-brown mottled silty clay. In the upper part of this layer a slightly reddish brown hue is noticeable in the coatings on the particles. With increasing depth the soil becomes grayer, and at a depth of about 30 inches the particles have a distinct coating of gray. In places a few calcareous concretions occur in the lower part of this layer. Stratified silt and clay lie below a depth of 40 inches. This soil is slightly acid to a depth of about 30 inches, below which it is neutral.

Lucas silt loam is mapped chiefly in the vicinity of Gypsum, and it occurs in small areas in Allen, Benton, and Salem Townships.

This soil occupies areas with gently undulating surface relief, and surface drainage and underdrainage range from fair to good. Areas in which the color of the surface soil is decidedly brown usually have good natural drainage, but where the surface color is somewhat grayish brown artificial drainage is desirable because of the heavy subsoil. Where artificial drainage is used it is well to place the tile lines from 4 to 5 rods apart.

Lucas silt loam is not an extensive soil, occupying only 0.6 square mile. About 90 per cent of the land is cleared and used for general farm crops and for fruit. Because of its comparatively low productivity this soil requires as heavy fertilization as Fulton silty clay loam. It is very well adapted to fruit growing.
LUCAS VERY FINE SANDY LOAM

To a depth of 6 or 8 inches Lucas very fine sandy loam consists of grayish-brown very fine sandy loam overlying yellowish-brown loam. This passes at a depth of 20 inches into mottled gray and yellowish-brown clay loam, and between depths of 26 and 30 inches the material is mottled gray and yellow silty clay loam. Laminated silt and clay are present at a depth of about 30 inches.

This soil occurs as narrow strips along stream valleys and as low knolls in the sandy sections of Clay and Harris Townships. Both surface drainage and underdrainage are good. Areas in which heavy silty clay lies within a few inches of the surface have only fair drainage, and tile drains placed from 4 to 5 rods apart are desirable.

About 95 per cent of the land is cleared and is used largely for general farm crops, with a small acreage in permanent pasture. This soil is better adapted to fruit than to general farm crops.

BONO SILTY CLAY

The surface soil of Bono silty clay consists of a 9-inch layer of very dark grayish-brown or black silty clay overlying a 6-inch sub-surface layer consisting of mottled dull-gray and yellowish-brown heavy silty clay. The subsoil between depths of 15 and 40 inches is mottled bluish-gray and yellowish-brown clay which becomes grayer with depth. In reaction this soil is neutral, but it does not show any accumulation of lime in the lower part of the subsoil. Included with this soil in mapping is an area, along Sandusky Bay about 1½ miles west of Sand Point, in which the surface soil is very dark gray or black clay loam and the subsoil is bluish gray with yellow mottlings.

Bono silty clay occurs in Bay and Portage Townships and in parts of the pump lands in Benton and Carroll Townships.

The surface relief is flat. Natural drainage is poor, and artificial drainage is necessary before the land can be used for crop production. Where tile are used they should be spaced from 3 to 4 rods apart.

This soil occupies a total area of 8 square miles, and about 95 per cent of the land is cleared. It is a very productive soil, especially for corn. Wheat and oats do well, but considerable damage occurs from lodging. Alfalfa suffers injury from the excess moisture held by this soil. Heavy fertilization is not required. For corn from 100 to 200 pounds of 20 per cent superphosphate (broadcast) and an equal quantity of a 4-12-4 fertilizer in the hill should be applied. For small grains it is desirable to use from 100 to 200 pounds of an 0–14–6 mixture or a fertilizer of similar analysis, particularly where the surface soil is somewhat mucky.

MAUMEE FINE SAND

The surface soil of Maumee fine sand consists of a 10 or 12 inch layer of very dark grayish-brown or nearly black mucky or loamy fine sand or fine sandy loam, and the subsoil is mottled gray and yellow fine sand.

This soil occupies low ridges in sections 34 and 35 of Portage Township. It is surrounded by swamp, consequently the borders
of the areas contain considerable organic material. Included with the soil in mapping is an area at Sand Point, consisting of black medium sand underlain by a 1 or 2 inch layer of very dark gray sand and this, in turn, by mottled gray and yellowish-brown sand.

The high water table causes this soil to have poor natural drainage, and adequate drainage can be provided only by lowering the water table in the surrounding swamps, which would require the building of dikes and pumping stations.

Although slow in warming up in the spring, because of the high water table, this is a good soil for vegetables and truck crops.

**DANBURY SILTY CLAY LOAM**

Danbury silty clay loam has a very dark grayish-brown or black silty clay loam surface soil, 7 inches deep, which when finely powdered is very dark brown. Between depths of 7 and 17 inches is brown silty clay containing a few dark-brown concretions in the lower part of the layer. The soil material in this layer breaks into particles, about one-fourth inch in diameter, which can be easily crushed. The third layer, extending from a depth of 17 to a depth of 34 inches, is yellowish-brown and gray mottled silty clay, the gray color becoming more pronounced with increasing depth. Dark-brown concretions are numerous in the upper part of this layer. The substratum, below a depth of 34 inches, consists typically of laminated silt and clay which are mottled gray and yellow. It contains numerous gray or reddish-gray calcareous concretions. In reaction this soil is neutral in the surface soil, slightly acid in the upper part of the subsoil, and alkaline in the lower part of the subsoil.

Included with this soil because of its very small extent is a soil derived from glacial till. This included soil is dark grayish-brown silty clay loam to a depth of 8 inches. Between 8 and 12 inches the material is slightly lighter in color and somewhat heavier in texture. Below a depth of 12 inches and extending to a depth of 20 inches is dingy-brown clay loam which breaks into irregular particles from one-fourth to one-half inch in diameter. Between 20 and 26 inches the material is brownish-gray slightly compact clay loam, with rust-brown coatings on the breakage faces. This layer is underlain by the parent material, calcareous mottled gray and yellow clay loam till. This soil occurs in the vicinity of Violet and is used almost entirely for fruit production.

Also included with this soil as mapped are several areas in which the color of the surface soil is the same as typical but the texture is silt loam. The subsoil is the same as that of the typical silty clay loam. This variation occurs in section 4 of Portage Township, on the point southeast of Danbury, along the south shore of East Harbor, and on the point between Middle Harbor and West Harbor.

The surface relief of Danbury silty clay loam is very gently undulating, giving fair surface drainage and underdrainage, but artificial drainage is desirable. The tiles should be placed from 5 to 6 rods apart.

Danbury silty clay loam occurs chiefly in Carroll, Erie, Bay, Portage, and Danbury Townships, and occupies a total area of 7 square miles. About 95 per cent of the land is cleared. This soil is well adapted to general farm crops, especially wheat, and is also a de-
sirable soil for fruit growing. Fertilization has not been practiced generally, although some farmers have been using superphosphate. For the fertilization of corn, the use of manure supplemented with superphosphate is desirable. When manure is not available, it is well to use a complete fertilizer, such as a 4–10–6, at the rate of 125 or 150 pounds an acre in the hill or row and to distribute 200 pounds of an 0–14–6 fertilizer broadcast. With modern attachments on the planter, which keep the fertilizer and seed corn separate, there need be no fear of injuring the germination of the seed with applications of the quantities mentioned. For small grains, such as wheat and oats, 200 pounds of an 0–14–6 fertilizer is desirable. Where alfalfa or clover is to be seeded in the wheat or oats it is good practice to use an additional 100 pounds of fertilizer. Superphosphate may be substituted for the 0–14–6 mixture.

DANBURY VERY FINE SANDY LOAM

Danbury very fine sandy loam to a depth of 8 or 10 inches is very dark brown very fine sandy loam. Between depths of 10 and 20 inches the material is bright yellowish-brown very fine sandy loam. Below a depth of 20 inches the soil becomes heavier, passing into sandy clay and at a depth of 40 inches into laminated silt and clay. The color is yellowish brown, with only slight gray and yellowish-brown mottlings appearing below a depth of 35 inches. Some small areas in which the surface soil is predominantly loam, but ranges from loam to very fine sandy loam within a distance of a very few feet, are included with mapped areas of this soil.

The surface relief is very gently undulating, and natural drainage, both of the surface soil and subsoil, is good.

This soil is mapped in sections 3 and 4 of Portage Township, near Sand Point, and just south of Catawba Island village. Its total area is 256 acres. All the land is cleared and is used for growing fruits and vegetables.

DANBURY CLAY LOAM

The 6 or 8 inch surface layer of Danbury clay loam is very dark grayish-brown clay loam, below which to a depth ranging from 12 to 15 inches is brown silty clay loam, becoming slightly heavier in the lower part. Below a depth of 15 inches the soil is similar to the corresponding part of Danbury silty clay loam, that is, mottled gray and brown silty clay overlying a mottled gray and brown calcareous laminated substratum.

A number of areas of Danbury clay loam are underlain by glacial till. In such areas the surface layer to a depth of 6 or 8 inches is very dark grayish-brown clay loam. This is underlain by a sub-surface layer, between depths of 7 and 15 inches, of variegated yellowish-brown and gray clay loam which has vertical breakage. The upper part of the subsoil, to a depth of 20 inches, is yellowish-brown heavy clay loam which breaks readily into aggregates ranging from one-fourth to three-fourths inch in diameter. The lower subsoil layer, between depths of 20 and 36 inches, is olive-drab and yellow heavy clay loam containing some fine gravel. The substratum is calcareous clay loam till. These included areas occur chiefly in Danbury Township, in the vicinity of Violet.
Also included with Danbury clay loam are some loam areas which are too small to show separately, the chief differences between the loam and the clay loam being in the texture of the surface soil.

Danbury clay loam occupies gentle slopes, and drainage is fair. Artificial drainage is necessary only on the more level parts, where the tile lines should be placed about 5 rods apart.

This soil occurs near Sand Point and along the shores of East Harbor and West Harbor. Nearly all the land is cleared and is used for growing fruit and general farm crops. Peaches are the principal crop grown at the present time. The fertilizer needs of this soil are very similar to those of Danbury silty clay loam.

**BROOKSTON CLAY**

Brookston clay to a depth of 6 or 8 inches is very dark grayish-brown clay. The subsurface layer is slightly lighter in color but is the same in texture. Below a depth of 12 inches the subsoil is slightly mottled dull-gray and yellowish-brown clay loam, the yellow coloration increasing with depth. Between depths of 30 and 36 inches the soil is mottled gray and rust-brown clay loam containing subangular and rounded limestone fragments. In close proximity to these limestone fragments the soil is highly calcareous. Highly calcareous and gravelly clay loam glacial till lies below a depth of 36 inches.

Typically Brookston clay is neutral in the upper layers and highly calcareous in the parent material. In some places, where the land has been heavily farmed, the surface soil may be slightly acid.

The surface relief of this soil is level, and consequently natural drainage is poor. The character of the subsoil is such that adequate drainage can be obtained by placing tile lines from 4 to 5 rods apart.

This soil occurs chiefly in Allen, Clay, Benton, and Danbury Townships. It has a total area of 21 square miles, of which about 90 per cent is cleared and in use for general farm crops. Corn, oats, and wheat, in the order named, are the leading crops. Alfalfa and sweetclover are being grown on larger acreages each year. The soil is especially well adapted to the growing of sugar beets.

Yields on Brookston clay are very similar to yields on Toledo silty clay. Corn yields range from 40 to 80 bushels and average about 45 bushels an acre. Yields of oats average 45 bushels; of wheat, 20 bushels; and of hay, from 1 to 3 tons an acre. Sugar-beet yields are subject to seasonal variations and range from 8 to 14 tons an acre.

Before attempting to improve crop yields on Brookston clay by the use of fertilizers, attention must be given to adequate drainage. This soil has in the past been tilled to some extent, but in many places drainage has been inadequate owing to the use of small tiles and the placing of the tile lines too far apart. No tile smaller than 4 inches in diameter should be used, and the lines should be placed not more than 5 rods apart. With adequate drainage provided, it is possible to grow such legumes as sweetclover and alfalfa. In some places, where the soil is slightly acid, it will be necessary to use lime in order to grow alfalfa and sweetclover, and individual field tests should be made to indicate whether or not the soil needs liming. The growing of legumes has a twofold advantage, as it increases the supply of nitrogen in the soil, thus lessening the demand for nitrogen-carrying fertilizers, and it improves the physical condition of the
soil. All the available manure is usually applied to the corn crop, and it can be supplemented by the use of superphosphate. An acre application of 125 or 150 pounds of a 4-12-4 or a 4-10-6 fertilizer in the row or hill is desirable. If manure is scarce, a broadcast application ranging from 150 to 200 pounds of an 0-14-6 fertilizer should be used in addition to the hill or row treatment. New types of fertilizer attachments, which separate the fertilizer from the seed, now make it possible to apply 125 or 150 pounds of fertilizer in the row with safety. For wheat and oats 200 pounds of 20 per cent superphosphate, or a mixed fertilizer, such as a 2-14-4 or an 0-14-6, is desirable. Where alfalfa is to be seeded in the grain it pays to use an additional 150 pounds of superphosphate. For sugar beets the use of 250 or 300 pounds an acre of a 2-12-6 fertilizer is recommended.

Table 6 gives the results of mechanical analyses of samples of the surface soil, subsurface soil, and several layers of the subsoil of Brookston clay.

**Table 6.—Mechanical analyses of Brookston clay**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Fine gravel</th>
<th>Coarse sand</th>
<th>Medium sand</th>
<th>Fine sand</th>
<th>Very fine sand</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>273660</td>
<td>Surface soil, 0 to 2 inches</td>
<td>0.8</td>
<td>2.4</td>
<td>3.7</td>
<td>8.2</td>
<td>7.7</td>
<td>29.6</td>
<td>47.6</td>
</tr>
<tr>
<td>273667</td>
<td>Subsurface soil, 2 to 5 inches</td>
<td>0.8</td>
<td>2.5</td>
<td>3.1</td>
<td>7.2</td>
<td>6.8</td>
<td>30.2</td>
<td>40.3</td>
</tr>
<tr>
<td>273668</td>
<td>Subsoil, 5 to 12 inches</td>
<td>0.9</td>
<td>1.9</td>
<td>3.0</td>
<td>6.8</td>
<td>6.7</td>
<td>27.7</td>
<td>53.0</td>
</tr>
<tr>
<td>273669</td>
<td>Subsoil, 12 to 23 inches</td>
<td>0.6</td>
<td>2.0</td>
<td>3.2</td>
<td>6.5</td>
<td>6.2</td>
<td>34.4</td>
<td>47.3</td>
</tr>
<tr>
<td>273670</td>
<td>Subsoil, 23 to 29 inches</td>
<td>1.0</td>
<td>2.5</td>
<td>3.4</td>
<td>7.8</td>
<td>6.0</td>
<td>35.0</td>
<td>44.1</td>
</tr>
<tr>
<td>273671</td>
<td>Subsoil, 29 to 36 inches</td>
<td>1.1</td>
<td>2.7</td>
<td>3.3</td>
<td>7.3</td>
<td>6.9</td>
<td>33.6</td>
<td>45.1</td>
</tr>
<tr>
<td>273672</td>
<td>Subsoil, 36 to 42 inches</td>
<td>1.5</td>
<td>2.6</td>
<td>2.9</td>
<td>6.2</td>
<td>6.8</td>
<td>30.7</td>
<td>49.4</td>
</tr>
</tbody>
</table>

1 Samples dispersed with sodium oxalate (complete dispersal); clay determined by the pipette method; silt determined by difference.

**BROOKSTON CLAY LOAM**

Brookston clay loam resembles Brookston clay in many respects, the chief difference being one of texture. The surface soil of the clay loam to a depth of 6 inches is very dark grayish-brown clay loam. Below this the soil material is somewhat lighter in color and passes at a depth of 12 inches into mottled gray and yellowish-brown clay loam which continues to a depth of 36 inches. This layer has a more pronounced yellow color than does the corresponding layer in Brookston clay. The substratum is highly calcareous glacial till. The surface and subsurface layers of this soil are neutral, the upper subsoil layer is neutral, and the parent material is highly calcareous.

Included with this soil as mapped are areas on terraces along Portage River in section 18 of Harris Township, in which the water action has removed the covering of lake-laid material, exposing the glacial till. The resulting soil is similar to Brookston clay loam except for the increased quantity of gravel on the surface.

Brookston clay loam occupies level areas and consequently has poor natural drainage. The presence of a small quantity of sand in this soil makes it somewhat more easily drained than Brookston clay. Tile lines spaced 5 rods apart should provide adequate drainage.

This soil occupies 4.7 square miles, principally in Clay, Harris, and Danbury Townships. Nearly all the land is cleared and used for growing general farm crops. Crop adaptations and fertilizer
needs are about the same as for Brookston clay. The clay loam is probably the best soil in the county for the production of sugar beets.

**WAUSEON FINE SANDY LOAM**

Wauseon fine sandy loam is associated with areas of Brookston soils. A typical profile of this soil shows 8 or 10 inches of dark grayish-brown fine sandy loam overlying gray, mottled gray and yellow, or mottled gray and yellowish-brown sandy loam which is underlain by clay at a depth of 20 or 24 inches. The subsoil is calcareous at a depth of about 30 inches. In places the intermediate layer of gray or yellow sandy loam is lacking, the soil consisting of an 8 or 10 inch layer of dark grayish-brown fine sandy loam over mottled gray and yellowish-brown clay. In reaction this soil is neutral or very slightly acid in the surface and subsurface layers and neutral or alkaline in the lower layers.

Included with mapped areas of this soil are areas occupying cut terraces along Portage River, in sections 8, 9, and 17 of Harris Township. Here the surface soil is dark grayish-brown loam or fine sandy loam extending to a depth of 10 inches. The subsoil to a depth of 20 inches is mottled yellowish-drab and gray sandy clay. Below a depth of 20 inches the material is very firm and tight gravelly clay loam.

The very gently undulating surface relief provides fair surface drainage, but underdrainage is poor and the land requires tiling for good crop production. Tile lines should be spaced about 5 rods apart.

About 90 per cent of the land is cleared and is usually farmed in conjunction with the Brookston soils. Crop yields are slightly lower and fertilizer requirements are slightly higher than on the Brookston soils.

**NAPPANEE SILTY CLAY LOAM**

Nappanee silty clay loam occurs as low knolls and along drainage ways in Clay, Allen, and Danbury Townships. The 6-inch surface layer of this soil is brownish-gray silty clay loam. Between depths of 6 and 13 inches the soil material is mottled gray and yellowish-brown silty clay loam, the gray color increasing with depth. The subsoil, between depths of 13 and 22 inches, is mottled gray and yellowish-brown heavy silty clay loam or very impervious clay.

The soil material in this layer breaks into irregular-shaped aggregates about one-half inch in diameter. The lower part of the subsoil is mottled dull-gray and yellowish-brown compact clay which breaks into aggregates slightly larger than those of the layer above. Calcareous clay till occurs at a depth of about 34 inches. In reaction this soil is acid in the surface, subsurface, and upper subsoil layers, neutral in the lower subsoil layer, and calcareous in the substratum.

Owing to the very gently undulating surface relief and to the heavy and impervious subsoil, natural drainage is very poor and artificial drainage is desirable for successful crop production. Tile lines should not be placed more than 3 rods apart.

About 90 per cent of the land is cleared, and it is used for general farm crops. The productivity of the soil is low, liming is necessary for growing alfalfa and sweetclover, and heavy fertilization is re-
quired for all crops. All the available manure should be applied to
this soil, usually on the corn crop, and in addition to manure, fer-
tilizer should be used on corn. For hill or row application, from 125
to 150 pounds an acre of a 4–10–6 fertilizer is recommended, supple-
mented with a broadcast application, at the same rate, of an 0–14–6
fertilizer. For wheat or oats, from 200 to 300 pounds of a 2–14–4
fertilizer can be used to advantage. Where a hay crop is to be seeded
in the grain crop the quantity of fertilizer should be increased by
one-half.

NAPPANEE LOAM

Nappanee loam has a surface layer about 6 inches thick consisting
of grayish-brown loam. The subsurface layer, extending to a depth
of 9 inches, consists of variegated grayish-brown light clay loam.
The upper subsoil layer, between depths of 9 and 21 inches, is mottled
grayish-brown and yellowish-brown very tight and impervious clay
loam containing a few dark-brown stains. Between depths of 21
and 30 inches the material is mottled yellowish-brown and brownish-
gray clay loam. The substratum is mottled gray and grayish-
brown clay loam till. Considerable quantities of pink and gray
calcareous material occur along breakage faces in the substratum.
This soil is located chiefly along streams in Harris and Danbury
Townships. The subsoils of some areas in Danbury Township are
less impervious but are similar in color and texture to the typical sub-
soil. In places, as just south of Rocky Ridge, and north of Violet in
Danbury Township, there is considerable gravel on the surface and
through the soil, and in such places the surface soil is somewhat
lighter in texture. The gravelly areas are shown on the map by
gravel symbols.

Typically this soil is slightly acid to a depth of about 20 inches,
but below this depth the subsoil is neutral or slightly alkaline.

Areas of this soil are level or very gently undulating, consequently
natural drainage is poor. The areas in Danbury Township are
better drained than those in the western part of the county, and in
this township tile lines placed from 4 to 5 rods apart should be
adequate for successful drainage, but in the western areas tile should
be placed from 3 to 4 rods apart.

Nappanee loam occupies 1.2 square miles, and practically all the
land is cleared. This is not a very desirable soil for general farm
crops but is well adapted to fruit.

CATAWBA LOAM

Catawba loam has a surface layer, about 6 inches thick, consisting
of grayish-brown heavy loam or light silt loam, the loam predomi-
nating. The subsurface layer, extending from a depth of 6 inches
to a depth of 10 inches, is brown clay loam with a slightly red cast.
The upper subsoil layer, between depths of 10 and 20 inches, is red-
dish-brown heavy clay loam. The lower subsoil layer, between 20
and 36 inches, is brown, slightly variegated with gray, clay loam.
Some gray calcareous streaks occur in the lower part of this layer.
The substratum is brown, yellowish-brown, and gray mottled clay
loam till and is calcareous. Limestone underlies this soil at a depth
ranging from 5 to 20 feet. In reaction the material in the surface
and subsurface layers is acid, in the subsoil is neutral, and in the substratum is calcareous. Several variations from typical are noticeable in this soil. In places the subsoil has a distinct reddish-brown color, and in other places it contains more brown and gray. Catawba loam areas on the islands have a more pronounced red color in the subsoil than have the subsoils in areas on the mainland, and some relation seems to exist between the intensity of red color in the subsoil and the depth to limestone bedrock. Several depressions or sink holes on Catawba Island are included with this soil. The soil in these areas consists of a 10-inch layer of brown loam overlying slightly compact brown loam or silt loam, and bedrock occurs at a depth ranging from 20 to 30 inches.

Catawba loam occupies gently undulating areas and has fair or good natural drainage, but tile drainage is desirable in the more level areas. The tile lines should be placed about 5 rods apart.

Areas of Catawba loam occur on Catawba Island, and on North Bass, South Bass, and Middle Bass Islands. Practically all the land is cleared. On the mainland, this soil is used largely, at present, for growing such fruit as peaches and apples, and on the islands it is used for growing grapes. Fruit trees require a nitrogen fertilizer, applied at the rate of one-fourth pound a tree for each year of age to a limit of 4 or 5 pounds.

**CATAWBA SILT LOAM**

Catawba silt loam, to a depth of 6 or 8 inches, is yellowish-brown silt loam with a slight gray cast. Beneath this is a 4-inch layer of grayish-yellow silt loam. The subsoil becomes gradually heavier and more compact with depth grading into brown clay loam at a depth of about 15 inches. Between depths of 15 and 30 inches the soil material is firm and tight reddish-brown clay loam, with gray coatings on the faces of the soil aggregates. Below this is a brown silty clay loam layer which breaks into irregular-shaped aggregates coated on the outside with gray material, some of which is calcareous. Below a depth of 40 inches the soil material consists of clay loam till which is mottled brown and gray, except where limestone is near by. Here it has a slightly red color. Some fine gravel is scattered through this soil, but the quantity is nowhere large.

Included with mapped areas of this soil is an area just east of Sugar Bluff, in which the surface soil ranges from silt loam to fine sandy loam and is partly covered by thin fragments of rocks, some of which are crystalline. The subsoil is reddish brown and is underlain by glacial till at a depth of about 20 inches.

Catawba silt loam occupies undulating areas and has good natural drainage. The land is practically all cleared and is used chiefly for fruit growing, being especially well adapted to the production of peaches.

*Catawba silt loam, mottled-subsoil phase.*—Catawba silt loam, mottled-subsoil phase, is developed under conditions of poorer drainage than the typical soil and if more extensive would be correlated in a separate soil series. The 7-inch surface layer is grayish-brown silt loam. It overlies a 4-inch layer of mottled gray and light-brown silty clay loam containing some brown concretionary material. Be-
tween depths of 10 and 20 inches the material is mottled grayish-brown and yellowish-brown heavy clay loam, with some light-gray material along the faces of the soil aggregates. Black concretions are present in this layer. The soil material between depths of 20 and 34 inches is slightly compact clay loam which is locally known as "hickory bottom." The color in the upper part of this layer is gray with a brown cast, and the gray color becomes darker with increasing depth. Calcareous clay loam till lies below a depth of 34 inches.

This soil is rather uniform throughout the county. There is some variation in the hardness of the so-called "hickory bottom" layer, but at no place does it approach the hardness of the subsoil of the Nappanee soils.

Poor natural drainage is the result of the nearly level surface relief of this soil. Artificial drainage is desirable and can best be obtained by placing tile lines about 3 rods apart.

Nearly all the soil is cleared and is used chiefly for fruit growing, to which it is fairly well adapted, although it is not so good for this purpose as typical Catawba silt loam.

**CATAWBA FINE SANDY LOAM**

Catawba fine sandy loam, to a depth of 8 inches, is grayish-brown fine sandy loam. Below this is a 6-inch layer of yellowish-brown fine sandy loam overlying a layer, about 15 inches thick, of reddish-brown slightly compact clay loam. The substratum is calcareous clay loam till. Small quantities of gravel occur in the surface layer. This soil covers only 64 acres in the county. The land is gently undulating and has good natural drainage. Fruit, principally peaches, apples, and grapes, are grown.

**CATAWBA GRAVELLY LOAM**

Catawba gravelly loam consists of a 6 or 8 inch layer of grayish-brown gravelly loam overlying an 18-inch layer of brown or slightly reddish brown gravelly loam. The substratum is reddish-brown clay loam till. This soil occurs on North Bass, Middle Bass, and South Bass Islands, where it occupies 384 acres.

The surface relief is undulating, providing good surface drainage and underdrainage. Grapes are the chief crop grown, and peaches occupy a very small acreage.

**RANDOLPH SILT LOAM**

Randolph silt loam, to a depth of 6 inches, is brownish-gray silt loam. Between depths of 6 and 11 inches the soil is variegated gray and brown light-textured silt loam, and below this is reddish-brown clay loam which becomes heavier with depth. Bedrock lies at a depth ranging from 20 to 30 inches.

Owing to variations in the depth to bedrock, there is some variation in the thickness of the soil layers. In places the reddish-brown clay loam is not developed, its place being taken by mottled gray and yellowish-brown clay loam. Areas of this kind occur about three-quarters of a mile southeast of Catawba Island village.
The surface relief is gently undulating, giving fair or good natural drainage, and artificial drainage is not required except on the more level areas.

Agriculturally this soil is unimportant. The land is largely cleared, and, in the eastern part of the county, is used for growing peaches and apples. It is best adapted to apples.

**Randolph Loam**

The 8 or 10 inch surface layer of Randolph loam consists of grayish-brown loam, and between depths of 10 and 15 inches the subsurface layer is light grayish-yellow loam. Below a depth of 15 inches is mottled brown and gray sandy clay which becomes heavier with depth and at a depth of about 26 inches grades into slightly reddish brown clay loam. The subsoil in place is firm and hard, but it crumbles readily when removed. Limestone lies at a depth ranging from 30 to 36 inches.

Two variations of this soil are included in mapping. One occurs along the Lakeside & Marblehead Railroad about 1 1/4 miles east of Piccola. The soil here consists of a 6-inch layer of brown fine sandy loam overlying a 15-inch layer of pale grayish-yellow fine sandy loam which rests on bedrock. The other variation occurs in two areas—one just west of the area described and the other 2 1/2 miles east and a little south of Piccola, in Danbury Township. The soil in these two areas consists of heavy brown loam to a depth of 6 inches. Below this and continuing to bedrock, which lies at a depth of 18 or 20 inches, is grayish-yellow or gray clay loam containing numerous glacial pebbles and gravel.

Owing to the gently undulating surface relief, both surface drainage and underdrainage are fair and artificial drainage is not necessary.

This soil is not extensive, occupying only 2.3 square miles. It is used for growing peaches and apples in the eastern part of the county and is kept in wood lots or pasture in the western part.

**Randolph Stony Loam**

Randolph stony loam includes areas of brown loam from 2 to 12 inches thick, overlying limestone, and numerous limestone blocks and outcrops are on the surface. Areas in which the limestone bedrock is exposed have been indicated by outcrop symbols. On Green Island the soil consists of 6 or 8 inches of black peatlike material containing considerable loam, overlying limestone bedrock.

Ledges and cliffs of limestone bordering the lake have been included with this soil and are shown on the map by outcrop symbols. Large areas of this soil occur on the islands, at Marblehead, and in Catawba Island Township, and smaller areas are in the western part of the county. This soil is unimportant agriculturally and has largely been left in wood lots.

**Millsdale Clay Loam**

Millsdale clay loam has developed under conditions of poor drainage where bedrock lies at a slight depth. The surface soil is very dark grayish-brown clay loam to a depth of 6 or 8 inches and is underlain by dull-gray and yellowish-brown mottled heavy clay
loam. Between depths of 16 and 26 inches the subsoil is more gray than the layer above and contains some soft dark-brown concretions. Calcareous till occurs at a depth of about 26 inches and continues to limestone bedrock which lies at a depth ranging from 30 to 40 inches.

Included with mapped areas of this soil are some areas of Millsdale loam which differs from the clay loam chiefly in the texture of the surface soil. Such areas occur north and south of Genoa. Millsdale clay loam occurs in section 4, Clay Township, section 23, Harris Township, and on the limestone upland near Marblehead. The total area is 384 acres.

The surface relief is level or very gently undulating, resulting in poor natural drainage, and artificial drainage is necessary for the production of general farm crops, but in places the slight depth to limestone bedrock hinders the placing of tiles at the proper depth. Much of this soil should be left in wood lots.

**GENESEE FINE SANDY LOAM**

Genesee fine sandy loam, to a depth of 10 inches, is brown fine sandy loam or very fine sandy loam. Below this depth the soil material changes little in color or texture, but it has a tendency to cohere in small granules. The depth of this alluvial deposit ranges from 3 to 5 feet.

The texture of this soil may range from light loam nearly to sand. Included with the soil as mapped are two areas along Portage River, in which the soil consists of a very dark brownish-gray loam surface soil overlying a mottled gray and yellow clay loam subsoil. One of these areas is on the south side of the river at Oak Harbor, and the other area is about 3 miles east of Oak Harbor. Another variation, in which limestone bedrock outcrops, occurs along Portage River above Elmore. Such areas are indicated by rock-outcrop symbols.

This is a comparatively inextensive soil, occupying 1.2 square miles. The land is naturally well drained and is suitable for most farm crops, but, on account of an occasional overflow in the spring, only such crops are grown as can be planted after the spring floods. Corn and oats are the principal crops.

**EEL SILTY CLAY LOAM**

Eel silty clay loam occurs as narrow areas along streams, and it is developed under conditions of poor drainage. The surface layer to a depth of 5 inches is grayish-brown silty clay loam. Between depths of 5 and 16 inches is grayish-brown silty clay loam which breaks readily into aggregates ranging from one-fourth to one-half inch in diameter. This layer is not so firm or so compact as the layer below. The subsoil below a depth of 16 inches is mottled brown and grayish-brown silty clay loam which breaks into irregular aggregates ranging from one-half to three-fourths inch in diameter.

The total area of this soil is small. Most of the land is cleared and used for general farm crops and pasture. Although the land is overflowed for short periods during the spring, damage to crops is slight.

*Eel silty clay loam, dark-colored phase.*—Eel silty clay loam, dark-colored phase, consists of a 6-inch layer of very dark gray or
almost black silty clay loam overlying dark-gray silty clay loam which continues to a depth of 30 inches with little change. It occurs as narrow areas along small streams. Some areas are used for pasture, others for general farm crops.

**FOX GRAVELLY SANDY LOAM, BEACH-RIDGE PHASE**

Fox gravelly sandy loam, beach-ridge phase, to a depth of 6 inches, is brown sandy loam or fine sandy loam containing considerable gravel. Beneath this is a 10-inch layer of reddish-brown gravelly fine sandy loam. Between depths of 16 and 28 inches the soil material is reddish-brown sandy loam containing some fine gravel. This layer is underlain by stratified sand and gravel slightly cemented in places with lime.

This soil occurs in Catawba Island and Danbury Townships where it occupies 128 acres. The undulating surface relief and the stratified character of the subsoil afford excellent drainage. This is an unimportant soil, agriculturally. Fruits, principally peaches and apples, are grown.

**RODMAN GRAVEL, BEACH-RIDGE PHASE**

Rodman gravel, beach-ridge phase, consists of a 3 or 4 inch layer of very dark brown gravelly loam overlying a 3 or 4 inch layer of gravel which contains some fine earth consisting of reddish-brown very fine sandy loam. The gravel layer is underlain by stratified sand and gravel. The gravel consists largely of flat pieces of limestone ranging from one-half inch to 6 inches in diameter.

This soil occurs on low ridges on the limestone upland at Marblehead and on South Bass Island. It is of little agricultural value, although it furnishes some pasture in the spring and early summer.

**BEACH SAND**

Beach sand occurs in narrow areas along the shores of Lake Erie and Sandusky Bay. It consists of incoherent pale-yellow sand. Shells are numerous along the water line. In most places there is no organic matter. A variation from the typical material, consisting of brown very fine sandy loam over a yellowish-brown fine sandy loam subsoil, is included with this soil in mapping. This variation occurs in section 26 of Portage Township. Some low sand dunes along the eastern edge of East Harbor and Middle Harbor are also included. Beach sand is used chiefly as building sites for summer cottages.

**MUCK**

Muck soils occur in sections 34 and 26 of Benton Township, near Sand Beach, and west of Gypsum. The surface layer, to a depth ranging from 6 to 10 inches, is finely divided very dark grayish-brown or black material high in organic matter. This layer is underlain by raw porous brown muck which is high in organic matter and contains less mineral matter than the layer above. Bluish-gray clay lies beneath the muck at a depth ranging from 20 inches to 4 feet.

Muck occupies shallow depressions and has poor natural drainage. In all the areas, except the one near Gypsum, adequate drainage can be had only by pumping out the water.
Corn is the principal crop. Small grains are grown occasionally, but the damage from lodging is sufficient to make these crops unprofitable. Truck crops, such as onions, celery, and cabbage, to which this soil is well adapted, are grown on a very small acreage.

MARSH

Marsh includes those areas which support a marsh vegetation, such as sedge grass or reeds, and are covered with water during all or part of the year. Marshes including areas of open water are greatly desired as duck ponds by hunting clubs or as muskrat farms by fur trappers. Many of the marshes could be drained by building dikes and removing the water by pumping. The pump lands described in another part of this report were formed in this manner. The soil resulting from the effects of drainage is either the dark-colored Bono soil or the gray variation of the Toledo soils.

STONE QUARRIES, MINES, PITS, AND DUMPS

This separation on the map includes all stone quarries, mines, pits, and dumps of refuse from factories. Most of the dumps consist of waste material from the production of lime or gypsum. Included with this separation is an area near the United States gypsum plant at Gypsum that is much broken by small depressions, from 10 to 40 feet in diameter, which have been caused by cave-ins of the underlying mines. The land included in this separation is nonagricultural.

MADE LAND

This classification includes fills made in connection with highway and railroad grades crossing water, and fills made from material dug from the lake bottom and used to fill in building sites along the lake front. The principal fills are those made for the highway and railroad grades across Sandusky Bay and those made for building sites at Port Clinton and Long Beach.

SOILS AND THEIR INTERPRETATION

The soils of Ottawa County have developed in a forested region under the influence of a humid temperate climate. The characteristic mature soils of the area are podzolic in character and can best be included with the gray-brown podzolic soils. The area, of which Ottawa County is a part, has been included by Fenneman ¹ in the eastern lake section of the central lowland area of the interior plains. It is part of a broad lacustrine plain bordering Lake Erie. Because of the nearly level surface, natural drainage is very poor over most of the county, so that the development of soils normal to well-drained situations in this region has been prevented. The parent material from which the soils of the county have been derived is either lacustrine or glacial in origin. These deposits rest

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on limestone, the underlying rock formation in all parts of the county. The depth to bedrock is variable. In the western part of the county a few outcrops occur, but for the most part the depth to bedrock is 10 feet or deeper. In the eastern part, as in Marblehead Peninsula, Catawba Island, and the islands in Lake Erie, over a considerable area the depth to bedrock is less than 3 feet, and outcrops are numerous. A mantle of glacial drift, composed largely of limestone material covers the bedrock, and this, in turn, is covered with lacustrine deposits, except in the southwestern part of the county, around limestone outcrops in the western townships, and on the more elevated areas in the Marblehead Peninsula, Catawba Island, and the islands in Lake Erie, where glacial drift is exposed at the surface. The lacustrine deposits, which form the surface material over a large part of the county, are composed largely of silt and clay, although locally small areas of sandy or gravelly material occur. Where bedrock comes near the surface, the lower part of the subsoil may be in part essentially residual from the limestone, although in most places a thin mantle of glacial drift covers the rock.

Practically all the region originally supported a heavy forest growth. Much of the central and western parts of the county is included in the Great Black Swamp, which, for the most part, supported a heavy forest growth in which elm was an important species.

Sampson and Transeau classify the vegetation of this part of the county into two main groups, the swamp-forest association and the beech-maple association. The swamp-forest association, which occurred on the level low-lying areas, included elm, black ash, silver maple, pin oak, swamp white oak, sycamore, sour gum, yellow birch, and on slightly better drained spots, bur oak, white oak, and big shellbark hickory. The beech-maple association, which occupied slightly elevated areas, comprised such trees as beech and hard maple, together with the tuliptree, black walnut, white walnut, red oak, yellow oak, and bitternut hickory.

The vegetation of the eastern part of the county, including Catawba Island, in Lake Erie, and the Marblehead Peninsula, is variable. The original growth consisted of red cedar, oak-hickory associations, and a mixed forest of black maple, black walnut, sugar maple, slippery elm, blue ash, and bitternut hickory as characteristic of limestone outcrops. Hardesty reports parts of Carroll, Erie, Bay, Portage, and Danbury Townships as being dominantly prairie, interspersed with groves of timber. The prairie must have been largely of the wet land type.

The humid temperate climate under which the soils of the county have developed is intermediate between that of the eastern coastal region and that of the continental interior, and it is modified by the influence of a large body of water (Lake Erie) which the county borders.

As a result of the action of the various soil-forming processes, soils with features normal to the region have developed. The character-

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istics of the various layers of the mature virgin upland soils are as follows:

(1) 0.5 inch to 1½ inches, a very thin layer of leaf litter and leaf mold.
(2) A 1½ or 2 inch layer of dark grayish-brown friable material containing considerable organic matter.
(3) A 8 or 8 inch layer of grayish-brown or yellowish-brown material, somewhat similar in texture to the layer above but containing less organic matter.
(4) An 8 to 14 inch layer of heavy plastic material, entirely leached of lime carbonate.
(5) The substratum, or parent material, consisting of partly weathered glacial drift, in places ice-laid and unassorted and elsewhere water-laid and assorted.

The first three layers constitute the A, or eluvial, horizon; the fourth is the B horizon; and the fifth, the C horizon.

The group of mature soils includes the Lucas and Fox soils, derived from water-laid materials, and the Catawba soils, derived from glacial till. In Ottawa County the Lucas soils are derived from fine-textured materials and the Fox soils from beach-ridge gravels. The soils of both groups are inextensive.

The Catawba soils are derived from glacial limestone till, to which the local rocks have contributed a large part of the material. These soils differ from the Miami soils chiefly in a more pronounced red color in the B horizon. All the area including Ottawa County was covered by water during the period this region was occupied by the glacial lakes, and probably the surface soil material was more or less modified by water action.

Catawba loam is the most extensive member of the Catawba series. A representative profile, 4 miles south of Catawba Island village, shows the following layers:

0 to 0.5 inch, leaf litter with a very slight quantity of leaf mold.
0.5 to 2 inches, dark grayish-brown friable loam containing considerable organic material. The pH value is 6.92.
2 to 8 inches, grayish-brown loam similar in texture to the layer above but containing less organic matter. The structure is platy. The pH value is 5.60.
8 to 12 inches, finely granular grayish-brown clay loam becoming heavier in texture and browner with depth. The soil aggregates range from one-eighth to one-fourth inch in diameter. The pH value of the material in this layer is 4.87.
12 to 20 inches (the B horizon), granular reddish-brown clay loam, the granules showing slight gray coatings. Old root channels are filled with gray or red clay. The pH value is 4.96. This horizon and the horizon above contain many small pores or minute channels filled with root hairs.
20 to 26 inches, granular heavy clay loam, in which the granules are angular and from one-half to three-fourths inch in diameter. The color of the granules is mainly reddish brown, although some are grayish brown with gray coatings. Some fine gravel is present in this layer. The pH value is 7.52.
26 to 36 inches, granular clay loam which is brown with a slightly gray cast. The granules are about one-half inch in diameter and have, for the most part, gray coatings with here and there a suggestion of red. Gray calcareous material streaks some of the breakage faces. The pH value is 7.86.
36 to 44 inches, granular mottled brown, yellowish-brown, and gray highly calcareous clay loam till. The granules are roughly cubical or rectangular in shape and range from one-half to three-fourths inch in diameter. Some of the calcareous material is segregated along breakage lines. This is the parent material. The pH value is 7.86.
Textural differences in the A horizons necessitated the mapping of silt loam, loam, fine sandy loam, and gravelly loam types of the Catawba series. Although texture was the chief difference in these separations it was noted that the lighter the texture the more pronounced the red color. The silt loam did not show so much reddish brown as the loam. A mottled-subsoil phase of the silt loam is mapped, in which the reddish-brown color is lacking, the B horizon consisting of mottled grayish-brown and yellowish-brown clay loam.

Most of the soils in Ottawa County have developed under conditions unfavorable to the development of the typical regional profile. These imperfectly developed soils can be classified into several groups, depending on factors largely responsible for their development. They are grouped as follows: Soils developed under forest vegetation with imperfect drainage; soils developed under forest vegetation with very poor drainage; soils developed under conditions of excessive drainage; soils developed from shallow deposits (this group is subdivided into two subgroups based on drainage conditions, one subgroup having fair to good drainage, the other having very poor drainage); soils developed under a prairie vegetation and having fair drainage; and youthful soils, or soils derived from recently deposited material.

The Fulton and Nappanee soils belong to the group of soils developed under imperfect drainage. These soils occupy low knolls, slightly higher than the surrounding level, on which the predominating vegetation belongs to the beech-maple association. The Fulton soils are derived from water-laid material and the Nappanee soils from glacial till.

A profile of Fulton silty clay loam as observed in the northeast quarter of section 14 in Allen Township shows the following layers:

- **0 to 0.5 inch**, leaf litter overlying a very slight quantity of leaf mold.
- **0.5 inch to 2 inches**, dark grayish-brown silty clay loam containing considerable organic matter. The pH value is 6.45.
- **2 to 5 inches**, light-gray and light grayish-yellow variegated silty clay loam having a platy structure. The pH value is 5.20.
- **5 to 8 inches**, mottled brownish-gray and yellowish-brown silty clay loam which breaks into irregular granules from one-half to three-fourths inch in diameter. This layer contains numerous pore spaces and minute channels filled with root hairs. The pH value is 4.83.
- **8 to 21 inches**, granular mottled grayish-brown and yellowish-brown clay, in which the granules are angular and range from one-fourth to one-half inch in diameter. Some soft dark-brown concretions from one-sixteenth to one-eighth inch in diameter occur in this layer. The number of pore spaces filled with root hairs is less than in the layer above, and roots do not penetrate the granules. When wet the soil material is very plastic, and when dry it is very hard. The pH value is 6.35.
- **21 to 26 inches**, granular mottled gray and yellowish-brown heavy silty clay which is grayish yellow when powdered. The granules are from one-half to three-fourths inch in diameter. A few dark concretions similar to those in the layer above are present. The soil material is less plastic and less hard than in the layer above. The pH value is 7.69.
- **26 to 34 inches**, calcareous mottled gray and yellow silty clay containing some calcareous and some dark-brown concretions. The pH value is 7.80.
- **34 to 37 inches**, laminated mottled gray and brownish-yellow calcareous silty clay. The calcareous material is in the form of concretions deposited on the breakage faces. The pH value is 7.89.

In addition to the silty clay loam described, the silt loam, loam, and very fine sandy loam members of the Fulton series have been mapped.
The difference in these soils is chiefly a difference in the texture of the surface and subsurface layers. The textural difference in Fulton very fine sandy loam continues to a depth of about 40 inches where the laminated silt and clay is reached.

The Nappanee soils differ from the Fulton soils chiefly in the character of the parent material, the Nappanee having developed from glacial till. The B horizon of the Nappanee soils is slightly tighter and more impervious than the B horizon of the Fulton soils.

The group of soils developed under conditions of very poor drainage occupies areas on which the swamp-forest association is the dominant vegetation. This group includes the Toledo, the Bono, and the Maumee soils, derived from water-laid material; the Brookston soils, derived from glacial drift material; and the Wauseon soils, consisting of a few inches of sandy material over a very heavy subsoil. Toledo silty clay is the most extensive soil of this group.

A representative profile of Toledo silty clay as observed in the southwest quarter of section 34 in Erie Township, consists of the following layers:

0 to 0.25 inch, a thin layer of leaf litter overlying a small quantity of leaf mold.

0.25 to 1 inch, granular very dark brown or black silty clay, in which the granules are angular or rounded and about one-eighth inch in diameter. Worm casts are abundant in this layer.

1 to 4 inches, silty clay which is almost as dark as the layer above but lacks the definite granular structure. When dry the material breaks into lumps which crumble into fine particles. The pH value is 6.48.

4 to 8 inches, granular dark-gray silty clay. The material in this layer has a distinct vertical breakage with a further breakage into granules from one-fourth to one-half inch in diameter. The pH value is 6.4.

8 to 15 inches, granular mottled dark-gray and yellowish-brown silty clay. The gray color is in part a true motting penetrating the granules and in part a coating on the granule surfaces. The granules are slightly larger than those in the layer above. Some minute dark concretions are present. The pH value is 6.71.

15 to 32 inches, coarsely granular mottled gray and yellowish-brown silty clay which breaks into irregular granules about three-fourths inch in diameter. In places the yellowish-brown color appears at the surface of the granules, but it is mainly in the interior. Small root channels are lined with gray clay. The pH value is 7.05.

32 to 42 inches, coarsely granular mottled dull-gray and rust-brown silty clay which breaks into granules about 1 inch in diameter, with little segregation of color along the granule faces. Old root channels are filled with gray silty clay. The pH value is 7.45.

42 to 48 inches, mottled gray and yellowish-brown silty clay which breaks into irregular lumps from 1 to 2 inches in diameter, the faces of which are covered with bluish-gray heavy clay with here and there a suggestion of reddish brown. The pH value is 7.32.

48 to 58 inches, variegated brown, reddish-brown, and gray silty clay which breaks into lumps from 1 to 2 inches in diameter. The red color exists as partial coatings on the breakage faces and as soft concretionary material. Some pink and gray calcareous material is deposited on some of the breakage surfaces. The pH value is 7.75.

58 to 68 inches, faintly laminated variegated brown, reddish-brown, pink, and gray silty clay which breaks into irregular lumps 2 inches in diameter. The gray color occurs along the vertical breakage lines as well as in the interior of the lumps. The calcareous material in this layer is not segregated. The pH value is 7.70.

Below 60 inches the soil consists of glacial till. The layers between depths of 42 and 66 inches are characteristic of the material just above the glacial till. Where the till occurs at a greater depth, the soil material between 42 and 66 inches is stratified mottled gray and yellowish-brown silt and clay.
On the basis of textural differences, the clay loam, loam, and very fine sandy loam of the Toledo series, in addition to Toledo silty clay, have been mapped. Except for the difference in texture and the presence of a slightly more yellow color, due to better oxidation, there are no pronounced differences in the profile characteristics of the clay loam and very fine sandy loam members of the Toledo series.

The Bono soils differ from the Toledo soils in a darker color in the surface soil and a more bluish-gray color in the subsoil.

The Maumee soils are very sandy dark-colored poorly drained soils underlain by a water-logged sand substratum.

In general the Brookston soils are similar to the Toledo soils in that the surface soils are dark colored and the subsoils are mottled gray and yellowish brown. The chief difference in the two soils is that the Toledo soils are derived from water-laid and assorted materials, whereas the Brookston soils are derived from ice-laid and unassorted materials. Brookston clay and Brookston clay loam are mapped.

The Wauseon soils are included in the group of soils developed under conditions of very poor drainage. They consist of a layer of sandy material, from 10 to 20 inches thick, overlying a heavy-textured lower subsoil layer. In Ottawa County the heavy-textured material is glacial till, and only the fine sandy loam is mapped.

A representative profile of Wauseon fine sandy loam as observed in a pasture in section 35 of Clay Township shows the following layers:

0 to 8 inches, dark-brown fine sandy loam containing considerable organic matter.
8 to 12 inches, pale yellowish-gray fine sandy loam which is firm in place, but when removed crumbles readily into fine particles.
12 to 20 inches, yellowish-brown fine sandy loam.
20 to 30 inches, mottled gray and yellowish-brown clay loam.
30 to 40 inches, mottled gray and yellowish-brown heavy calcareous glacial till.

One soil in the county has excessive drainage. This soil occupies old beach ridges and is correlated as a beach-ridge phase of Rodman gravel.

Shallow deposits over bedrock have contributed to the development of a fourth group of imperfectly developed soils. These soils occur wherever the underlying limestone bedrock lies within 3 feet of the surface. A difference in drainage conditions has resulted in the development of two soil series. The brown or yellowish-brown soils developed under fair or good drainage are classified in the Randolph series.

A profile of Randolph silt loam as observed in a pasture 1 mile southeast of Piccola shows the following layers:

0 to 2 inches, dark-brown silt loam containing much organic matter. The pH value is 7.50.
2 to 6 inches, finely granular light yellowish-gray silt loam with a platy structure. The pH value is 7.10.
6 to 11 inches, granular mottled gray and brown light silt loam, in which the granules range in diameter from one-eighth to one-fourth inch. Pore spaces are numerous and are filled with fine root hairs. Old root channels are filled with brown silt loam. The pH value is 6.85.
11 to 15 inches, reddish-brown clay loam which breaks into granules ranging from one-fourth to one-half inch in diameter. The pH value is 6.75.
15 to 20 inches, reddish-brown clay loam which is slightly darker than the material in the layer above. The main breakage is vertical, into
lumps about 2 inches by three-fourths inch, with a secondary breakage into irregular granules from one-fourth to one-half inch in diameter. Roots, in general, follow the breakage joints but in a few places penetrate the granules. The pH value is 7.65.

Below a depth of 20 inches, limestone bedrock.

This profile is typical of the more shallow areas of Randolph silt loam. Where the underlying bedrock occurs at a depth of 30 inches or deeper, a thicker layer of mottled material, with only a few inches of reddish-brown soil, occurs just above the bedrock.

Randolph loam and Randolph stony loam are also mapped in Ottawa County. The loam resembles the silt loam in most respects, the chief difference being in the texture of the surface and subsurface layers. The stony loam is very shallow and consists of 3 or 4 inches of dark-brown loam over a layer, from 4 to 12 inches thick, of yellowish-brown or slightly reddish brown loam. In most places bedrock lies within 15 inches of the surface.

The second series of soils derived from shallow deposits and which are developed under very poor drainage conditions are classified in the Millsdale series.

A profile of Millsdale clay loam as observed in section 4 of Clay Township shows the following layers:

0 to 2 inches, very dark grayish-brown clay loam high in organic matter. The pH value is 7.55.
2 to 6 inches, granular dark-gray clay loam containing less organic matter than the layer above. The pH value is 7.55.
6 to 16 inches, granular mottled dull-gray and rust-brown heavy clay loam, in which the granules are from one-fourth to one-half inch in diameter. Numerous minute pores are present. The pH value is 7.60.
16 to 20 inches, mottled gray and rust-brown clay loam which is plastic when wet. Some breakage faces are coated with gray clay. The pH value is 7.55.
20 to 34 inches, mottled gray and rust-brown clay loam till that is highly calcareous. Most of the gray color is confined to the breakage faces, and some of the calcareous material is deposited on breakage surfaces. The pH value is 7.84.

Below a depth of 34 inches, limestone bedrock.

A fifth group of imperfectly developed soils has originated in the prairie areas of the county under fair conditions of drainage. Although red oak, elm, ash, and shagbark hickories are now growing on these soils, old reports describe parts of this region as prairie, and the characteristics of the soil itself are those of prairie soils. Such soils are classified in the Danbury series.

A profile of Danbury silty clay loam as observed in a pastured wood lot in section 8 of Portage Township shows the following layers:

0 to 7 inches, finely granular very dark grayish-brown silty clay loam containing much organic matter. The granules in this layer are rounded. When finely powdered the soil material has a distinct dark-brown color. The pH value is 7.44.
7 to 17 inches, granular brown silty clay having slightly gray coatings on breakage faces. A cut surface of this soil shows yellowish brown, and the powdered material is yellowish brown. The soil material has a distinct vertical breakage, which gives the appearance of a columnar structure. The soil masses break readily into granules about one-fourth inch in diameter. Old root channels are filled with dark-gray silty clay loam. The pH value is 5.70.
17 to 25 inches, slightly mottled brown and gray clay containing numerous soft dark concretions about one-sixteenth inch in diameter. The main
breakage is into aggregates, from one-fourth to 1 inch in diameter, which break into granules from one-eighth to one-fourth inch in diameter. There is no noticeable segregation of color in this layer. Old root channels are filled with dark-gray silty clay loam. The pH value is 6.10. 25 to 34 inches, mottled gray and brown clay with here and there a tinge of red throughout the layer. The vertical breakage is distinct, with definite cleavage surfaces coated with heavy clay. The breakage is into large aggregates from 1 inch to 1½ inches in diameter. The pH value is 7.05. 34 to 40 inches, slightly laminated mottled gray and brown silty clay, with gray calcareous deposits and concretions along breakage faces. The breakage is into granules from one-half to three-fourths inch in diameter. These granules are gray on the exterior and mottled gray and yellow in the interior. The pH value is 7.86.

Textural differences have resulted in mapping a clay loam and a very fine sandy loam as well as the silty clay loam of the Danbury series. The first two soils are very similar to the silty clay loam in general characteristics, but the subsoil of the very fine sandy loam is brighter yellowish brown than the subsoil of the silty clay loam. In places in Ottawa County the substratum material is heavy glacial till rather than laminated silt and clay.

The sixth group of imperfectly developed soils are those soils of recent deposition, occurring along streams. Two series are recognized, one having good drainage, the other poor drainage.

The well-drained soils are classified with the Genesee series. Only Genesee fine sandy loam is mapped. A profile as observed in section 23 of Harris Township shows the following layers:

- 0 to 10 inches, dark-brown fine sandy loam, with a pH value of 8.09.
- 10 to 30 inches, brown or dark-brown, slightly lighter than in the layer above, very fine sandy loam which has a tendency to cohere in small granules.

The poorly drained soils along the streams are classified in the Eel series. A profile of Eel silty clay loam as observed in section 13 of Benton Township shows the following layers.

- 0 to 5 inches, finely granular grayish-brown silty clay loam, with a pH value of 7.47.
- 5 to 18 inches, granular grayish-brown silty clay loam, in which the granules are from one-fourth to one-half inch in diameter and have dark-gray coatings. The pH value is 7.5.
- 18 to 26 inches, coarsely granular mottled gray and yellowish-brown silty clay loam, in which the granules are from one-half to three-fourths inch in diameter. The pH value is 7.75.

Very dark grayish-brown stream-bottom soils have been mapped as a dark-colored phase of Eel silty clay loam.

Small areas of organic, or muck, soils occur in the county. No attempt was made to classify these soils in a definite series. In general, the material consists of a 6 to 10 inch layer of finely divided very dark grayish-brown or black material high in organic matter, overlying raw porous brown muck or peat which is high in organic matter and contains less mineral matter than the layer above. Bluish-gray clay lies beneath the muck at a depth ranging from 20 inches to 4 feet.

**SUMMARY**

Ottawa County is located in northern Ohio, bordering Lake Erie. In addition to the mainland area, the county includes several islands in Lake Erie and in Sandusky Bay.
In the central and western parts of the county the surface relief is predominantly level, whereas in the eastern part and on the islands it is undulating. Natural drainage is very poor, except in the undulating areas where it ranges from fair to good.

The mean annual temperature at Danbury is 50.7° F., and the mean annual rainfall is 29.67 inches. Lake Erie has a very marked effect on the climate of areas adjacent to it. As a result of this influence the growing season is approximately 20 days longer in the eastern than in the western part of the county.

The soils of the county have developed under the influence of a humid temperate climate and a heavy timber cover. The characteristic mature soils are included with the gray-brown podzolic soils. In the western part of the county the light-colored soils derived from lacustrine deposits are included in the Lucas and Fulton series and those derived from glacial till in the Nannenee series. Fulton silty clay loam is the most extensive soil of this group. The light-colored glacial soils of the eastern part of the county are included in the Catawba series. The loam and silt loam are important agricultural soils. Soils occurring on old beach ridges have been classified as the beach-ridge phases of the Fox and Rodman series.

The most extensive soils of the county are imperfectly developed as a result of very poor natural drainage. These soils are dark colored and for the most part supported a heavy forest growth. Those soils derived from lacustrine deposits are included in the Toledo, Bono, and Maumee series. Toledo silty clay is the most important, agriculturally, and the most extensive soil in the county. The Brookston soils are derived from glacial till and the Wauseon soils from lacustrine sands overlying heavy-textured materials.

Included with the dark soils are the Danbury soils. These soils have yellowish-brown subsoils and are only slightly mottled, as compared with the Toledo soils which have highly mottled subsoils, in which gray predominates. The Danbury soils which occupy gently undulating areas have better natural drainage than the other dark soils. Apparently they have developed under prairie conditions.

Soils with bedrock lying at slight depths (between 2 and 3 feet) occur in many parts of the county. The light-colored soils of this group are included in the Randolph series and the dark-colored soils in the Millsdale series.

Two types of agriculture are important in the county. In the central and western parts, where the Toledo and Brookston soils predominate, general farming is followed, with corn, oats, wheat, clover, and alfalfa as important crops. Sugar beets, tomatoes, and cucumbers are the chief special cash crops. Some dairying and livestock raising is carried on in conjunction with general farming. In the eastern part of the county fruit growing is the chief industry. Peaches, apples, pears, and grapes are important crops. Grape growing is confined chiefly to the islands in Lake Erie. Fruit is grown chiefly on the light-colored soils.

There are no large markets in the county, but railroads and excellent highways make it possible to ship agricultural products to Cleveland, Toledo, Pittsburgh, and other large cities.
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