U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY, E. A. BIRGE, DIRECTOR; COLLEGE OF AGRICULTURE, UNIVERSITY OF WISCONSIN, H. L. RUSSELL, DEAN; A. R. WHITSON, IN CHARGE SOIL SURVEY.

SOIL SURVEY OF OUTAGAMIE COUNTY, WISCONSIN.

BY

W. J. GEIB, IN CHARGE, AND H. V. GEIB, OF THE U. S. DEPARTMENT OF AGRICULTURE, AND MARION C. FORD AND MARTIN O. TOSTERUD, OF THE WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1918.]

WASHINGTON
GOVERNMENT PRINTING OFFICE
1921.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., August 10, 1920.

SIR: I have the honor to transmit herewith the manuscript report and map covering the soil survey of Outagamie County, Wis., and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils, 1918, as authorized by law. This work was done in cooperation with the Wisconsin Geological and Natural History Survey and the College of Agriculture, University of Wisconsin.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. E. T. MEREDITH,
Secretary of Agriculture.

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DESCRIPTION OF THE AREA.

Outagamie County is situated in the east-central part of Wisconsin. It is approximately rectangular in shape and has an area of 646 square miles, or 413,440 acres.

Outagamie County has the topographic features characteristic of a glacial region. The eastern, central, and southern parts, comprising about two-thirds of the total area, have a surface covering of glacial drift, and are undulating to rolling, consisting of low hills and shallow basins, the latter often without outlet. The distribution of surface irregularities is wholly without system. The natural drainage of this region is imperfect, but artificial drainage has reclaimed part of the wet areas.

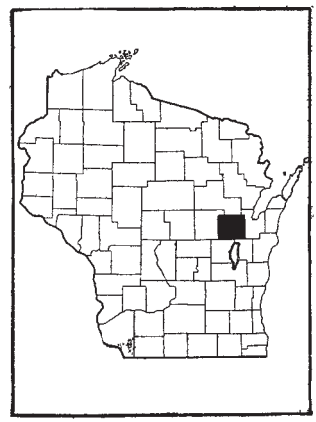

FIG. 1.—Sketch map showing location of the Outagamie County area, Wisconsin.

Scattered through this region are many smooth areas of all sizes, some of them several square miles in extent. Toward the southeastern part of the county such areas increase in size, and one broad belt extends across the corner of the county north of and almost parallel to Fox River. These areas occupy depressions filled with lacustrine or outwash deposits.

In the northwestern part of the county, between the Embarrass, Wolf, and Shioc Rivers, is a broad belt made up of the alluvial deposits of these streams. The topography for the most part ranges from almost level to gently undulating. Large areas of poorly drained land, consisting mainly of peat marshes, occur within this level belt.

The northern and western portions of Outagamie County are drained through Wolf River and its tributaries into Lake Michigan. The Embarrass River, in the western part of the county, flows into Wolf River at New London. The Shioc River, to the east of Wolf River, joins the latter just north of the village of Shiocton. The northeastern part of the county is drained by Duck Creek, which flows eastward into Green Bay. The Fox River, flowing from Lake

Winnebago to Green Bay, cuts across the southeastern part of the county in a northeasterly direction.

Branches from these main streams ramify into all parts of the county. There are some large areas where the surface is nearly level and where the natural drainage is deficient, and in the northwestern part of the county several large marshes occur, but over practically all of these areas artificial drainage is possible.

The Wolf, Embarrass, and Shioc Rivers are meandering, sluggish streams, and much of the low, flat land bordering their channels is subject to overflow in the spring. A proposed canal running from Wolf River near the northern boundary of the county in an easterly direction, emptying into Duck Creek at the eastern extremity of the county, would carry the high waters of the Wolf River in a direct line to Green Bay by a route which assures sufficient fall and where high banks prevent the overflowing of adjoining land. The practicability of this project, however, is still open to question.

The streams in the eastern and southern parts of the county have considerable fall. Fox River in a distance of 35 miles has a drop of 170 feet. It flows in a gorge between two clay banks, with a floor of heavy bedded limestone. The stream can be dammed with material taken from its own bed and without overflowing the adjacent lands. The excellent water-power facilities have been developed, and this region is famous as a paper and pulp producing center. Water powers in this stream are made especially valuable by the great natural reservoir afforded by Lake Winnebago. This lake has an area of over 300 square miles, and neither floods nor droughts cause any serious fluctuation in the flow of Fox River.

The first settlements in Outagamie County were made along Fox River. The first white settler located here about 1790, near the present site of Kaukauna. Other Indian traders soon came, and small areas were cleared and devoted to corn, potatoes, and small grains. In 1843 a missionary to the Indians brought in a large colony of Dutch immigrants, who established themselves at Little Chute. In the same year the first houses were built at Appleton, the present county seat. The county was established in 1851.

Up to 1840 the main occupation was fur trading, but after that date the cutting of white pine and hardwood forests was carried on rapidly, and the development of agriculture and manufacturing industries followed closely. The Fox River was the chief avenue of commerce before the building of the railroads, which began about 1860.

The population is quite evenly distributed over the county. The township of Maine is most thinly settled, and the section directly bordering the Fox River is the most thickly settled. The census of 1910 reports the population of the county as 49,102, of which 45.4 per cent is classed as urban and 54.6 per cent as rural, the latter comprising all towns with less than 2,500 inhabitants.

Appleton, the county seat, had a population in 1910 of 16,773. Kaukauna, the second largest place, had 4,717 inhabitants. New London, on the west county line, had 820 inhabitants in Outagamie County and 2,563 in Waupaca County. Little Chute had a population of 1,354. The population of Seymour was 1,109, of Hortonville 863, of Shiocton 536, of Blackcreek 516, and of Bear Creek 341. By far the greater part of the population is American born. [1]

The Oneida Indian Reservation is situated on Duck Creek in the northeast corner of Outagamie County and the northwestern part of Brown County. It comprises over 60,000 acres, a little more than half of this area lying in Outagamie County. The Indians, as a rule, have done little to improve the land, but a few have cleared farms and built fine houses. During the last few years most of the Indians have been given the clear title to their lands, with the privilege of selling or disposing of them, and white settlers and land companies are rapidly getting control of a large part of the area. As a result, much land which has heretofore lain idle is being cleared and improved. Settlement is densest in the southern part of the reservation along Duck Creek. The northern part is very thinly settled.

Outagamie County is well supplied with railroad facilities. Large centers of population, including Chicago, Milwaukee, Superior, Madison, St. Paul, and Minneapolis, are within easy reach.

The wagon roads throughout the county are generally in fair condition. Many of the main roads have been improved under a State law and are surfaced with gravel or crushed rock. A system of concrete roads is now under construction, to connect all of the principal towns in the county. Already more than 20 miles of concrete road are in use. Where the country is nearly level and the drainage somewhat deficient, the secondary roads are sometimes rather poor, especially in spring when the frost is leaving the ground and sometimes in the fall or during other wet seasons.

The towns within the county afford a market for much of the farm produce, but the greater part is shipped to outside points. Among the agricultural products those of the dairy probably are most important. Butter and cheese are shipped to all parts of the country. Live stock of all kinds is shipped from every town in the county.

CLIMATE.

The climate of Outagamie County is typical of that of east-central Wisconsin. It is healthful, though subject to extreme changes in temperature. The winters are long and severe. The thermometer frequently falls as low as $-20°$ F, and the lowest temperature on record is $-37°$ F. The ground freezes to a depth of 1 to 3 feet.

[1] Since this report was written the preliminary announcement of the population of Outagamie County and its civil divisions in 1920 has been issued by the Bureau of the Census, as follows: Outagamie County 55,113; urban 26,611; rural 28,502: Appleton 19,651; Bear Creek 337; Blackcreek 516; Hortonville 960; Kaukauna 5,951; Kimberly 1,382; Little Chute 2,017; Seymour 1,280; Shiocton 501; New London, total 4,667, part in Outagamie County, 1,099.

Snow usually remains on the ground from December to March or later and protects such winter crops as clover, alfalfa, and wheat. The summers are comparatively short, but pleasant. The thermometer sometimes reaches 100° F. or more. The highest temperature recorded at New London is 104° F., but such extremes are rare. The hottest periods during the summer months seldom continue for more than a few days, and it is unusual for the temperature to remain below zero for more than a week at a time during the winter.

The average rainfall of 32.68 inches is distributed throughout the year, although the precipitation is heaviest during the growing season and lightest in the winter. The average for the summer months of June, July, and August is 11.63 inches.

The average date of the last killing frost in the spring, as recorded at New London, is May 10, and that of the first in the fall, September 25. This gives an average growing season of 138 days. The length, however, varies somewhat in different parts of the county, and in the southeastern part of the county, in the region of the Fox River, the season may be 5 to 10 days longer. Killing frost has been recorded at New London as late in the spring as June 12 and as early in the fall as August 30.

In the following table are given the more important climatic data as recorded by the Weather Bureau station at New London:

Normal monthly, seasonal, and annual temperature and precipitation at New London.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1916).
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	20.5	53	−25	1.39	0.82	0.73
January	15.4	52	−31	1.10	1.16	2.89
February	16.1	50	−37	1.28	.84	1.23
Winter	17.3	53	−37	3.77	2.82	4.85
March	29.6	82	−18	2.04	.12	1.79
April	44.5	87	8	2.69	5.89	2.27
May	56.1	91	20	1.41	1.63	5.35
Spring	43.4	91	−18	9.14	7.64	9.41
June	65.8	104	32	3.94	1.16	6.81
July	70.4	102	41	4.35	.78	1.70
August	67.9	97	33	3.34	2.78	3.78
Summer	68.0	104	32	11.63	4.72	12.29
September	60.5	97	19	3.67	4.83	6.40
October	48.8	85	14	2.50	1.30	4.75
November	33.6	71	−14	1.97	2.34	2.70
Fall	47.6	97	−14	8.14	8.47	13.85
Year	44.1	104	−37	32.68	23.65	40.40

AGRICULTURE.

The first farms opened after the advance of the lumbermen were small, and large areas remained in the cut-over stage for a long time. The timber was first removed from the region adjoining the Fox River, and agricultural development began here. The early settlers grew wheat, corn, potatoes, hay, and various root crops, for home use or local consumption. The farming methods were crude, and no attempt was made to follow any definite system of rotation or cultivation. The Fox Valley soils are heavy, and cultural operations were not thorough.

While nearly all of the merchantable timber has been removed, and the greater part of the county placed under cultivation, in some sections large areas still remain undeveloped. The northeastern part of the county, which was originally included in the Oneida Indian Reservation, is least developed. In the northwestern part of the county, in Maine, Deer Creek, Bovina, and Maple Creek Townships, there are also considerable unimproved areas, owing to a large extent of poorly drained sandy soils. The greater part of the county is highly improved agriculturally.

Practically all the general farm crops now grown were produced when the county was first settled, but the relative importance of a number of them has changed. In 1879 wheat was grown on 40,906 acres, which was more than twice the acreage devoted to oats or corn. In 1889 there were only 22,000 acres in wheat, but the area in oats had increased to over 31,000 acres. In 1909 wheat occupied only 549 acres, while the area in corn was 28,000 acres and that in oats 53,000 acres. In 1879 there were only about 3,000 acres in barley, while in 1909 there were over 17,000 acres. The following table shows the acreage of the leading crops at each of the last four census periods:

Acreage of leading crops in Outagamie County in 1879, 1889, 1899, and 1909.

Crop.	1879	1889	1899	1909
	Acres.	*Acres.*	*Acres.*	*Acres.*
Wheat	40,906	22,009	15,113	549
Corn	17,559	11,908	20,344	28,038
Oats	15,209	31,478	54,680	53,004
Barley	2,964	3,907	10,229	17,403
Rye	1,269	4,191	2,961	2,744

The agriculture of Outagamie County at present consists chiefly of general or mixed farming, with dairying as the most important branch. The leading crops, named according to acreage, are oats, hay, corn, barley, potatoes, and rye, with buckwheat, peas, beans, and wheat as crops of lesser importance. During the last few years

the acreage of wheat has increased, the assessors' returns for 1917 indicating a total of 2,350 acres.

Practically all of the crops are grown to some extent as sources of income, hay, corn, oats, rye, and barley being sold to some extent directly from the farms. Potatoes are grown mainly for sale, although they are one of the most important subsistence crops. By far the greater proportion of the hay, corn, and oats produced is used in feeding live stock, and reaches the market in the form of dairy products, beef, and pork.

Oats are grown throughout the county, and on nearly all of the soils, but better yields are obtained on the fine sandy loams, loams, and clay loams than on the soils of lighter texture.

In 1909 there were 48,502 acres devoted to the production of hay. This consists mainly of timothy and clover, grown either together or separately, and alfalfa. A small proportion of the hay crop consists of oats, or oats and peas, cut green. The area occupied by hay crops in 1917, as reported by the assessors, was nearly 55,000 acres, which is somewhat larger than the total acreage in oats.

In 1917 corn is reported grown on a total of 39,000 acres. While corn will usually mature in this section, a large proportion of the crop is used as ensilage, nearly every farm having a silo. The soils best adapted to corn are the fine sandy loams that have a rather heavy subsoil; the sandy surface soil warms up quite early and the seed germinates quickly and the plants and the heavy subsoils hold a good supply of moisture. On the heavier soils, where the drainage is rather deficient and the ground rather cold in the spring, the crop makes a much better start.

Barley and rye are crops of considerable importance. In 1909 there were 17,400 acres in barley, but in 1917 only 12,000 acres are reported. Rye is confined largely to the sandy sections of the county, since the lighter soils will produce rye better than any other grain crop. In 1917, 4,100 acres are reported in rye.

Potatoes are an important crop, but potato growing is not nearly so well developed as in Waupaca or Portage Counties, to the west. This is chiefly due to the fact that the soils are predominantly heavy, and not so well suited to the commercial growing of potatoes as the lighter soils in the other two counties mentioned. The area reported in potatoes in 1909 was 4,276 acres, and in 1917, 3,700 acres. Potato growing on a commercial scale is largely confined to the northwestern part of the county, where sandy soils predominate. The crop is also grown to a considerable extent on such soils as the Kewaunee fine sandy loam, which is very well suited to the crop.

A few special crops are grown to some extent. The most important is cabbage, which is planted most extensively in the vicinity of Shiocton, chiefly on the alluvial soils. A total of 2,550

acres is reported in cabbage in 1917, the yield averaging 9.8 tons per acre, the total production amounting to nearly 25,000 tons. Onions are grown to some extent, but not on so large a scale as in some previous years. In 1909 the census reported 403 acres in this crop. Sugar beets are grown to a small extent, and the crop could profitably be given more attention. Some trucking is carried on in the vicinity of nearly all the towns, especially near Appleton and Kaukauna, although the soils here are not especially suited to this industry. The truck crops consist of cabbage, lettuce, radishes, onions, strawberries, and other vegetables and small fruits.

Fruit growing receives comparatively little attention in Outagamie County, as this region is not especially well adapted to orcharding. The 1910 census reports a total of 6,623 maple trees in the county used for the production of maple sirup and sugar.

The raising of live stock is an important industry in this county. Dairying is the most important branch of the live-stock industry, but some beef cattle and a large number of hogs are raised. In 1909 there were 55,967 head of cattle, 11,795 horses, 46,576 hogs, and 9,774 sheep on farms in this county, and the value of animals sold or slaughtered in that year amounted to $1,023,153.

The census of 1910 reported slightly over 40,000 dairy cows and heifers in this county. In 1909 approximately 9,492,384 gallons of milk was produced. The dairy products find their way to market chiefly in the form of cheese, butter, and condensed milk, but considerable quantities of whole milk are delivered in the towns and cities of the county, and some whole milk is shipped to Green Bay. A condensery in New London, just over the line in Waupaca County, receives a large amount of milk from Outagamie County. In 1917 there were 21 butter factories and 86 cheese factories in the county. The number of cheese factories seems to be increasing gradually, while the number of butter factories has decreased slightly in recent years. In 1917, 9,535,888 pounds of cheese with a value of $2,081,424 was produced in the county. The dairy cows are mostly of the Holstein breed, and there are a number of purebreds throughout the county, although grade animals still predominate.

Differences in the character of the soils in various parts of the county have some influence upon the distribution of the crops. Oats are grown more extensively on the heavier soils, while potatoes and rye are grown with most profit on the soils of a more sandy nature. Clover and timothy make their best growth on the heavy soils, and the dairy industry is most successful and most highly developed in the regions where the soils are fine sandy loams or heavier.

The general methods of farming are practically the same as those throughout the general farming and dairying sections of Wisconsin.

Modern machinery is found on all the farms, and where the acreage justifies it the tractor is used. As a rule the farm buildings are substantial and kept in good repair, but on the light sandy types the buildings reflect the lower producing power of the soils.

While practically every farmer changes crops more or less often, there are but few who have worked out a definite crop rotation. The rotation perhaps most commonly followed consists of a small grain, followed by hay for one or two years, and corn. It is not at all uncommon for a field to be in corn or a small grain for two or more years, and fields are often permitted to remain in grass for hay or pasturage for several years. On the extremely sandy types where the soil is rather loose and tends to drift somewhat, it is desirable to arrange a system of cropping that will allow the ground to be covered as much of the time as possible. The best methods to follow have not been worked out by the farmers on such soil.

Stable manure is the only fertilizer used to any great extent. While this is a dairying region, the supply of stable manure is not sufficient to keep up the productiveness of the farms, and it is becoming evident that it is both necessary and profitable to supplement the manure with commercial fertilizers. Commercial fertilizers are used on a few farms at present, chiefly in growing special crops. Acid phosphate has been found especially helpful. From 200 to 300 pounds is the usual acreage application on small grains or corn. Where the supply of nitrogen in the soil is low and where it is desired to give the crops a quick start, such as corn should have in this region, a small amount of nitrogen can be used in connection with the phosphate fertilizer. A mixture analyzing 2–10–0 [2] is well suited for this purpose. However, the nitrogen and organic matter which many of the soils in this region need can be most economically supplied through the use of stable manure supplemented by green-manuring crops, of which the legumes are best. On all of the heavy soils little difference in yields results from the use of potash on the general farm crops, but in the lighter soils, and especially where trucking is carried on, a mixed fertilizer containing from 1 to 3 per cent or more of potash can be used to advantage.

The supply of farm labor in this region is fairly adequate. In many cases women and children assist with the farm work. Farm hands hired for the year or by the month are paid (1918) $35 to $75 a month. Married men are usually given a house in which to live, as well as fuel and a garden. During haying and harvest periods, when extra labor is often needed, the wages range from $2 to $4 a day.

There were 3,650 farms in Outagamie County in 1910, comprising 81.3 per cent of the total land area. Approximately 66 per cent of

[2] Respective percentages of nitrogen, phosphoric acid, and potash.

the land in farms is classed as improved. The average size of the farms is 92 acres, of which on the average 61 acres is improved. Practically 91 per cent of the farms are operated by owners.

In 1900 the average assessed value of land in Outagamie County was $32.73 per acre, and in 1910, $55.47. Where general farming is most highly developed, well-located and highly improved farms sell at the present time (1918) for $100 to $200 an acre. The extremely sandy soils which have a rather low producing power sell for $20 to $50 an acre. Between these extremes all sorts of valuations are to be found. The unimproved lands which have a fair to good agricultural value range in price from $20 to $40 an acre. The marsh lands which are unimproved have a very low selling price.

SOILS.[3]

Outagamie County, in common with the greater part of eastern and northern Wisconsin, owes the general character of its surface soils to several distinct methods of accumulation. They are of glacial, alluvial, and lacustrine origin. In addition, the accumulation of organic matter in low places has resulted in the formation of large areas of Peat soils. In a geological classification which takes into consideration the underlying rocks the county naturally falls into several divisions.[4]

Extending across the eastern end of the county and covering about one-fourth of its surface are the Trenton and Galena limestones. Next in a narrow strip extending northeast and southwest, is the St. Peters sandstone. Then comes an irregular belt, covering about three townships, of lower Magnesian limestone. The remainder of the county to the northwest is underlain by Potsdam sandstone.

In the erosion of the Wolf River Valley, in the town[5] of Hortonia, the sandstone below was readily removed and the more resistant ledges of dolomite left projecting in vertical cliffs of moderate height.

All the various formations have contributed to a greater or less extent to the soils, and, in addition, a region of crystalline rocks to the north has contributed to those of glacial origin. In the northwestern quarter of the county there are a number of large streams along which there are extensive areas of bottom land, occupied by soils of the Merrimac and Whitman series and Peat. Much of the

[3] Outagamie County adjoins Waupaca County on the west. In certain cases the maps of these areas do not appear to agree on the boundaries. The types of the Dunning series in Waupaca County are mapped with the Whitman series in Outagamie, and those of the Merrimac are mapped as Plainfield. This is due to a gradual transition between these series and to the very small area of the Dunning and Merrimac types found in Outagamie County. For the same reason a small area of the Gloucester type in Waupaca County has been mapped in this area as Coloma.

[4] The geological discussion in this report is based upon The Geology of Wisconsin, by the Wisconsin Geological and Natural History Survey.

[5] The word "town" as used in Wisconsin is equivalent to township.

sediment has come from granitic rocks to the north, having been carried to its present position by the action of the streams.

In the upland portion of much of this region, especially in the towns of Maine, Deer Creek, and in a portion of Bovina, the soil is very sandy, having been derived largely from the Potsdam sandstone.

In the southeastern part of the county there is a considerable area of level land within the immediate Fox River Valley where the soil consists of red clay. This is largely of lacustrine origin, having been deposited in the quiet waters of Lake Michigan when that body of water stood at a higher level than at the present time.

Between the Fox River Valley and the northwestern quarter of the county previously referred to, there is a very extensive belt, reaching across the county from northeast to southwest, which differs somewhat from the other two regions. It is for the most part rolling and has a subsoil which consists largely of red clay. It embraces the greater part of the county, and includes the best agricultural regions. The soil is partly glacial and partly lacustrine. The red clay was deposited in quiet waters, but since deposition it has been modified to a greater or less extent by glacial action.

The soils of Outagamie County are classified into 10 series, which include 24 types, exclusive of Peat.

The Kewaunee series is made up of brown and light-brown soils having heavy, red clay subsoils. The subsoil consists largely of lacustrine material, modified to a greater or less degree by glacial action. The surface is sufficiently rolling to cause fairly good or even adequate drainage. In this county the Kewaunee fine sandy loam, loam, silt loam, and clay loam are mapped.

The soils of the Superior series are very similar to those of the Kewaunee, consisting of the same material, but they occupy level to very gently undulating areas, and the surface drainage is somewhat deficient. The types mapped in the Superior series in Outagamie County are the fine sandy loam, loam, silt loam, and clay loam.

The Poygan series consists of dark-colored, low-lying, poorly drained material. The surface soil is very high in organic matter, while the subsoil consists of the red clay characteristic of the Superior series. The types mapped in this county are the Poygan fine sandy loam, silt loam, and clay loam.

The Coloma series includes the light-colored upland soils derived through glacial action largely from the Potsdam sandstone. The types mapped are the very fine sand and fine sandy loam.

The Merrimac series consists of light-colored soils which occur as outwash plains or stream terraces, and which have been derived, largely through the action of water, from glaciated crystalline-rock material. The types mapped in this series are the very fine sandy loam and loam.

The Plainfield soils are similar to the Merrimac, except that they have been derived largely from sandstone material and deposited in the form of outwash plains or stream terraces. The only type mapped in this county is the very fine sand.

The Miami series consists of light-colored upland soils which were originally forested and which consist of glacial material derived in part from limestone. The types mapped in this county are the Miami fine sandy loam and loam.

The Whitman series consists of low-lying, dark-colored soils which occur within stream valleys, or occupy outwash plains or depressions in the upland where the material has come largely from glaciated granitic areas and where the soils are in an acid condition. The types mapped are the Whitman fine sandy loam and loam.

The Clyde series consists of low-lying, dark-colored soils occupying stream valleys, old lake beds, or ponded valleys where the material has come largely from limestone. The soils are very similar to the Whitman, except that they contain a considerable amount of lime carbonate and are very seldom in an acid condition. The members of this series mapped are the Clyde fine sandy loam, till phase, and silt loam, till phase.

The Genesee series consists of brown or light-brown soils which occur as first-bottom land in glaciated sections. In this county they are of very small extent. Two types, the very fine sandy loam and silt loam, are mapped.

In subsequent pages of this report the various soils mapped in Outagamie County are discussed in detail. The distribution of the various soils is shown on the accompanying map, and the actual and relative extent of each is shown in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Kewaunee loam	62,656	15.2	Whitman fine sandy loam	9,792	2.4
Peat	51,264	14.5	Superior fine sandy loam	7,808	1.9
Shallow phase	8,704		Whitman loam	5,888	1.4
Kewaunee fine sandy loam	49,984	12.1	Miami fine sandy loam	5,184	1.3
Superior clay loam	28,032	6.8	Poygan clay loam	4,352	1.0
Kewaunee silt loam	26,368	6.4	Plainfield very fine sand	2,560	.6
Superior loam	23,488	5.7	Genesee very fine sandy loam	2,176	.5
Kewaunee clay loam	22,592	5.5	Clyde silt loam, till phase	1,728	.4
Superior silt loam	22,528	5.4	Coloma fine sandy loam	1,152	.3
Poygan silt loam	17,216	4.2	Poygan fine sandy loam	960	.2
Merrimac very fine sandy loam	16,512	4.0	Clyde fine sandy loam, till phase	832	.2
Coloma very fine sand	15,488	3.7	Miami loam	576	.1
Merrimac loam	12,928	3.1			
Genesee silt loam	12,672	3.1	Total	413,440	

KEWAUNEE FINE SANDY LOAM.

The Kewaunee fine sandy loam, to an average depth of 8 inches, is a brown to rather dark brown, mellow fine sandy loam. Immediately below this depth the material becomes somewhat lighter, frequently being pale yellow. The texture often becomes a little finer, but in some places a small amount of fine gravel occurs with the material. At about 18 inches a heavy, compact, red clay is encountered. This continues to a depth which is undetermined, but which is always much more than 3 feet. The chief variation in this soil is in the depth of the sandy material over the red clay, which may range from 8 to about 24 inches. There is also some variation in the texture of the surface material, there being a few places in which this could be classed as a sandy loam, and others where it approaches a loam in texture. Such variations, however, are too small in extent to be indicated on the map.

Stones are not common in this soil, but a few bowlders were found. Areas in which they occur in sufficient numbers to interfere to any extent with farming operations are indicated by symbol on the map. Fragments of partly decomposed limestone occur in some areas, chiefly at depths of 2 or 3 feet.

This is the most widely distributed soil in the county, areas being found in every town. It is most extensive in the southwestern one-fourth, and it predominates in the town of Dale, in the western part of Hortonia Town, and in Maple Creek Town. It is also quite extensive in the towns of Cicero and Ellington.

The surface ranges from undulating to rolling, and the natural drainage is adequate. This lighter textured soil is much better drained than the silt loam and clay loam of the series.

The heavy, red clay subsoil of this type is of lacustrine origin, but it has been influenced to some extent by glacial action. The sandy material has probably been brought to its present position largely through the action of glacial ice and could not be classed with the lacustrine material. The sandy material is sometimes found to be slightly acid, but the heavy clay subsoil normally contains more or less lime carbonate.

The original forest on this soil consisted of maple, hemlock, and birch, with some beech, pine, and basswood. While there are still a few woodlots left, by far the greater part of the type is now in highly improved farms. It is the predominating type in some of the most highly improved and prosperous farming communities in the county. All the common crops are successfully produced. Potatoes are grown more extensively than on the heavier soils of the region. Alfalfa does well and is grown on a larger acreage every year. The type is adapted to a larger number of crops than the heavier soils and can be worked under a wider range of moisture

conditions. Its sandy surface texture permits it to drain out and warm up early in the season, and crops frequently have the advantage of a week or ten days, and sometimes even a longer period, over those grown on the heavy soils, especially those of level surface.

The Kewaunee fine sandy loam is somewhat deficient in organic matter, and the stable manure applied to the soil should be supplemented by turning under green-manuring crops; of these the legumes are best. The type also responds readily to the use of phosphate fertilizers.

KEWAUNEE LOAM.

The surface soil of the Kewaunee loam consists of about 10 inches of brown, mellow loam, moderately high in organic matter. The subsoil, which extends to an undetermined depth, consists of the heavy, compact red clay so widely distributed in this region. The type is practically stone free, and except on a few scattered knolls, gravel is seldom found either on the surface or in the soil mass.

The Kewaunee loam is one of the most important and most extensive types of soil in Outagamie County. It is confined chiefly to the eastern half of the county and is the predominating type in the towns of Seymour, Osborn, Freedom, and Center. Small areas are found in every town in the county with the exception of Maine and Deer Creek.

The surface ranges from undulating to gently rolling, and surface drainage is for the most part good. Bordering the Superior soils, and also in a few depressions and in some places along streams, the drainage is sometimes slightly deficient, and tile could be installed to advantage.

This soil has been derived chiefly from lacustrine material which has been modified to a small extent by glacial action. It has the same origin as the soils of the Superior series, and differs from them only in topography.

The original forest growth consisted of maple, birch, and hemlock, with some hickory, oak, basswood, beech, and pine. Practically all this has been removed.

The Kewaunee loam is one of the most highly improved soils of Outagamie County, many of the finest farms being located upon it. Almost every acre is tillable. All the common farm crops are successfully grown. Yields are somewhat higher than on the clay loam soils, owing partly to the fact that the soil can be worked under a somewhat wider range of moisture conditions, and partly because it can be placed in better tilth earlier in the spring. General farming and dairying are the leading types of agriculture.

The rotation most commonly practiced consists of a small grain, clover or clover and timothy, and corn. No commercial fertilizer

is used on this soil, but considerable manure is applied and a green-manuring crop is occasionally plowed under. This helps to increase the supply of organic matter in the soil, and supplies a considerable amount of nitrogen. Tests indicate that this soil responds profitably to the use of phosphate fertilizers. The surface soil of the type is seldom acid, and considerable lime carbonate is generally present in the subsoil.

KEWAUNEE SILT LOAM.

The Kewaunee silt loam, to a depth of about 8 inches, consists of a brown to dark-brown, rather compact silt loam containing a moderate amount of organic matter. It is practically free from gravel and stones. The subsoil consists of the heavy, red clay which is characteristic of the Kewaunee series.

This type covers an area of more than 26,000 acres. It is the predominating type in the town of Greenville, and is also quite extensive in the town of Grand Chute. There are numerous small areas in the southeastern part of the county.

The surface varies from undulating to gently rolling, and in some places could be classed as rolling. As a consequence, surface drainage is usually good, although the heavy, compact subsoil does not allow the water to flow freely through it. On some of the more gently sloping areas, and in depressions between hills, tile drains could be installed to advantage.

This soil has been derived largely from lacustrine deposits, which have been overriden and reworked to a varying extent from place to place by glacial ice. While the surface soil is sometimes slightly acid, the subsoil usually contains a considerable amount of lime carbonate.

The original forest growth consisted chiefly of maple, birch, basswood, and hickory, with some beech, elm, hemlock, and pine.

This is one of the more desirable soils of the county upon which agriculture is very highly developed. It is strong and productive, and well adapted to all the common crops. Small grains and grasses do especially well, and dairying is the leading branch of agriculture. A rotation followed on many farms consists of a small grain, clover, or clover and timothy, and corn.

This soil is not as difficult to cultivate as the clay loam, but nevertheless it requires heavy work stock and implements. The soil is somewhat low in organic matter, and the occasional plowing under of a green-manuring crop would not only increase the supply of organic matter, but also improve the structure of the soil. Field tests indicate that the use of phosphate fertilizers would be profitable on this type, though commercial fertilizers are seldom used at present.

KEWAUNEE CLAY LOAM.

The Kewaunee clay loam, to a depth of 3 to 4 inches, consists of a compact silt loam or silty clay loam, of a brown or slightly reddish brown color. This material grades abruptly into a heavy, compact, pinkish-red clay subsoil, which extends to great depths, road cuts and stream banks in places revealing it at 40 to 50 feet below the surface. The type is practically free from stones, and gravel is seldom encountered. A few small limestone fragments or concretions are sometimes found within the soil mass.

This type is most extensively developed in the southeastern part of the county, and is the predominating type in the towns of Vandenbroek and Buchanan. Small areas lie in the towns of Grand Chute, Greenville, Center, and Black Creek.

The surface varies from undulating to rolling and in a few places in Buchanan Town the type is quite broken. Surface drainage is naturally good, but the compact subsoil does not allow the free internal movement of moisture. The only difference between this soil and the Superior clay loam is in topography.

The Kewaunee clay loam is largely of lacustrine origin, but the material has been influenced by glacial action since its deposition to a much greater extent than that giving rise to any of the Superior soils. This accounts in large measure for the more uneven topography.

The original forest growth on the Kewaunee clay loam consisted largely of maple, birch, hickory, and basswood, with some beech, elm, and pine. Practically all the merchantable timber has been removed, and nearly all the type is now cultivated. It is an excellent soil, well adapted to general farming and dairying, and all of the farm crops common to the region are successfully grown. A rotation quite commonly practiced consists of a small grain one or two years, followed by clover or a mixture of clover and timothy for one or two years, and then by corn.

As the soil is very heavy and somewhat deficient in organic matter, it would be advisable to supplement the stable manure by plowing under a green-manuring crop, preferably a legume, about once in every four or five years. This would improve the structure of the soil and also increase its supply of nitrogen. The soil should respond to applications of commercial fertilizer containing phosphoric acid.

SUPERIOR FINE SANDY LOAM.

The soil of the Superior fine sandy loam, to a depth of 8 to 10 inches, consists of a loose, friable loam or fine sandy loam of a dark-brown color. It usually becomes somewhat lighter in color and coarser in texture with depth, and at 12 to 20 inches gives way to

the heavy red clay characteristic of this series. This heavy clay subsoil frequently contains thin seams of fine sand and very fine sand, and in places it may contain some limestone fragments. The depth at which the heavy subsoil is encountered is somewhat variable, ranging from 8 to 24 inches.

Areas of this soil occur in every town, excepting Cicero, Vandenbroek, and Buchanan, but the total extent is small, being only a little more than 12 square miles, or 1.9 per cent of the area of the county.

The surface is level, with few undulations. The natural drainage is somewhat deficient because of the heavy subsoil, but is somewhat better than that of the heavier members of the series. Tile drains, however, could be profitably installed over much of this type.

The original forest growth of maple, birch, elm, hemlock, and pine has been largely removed, and the greater part of the land is under cultivation. All the common crops are successfully grown. Because of its occurrence in small areas there are few, if any, farms located entirely upon this soil.

In many places, for best results with the Superior fine sandy loam, the drainage must be improved, but there are many areas where tile drains are not necessary. The productiveness of the soil could be increased by increasing its supply of organic matter.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Superior fine sandy loam:

Mechanical analyses of Superior fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
312941	Soil	0.8	5.0	6.4	42.5	17.2	21.2	6.8
312942	Subsoil	.0	2.8	2.8	11.6	7.8	51.6	23.4

SUPERIOR LOAM.

The Superior loam, to a depth of about 10 inches, consists of a dark-brown friable loam which contains a moderate amount of organic matter. The type is free from stones and contains little gravel. The subsoil below 10 inches grades abruptly into the heavy, compact, red clay which is characteristic of this series.

The Superior loam covers a total area of approximately one township. It is developed most extensively in the northern half of T. 23 N., R. 19 E., and in the towns of Seymour, Osborn, and Freedom.

Owing to the level surface, which is characteristic of this series, and the heavy subsoil, the natural drainage is somewhat deficient. There are associated with this type a large number of areas of the

Poygan soils, which occupy poorly drained depressions. Much of the Superior loam would be benefited by drainage, but up to the present time (1918) few tile drains have been laid.

The material forming this soil is largely of lacustrine origin, but it has been modified since its deposition by glacial action. There is considerable limestone material in the 3-foot section, and the surface is seldom acid, while the subsoil normally contains considerable quantities of lime carbonate.

The native forest consisted largely of maple, elm, and hickory, with some basswood and white pine, and in places a scattering of beech. Most of the type has been cleared and placed under cultivation and is now in highly improved farms. Almost the only exception is in the northern part of T. 23 N., R. 19 E., which is included in the Indian reservation. All the crops common to this region are grown upon this type. It is a good general farming soil and is especially adapted to small grains and grasses. The dairy industry has been developed to a place of considerable importance.

Owing to its rather poor drainage the type warms up somewhat slowly in the spring, and the planting of corn is often delayed. In the improvement of this soil artificial drainage is an important step. The laying of a system of tile drains would be a profitable investment on every one of the farms. In fact, all lines of improvement on this soil depend upon drainage for their success.

SUPERIOR SILT LOAM.

The Superior silt loam, to a depth of about 8 inches, consists of a dark-brown silt loam containing a considerable amount of organic matter. The surface soil is free from gravel and stones. The subsoil consists of a heavy, compact, pinkish-red clay which extends to a depth of more than 3 feet.

There are a few unimportant variations in this soil, the chief one being in the depth of the silty material over the heavy red clay subsoil. This may vary from 4 inches up to 10 or 12 inches. There is some variation in the content of organic matter, which is most abundant in slightly depressed areas.

The Superior silt loam occupies in the aggregate about 22,500 acres, irregular areas ranging in size from a few acres to 5 or 6 square miles, extending in more or less definite belts across the eastern part of the county in a northeastern and southwestern direction. The type occurs extensively in T. 24 N., R. 19 E., and in the towns of Osborn, Freedom, Grand Chute, and Center. There are only a few small areas in the western half of the county.

The surface is level or very gently undulating, and because of the heavy character of the subsoil the natural drainage is somewhat deficient. During the spring, when heavy rains often occur, the soil becomes saturated, and it warms up more slowly than types having

a more rolling surface. Over a considerable part of the Superior silt loam tile drains could be installed to advantage.

This soil has been derived largely from lacustrine material which was deposited in quiet waters at a time when the Great Lakes stood at a much higher level than at the present time. After the original deposition the material was modified to some extent by glacial action.

The original forest growth consisted chiefly of maple, birch, elm, beech, and pine. Practically all of the merchantable timber has been removed, and most of the type has been cleared and is now in highly improved farms. Almost the only exception is in the extreme northeastern corner of the county in T. 24 N., R. 19 E., where the land until very recently was part of the Indian reservation.

The chief crops grown on this soil are hay, small grains, corn, and root crops. The soil is naturally strong and productive, and when adequate drainage is provided very good yields are obtained. On practically all the farms on this type there is some land which is too wet for cultivated crops, and for the improvement of this land drainage is essential. When thoroughly drained this soil will rank with the best in the county. It is somewhat more difficult to cultivate than soils of lighter texture, but if plowed when moisture conditions are favorable a good seed bed can be worked up with little difficulty. The supply of organic matter is rather low, and should be increased by supplementing the supply of available manure with green-manuring crops, of which the legumes are best.

SUPERIOR CLAY LOAM.

The Superior clay loam, to an average depth of 6 inches, consists of a light grayish brown clay loam, grading quite abruptly into heavy, compact red clay, which extends to an undetermined depth. The light-colored material over the red clay varies from 1 to 8 inches in depth. In the heavy clay subsoil, especially in the lower depths, it is not uncommon to find thin seams of fine and very fine sand. The material within the 3-foot section may contain a small amount of very fine rock fragments, largely of limestone. The texture of both the soil and subsoil of this type is very uniform.

The Superior clay loam is found chiefly in the towns of Kaukauna, Freedom, Vandenbroek, and Grand Chute. Its surface is level or very gently undulating, and natural drainage is deficient. During the early spring, parts of the type are frequently covered with an inch or more of water. Because of the heavy, impervious nature of the subsoil the type remains wet and "cold" for some time during the early part of each growing season, and planting is frequently delayed. Practically all this soil would be improved by drainage, but up to the present time few tile drains have been laid.

In common with the other types of this series the clay loam is derived from material of lacustrine origin, which has been modified to

some extent by glacial action. The surface soil is very seldom acid, and the subsoil in most places contains lime carbonate in considerable quantities.

The original forest growth on this soil consisted chiefly of maple, elm, oak, and pine. By far the greater part of the type is under cultivation and highly improved. Practically all of the crops common to the region are successfully grown, but the soil is better adapted to small grains and grasses than to corn. Where drainage has been improved corn can be grown successfully, and all the other crops are much more certain of giving satisfactory yields; moreover, with improved drainage the soil warms up earlier in the spring, giving crops a better start.

POYGAN FINE SANDY LOAM.

The surface soil of the Poygan fine sandy loam, which extends to a depth of about 7 inches, is a dark-brown to black, friable, mellow fine sandy loam, relatively high in organic matter. The subsoil to 3 or 4 inches usually is a fine sand, grading below into a pinkish-red clay loam to clay.

Small areas of this type are scattered throughout the county, occupying depressions and gentle slopes bordering streams or marshes. It is associated with the Poygan silt loam or the Kewaunee fine sandy loam. The surface is low and flat to gently sloping, and natural drainage is poor.

The material composing the Poygan fine sandy loam is largely of lacustrine origin, but the type has been influenced to a slight extent by glacial action, by the overflowing of streams, and by the washing down of material from neighboring hillsides. The dark color is due to the presence of organic matter, the accumulation of which has been favored by the moist conditions.

A forest consisting mainly of ash, elm, and maple, with some oak, hickory, birch, willow, poplar, and alder, originally covered this soil. The best timber has been removed, but very little of the land has been brought under cultivation.

When well drained it gives fairly good yields. It is an easier soil to handle than the Poygan silt loam or clay loam, but yields, especially of grain and hay, are not as large as on the latter types.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Poygan fine sandy loam:

Mechanical analyses of Poygan fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
312945	Soil	0.0	1.2	1.5	67.3	10.4	14.3	5.3
312946	Subsoil	.3	2.3	7.3	16.7	16.0	43.5	13.8

POYGAN SILT LOAM.

The Poygan silt loam, to a depth of 8 to 10 inches, is a dark-brown to black, sticky, compact silt loam, rich in organic matter. The subsoil becomes lighter in color for a few inches before grading into heavy, tenacious red clay at 12 to 15 inches. In places the red color of the subsoil may entirely disappear, but the texture and other characteristics remain the same. Areas in which the subsoil consists of blue clay are too small to be mapped separately.

Small areas of Poygan silt loam occur scattered throughout practically every township in the county. It is closely associated with the soils of the Superior and Kewaunee series, and occupies depressions and flat areas bordering streams and marshes.

The surface is flat or gently sloping. The type is low lying, and the subsoil is quite impervious, so that the natural drainage is very poor.

This type is largely of lacustrine origin. The dark color of the surface soil is due to a relatively large content of organic matter.

The original forest growth consisted principally of black ash, elm, and maple, with some oak, hickory, poplar, birch, and alder. In most places the valuable timber has been removed.

Very little of this type is under cultivation. The greater part of it is in need of artificial drainage, and in its present condition is valuable chiefly as pasture land. Where the type has been properly drained it has a high agricultural value. It is not well adapted to potatoes, but other crops, among them small grains, grasses, cabbage, and sugar beets do well.

When wet the surface soil of this type is plastic and somewhat sticky, and although the high content of organic matter considerably improves the structure, great care should be exercised in choosing the time for plowing, as the physical condition of the soil is easily impaired if it is worked when too wet.

POYGAN CLAY LOAM.

The Poygan clay loam, to a depth of 8 to 15 inches, is a dark-brown to black, sticky, compact clay loam, rich in organic matter. The subsoil consists of an upper layer, a few inches thick, lighter in color than the soil, and a lower layer of pinkish-red clay into which the former grades at depths of 15 to 20 inches. This clay, which is very compact and tenacious, extends to an undetermined depth.

The Poygan clay loam is an inextensive soil. Small areas are mapped near the center and in the southeastern parts of the county, the largest occurring north of Stephensville in Ellington Town. The type is closely associated with the Superior clay loam and silt loam, and occupies depressions and low, gently sloping areas bordering streams. The subsoil is impervious, and natural drainage is very poor.

This type is largely of lacustrine origin. The dark color is due to a large accumulation of organic matter, the growth of vegetation having been favored and the decay of plant remains controlled by the moist conditions which prevailed over the type.

The original forest growth consisted mainly of black ash, elm, and maple, with some oak, hickory, poplar, and alder. Most of the valuable timber has been cut.

Less than half of this type is under cultivation, the greater part of it being badly in need of drainage, and in its present condition valuable only as pasture and for the cutting of marsh hay. Where the type has been properly drained it has a high agricultural value. It is especially adapted to hay and small grains, and corn and other crops common to the region do well. The soil is too heavy for potatoes, but cabbage and sugar beets are grown with fair success. The tilth of the soil is easily impaired if it is worked while wet.

COLOMA VERY FINE SAND.

The surface soil of the Coloma very fine sand extends to a depth of about 6 inches, and is a brown to light-brown, loose, incoherent very fine sand, free from stones and gravel. The subsoil is a yellowish-brown very fine sand which becomes lighter in color with depth. The organic content varies from place to place, being greatest in depressions, where the moisture conditions have favored an accumulation of humus-forming material. In most places, however, the soil is very deficient in organic matter.

This type is of small extent. It is confined chiefly to the northern part of the county, the largest areas occurring in Maine Town. It ranges in topography from gently rolling to hilly, and, owing to this and to the loose, open structure of the soil and subsoil, drainage tends to be excessive, and crops are likely to suffer from drought except in seasons of heavy rainfall.

The Coloma very fine sand consists of glacial debris, most of which occurs in the form of lateral or recessional moraines. The parent rock from which most of the material has been derived is the Potsdam sandstone, over which the ice sheet passed, grinding off rock fragments and transporting the material for some distance. On account of its very fine texture and its incoherence the surface soil has in many places been modified by wind action.

The original forest growth on this soil consisted mainly of oak and white pine, with some hickory, maple, and other hardwoods. Nearly all the valuable timber has been removed,

Over half the type is under cultivation to general farm crops. Corn gives an average yield of 20 bushels per acre, oats 15 to 20 bushels, rye about 12 bushels, timothy and clover three-fourths to 1 ton, and potatoes 50 to 100 bushels. With careful cultivation,

systematic rotation of crops, and the use of fertilizer these yields have been more than doubled by some farmers.

Over most of this type little attention is given to following a rotation particularly adapted to the soil. The methods of cultivation are similar to those followed on other sandy types of the county, and on the whole are not such as tend to increase the productiveness. In order that larger yields may be obtained it will be necessary to increase the supply of organic matter. This may be done by applying stable manure or Peat, by growing legumes, or by green manuring. It would be profitable to go to considerable expense in getting a good stand of clover, as this will greatly assist in keeping up and improving the producing power of the soil. To get clover started the use of lime and of commercial fertilizers containing both potash and phosphoric acid may be necessary. If wood ashes are avialable they may be substituted for the other potash carriers, and the lime in the ashes will help to correct the acidity which is common in this soil. Soy beans and yellow lupines are also good soil improvers. A rotation consisting of clover, rye, and potatoes, the second crop of clover being plowed under, usually gives good results on sandy soils. The growing of clover and the plowing under of green crops also have a beneficial effect on the physical condition of the soil, tending to increase its power to hold water and aiding in the control of drifting. Potatoes, strawberries, cucumbers, melons, tomatoes, raspberries, and similar crops could be profitably grown on this soil to a much greater extent than at present.

Two variations occur in the areas mapped with the Coloma very fine sand. Both are coarser than typical, averaging a fine sand. One variation is mainly confined to the northern part of the county, but the principal areas occur in the vicinity of Hortonville and Stephensville in the southwestern part. Other small areas are scattered throughout the county, usually occupying small hilltops or ridges. The surface soil to a depth of 8 to 12 inches is a grayish-brown, loose, open fine sand, containing little organic matter. The subsoil is a loose fine sand continuing to over 3 feet, and grading from light brown to yellowish brown or pale yellow in the lower depths. Gravel beds covered by a thin mantle of surface soil are often found. As in the typical soil, the organic content varies, being higher in the depressions, where moisture conditions have favored an accumulation of humus-forming material. Dunes formed by wind-blown sand are occasionally found. The topography ranges from undulating to hilly. On account of the loose, open structure the natural drainage is somewhat excessive, and crops are likely to suffer from drought except during seasons of excessive rainfall. About 75 per cent of this variation is under cultivation.

The other variation is of small extent, and is found chiefly in the town of Liberty, in sections 13 and 14, with a number of small patches in other parts of the county. The surface soil to a depth of about 8 inches consists of a loose, grayish-brown fine sand, entirely free from stones and gravel. It is low in organic matter. Below 8 inches the material becomes a light-brown or yellowish-brown fine sand which extends to a depth of 24 to 36 inches before the red clay is encountered, the average depth being near the linear limit. The surface is undulating to gently rolling. Drainage is good, and in some places rather excessive. The heavy, red clay of the subsoil is of lacustrine origin, but has been modified somewhat by glacial action. The surface sandy material is glacial, having been derived in part from crystalline rocks and in part from sandstone material. The original forest on this soil was chiefly pine and hemlock, with some hardwoods. The greater part of the land has been cleared and placed under cultivation, but yields are somewhat low owing to the light sandy texture. All the crops common to the region are grown with more or less success. Because of its small extent and its occurrence in small patches, few if any farms are located entirely upon this variation of the Coloma very fine sand, and no system of management has been worked out for its particular needs.

COLOMA FINE SANDY LOAM.

The soil of the Coloma fine sandy loam, to an average depth of 8 to 10 inches, is a light-brown to grayish-brown fine sandy loam, resting upon a subsoil of about the same texture, but having a somewhat lighter color. At lower depths the material is usually a fine, yellow sand, often containing varying amounts of fine gravel. The soil is uniform in texture in the different areas and is stone free.

This type is one of minor importance. It occurs in small, scattered areas, the most important of which are found in Grand Chute and Maine Towns. The surface is undulating to gently rolling and this in connection with the sandy nature of the material results in thorough and in many places excessive drainage.

The material forming this soil is of glacial origin, chiefly, it is thought, from sandstone rocks, but material from crystalline rocks has been incorporated with it. In most cases the soil is acid.

Practically all the original forest growth of mixed pine and hardwoods, the latter predominating, has been removed. The soil is of only medium agricultural value. It is deficient in organic matter, but by growing green-manuring crops, following good crop rotations, and using proper fertilizers, the type can be built up to a fairly high state of productiveness. A good rotation consists of a small grain, clover, and potatoes, the second crop of clover to be plowed

under. Liming will help in getting clover started, and commercial fertilizers can also be used with profit. A 2–10–0 fertilizer applied at the rate of about 200 pounds per acre, should give good results.

MERRIMAC VERY FINE SANDY LOAM.

The Merrimac very fine sandy loam, to a depth of 6 to 8 inches, is a brown to dark-brown, loose, friable very fine sandy loam, free from stones and gravel and carrying a moderate amount of organic matter. The subsoil grades very rapidly into a yellowish-brown to pale-yellow very fine sand, of undetermined depth.

This type is closely associated with the Merrimac loam, but is somewhat more extensive. It is confined to the northwestern part of the county, where it is found on the broad, flat plains bordering Embarrass, Wolf, and Shioc Rivers. A large area occurs in Deer Creek Town, northeast of Bear Creek, and another in Bovina Town, north of Shiocton. The former area is a little lighter in texture than typical.

The topography of the Merrimac very fine sandy loam is flat to very gently undulating. The surface is only a few feet above the mean high-water mark of the neighboring streams, and after unusually heavy rains some of the type is subject to overflow. Owing to the loose character of the soil and the sandy subsoil, the drainage is fairly good, except when the water in the streams is high, in which case the water table lies close to the surface.

This soil is of alluvial origin, and composed of sediments derived mainly from the granitic rocks farther north and deposited in their present position by the overflow waters of the neighboring streams. In places the surface has been slightly modified by wind action.

The original forest growth consisted chiefly of ash, elm, maple, basswood, birch, and oak, with some beech and pine. Most of the timber has been removed. This is a good agricultural soil, and over 90 per cent of it is under cultivation. General farming and dairying are the leading types of agriculture, although in the vicinity of Shiocton truck farming has come into prominence. Of the general farm crops, hay, oats, corn, barley, and rye are grown most extensively. Hay does not do quite as well as on the Merrimac loam, but yields of 1½ to 3 tons per acre per season are not unusual. Oats give slightly lower yields than on the Merrimac loam, averaging between 30 and 50 bushels per acre. Potatoes are grown to some extent, and yield 100 to 150 bushels per acre. Of the special crops, cabbage, sugar beets, and onions are by far the most important. Where good methods are followed yields of 8 to 12 tons of cabbage per acre are obtained. Sugar beets yield 6 to 12 tons per acre, and onions from 150 to 350 bushels.

A rotation similar to that used on the Merrimac loam is followed by the best farmers. To maintain the productiveness of this soil where an ample supply of stable manure is not available, it is well to plow under a crop of clover or some other green manure at least once in each rotation. The soil is very easy to cultivate, and except under very unfavorable moisture conditions no difficulty is encountered in preparing a good seed bed. To insure best results on this soil the water table must be lowered, which means the establishing of extensive drainage projects. The present value of the land ranges from $50 to $150 an acre, depending upon the location, the improvements, and the condition of the farm.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Merrimac very fine sandy loam:

Mechanical analyses of Merrimac very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
312907	Soil	0.2	0.4	0.2	9.9	64.2	20.1	4.9
312908	Subsoil	.1	.2	.3	12.3	68.2	15.7	3.0

MERRIMAC LOAM.

The surface soil of the Merrimac loam, extending to a depth of 8 to 10 inches, is a dark-brown, friable loam, free from stones and gravel. The soil carries a large percentage of very fine sand, and is fairly high in organic matter. The subsoil grades rapidly into a yellowish-brown very fine sand which becomes pale yellow at about 24 inches, and continues to depths below 4 feet.

In places the soil is nearly as heavy as a silt loam, and where this is the case the sandy subsoil is not encountered within 24 inches of the surface. A small area of this heavier soil is mapped just southwest of Helena, and another southeast of Bear Creek in Deer Creek Town.

The Merrimac loam is closely associated with the Merrimac very fine sandy loam, but it is of smaller extent. It is confined to the northwestern part of the county, where it is found on the broad, flat plains bordering the rivers. The largest areas occur in Deer Creek and Maple Creek Towns.

The surface is flat to very gently undulating. The type lies only a few feet above the normal high-water mark of the neighboring streams, and after unusually heavy rains portions of it are inundated. Owing to the sandy character of the subsoil the drainage usually is fairly good, except when the rivers are high. At such times the water table is close to the surface.

The material forming this type of soil, which is of alluvial origin, comes mainly from granitic rocks.

The forest growth originally covering this soil was chiefly ash, elm, maple, birch, and basswood, with some oak, hemlock, beech, and pine. Almost all the valuable timber has been removed.

Practically all this type is under cultivation. General farming and dairying are the most important branches of agriculture. The soil is well adapted to hay and oats, and all the general farm crops do fairly well. The soil is not as well adapted to potatoes as is the Merrimac very fine sandy loam, being a little too heavy. Corn does not do well after a wet spring, as the ground remains cold until late in the season, and the high water table retards the development of the root system. Of the special crops, cabbage and sugar beets are most important. Cabbage yields 8 to 15 tons and beets 6 to 12 tons per acre.

Where good methods of farming are followed the productiveness of this soil is gradually being increased, but where careless methods are practiced the yields are gradually declining. Spring wheat was formerly grown with good results, but yields gradually declined and the crop was finally abandoned over most of the area. The best farmers follow a rotation consisting of corn, a small grain, chiefly oats or barley, and clover and timothy. Hay is cut for one or two years, and is usually pastured a year, after which the land is manured and plowed for corn.

The Merrimac loam is comparatively easy to cultivate, and when it is worked under favorable moisture conditions no difficulty is encountered in working up a good seed bed. It is usually best to plow in the fall, for if the spring is wet some difficulty may be met in getting the crop sown on time.

This land sells for $60 to $100 an acre, depending upon the location and improvements.

Better drainage is the first need of this soil. To insure best results with this and similar types, the establishment of extensive drainage projects will be necessary, and this can only be brought about through cooperation of the majority of the landowners. With good drainage this would be an excellent soil.

PLAINFIELD VERY FINE SAND.

To an average depth of 8 inches the Plainfield very fine sand consists of a loose, grayish-brown very fine sand containing little organic matter. It is entirely free from gravel and stones. Below 8 inches the material becomes lighter in color, usually being pale yellow or yellowish brown. The texture continues a very fine sand to an undetermined depth.

This soil is of very small extent. It is found in a number of small areas in several sections of the county, chiefly in Maine, Deer Creek, and Bovina Towns.

The surface is level or only gently undulating, with some minor irregularities caused by wind action. In many places the water table is not far below the surface, so that during part of the year the drainage is none too good. When the streams are low the loose, open character of the material permits the free movement of water through the soil, and the type often suffers from lack of moisture during the dry periods likely to occur in summer.

This soil is of alluvial origin, and consists of valley filling or outwash material. The alluvium has come mainly from sandstone rocks, and practically all of the type is acid.

The original forest consisted largely of pine, with some hardwoods, but practically all of the timber of value has been cut.

This soil is of rather low productiveness, and only a small part of it is under cultivation. It is low in organic matter, but it can be improved more readily than sands of coarser texture, and by means of green manuring and the use of commercial fertilizers can be built up to a condition that will insure profitable yields. Its improvement should be directed along the same lines as suggested in the case of the Coloma very fine sand.

MIAMI FINE SANDY LOAM.

The surface soil of the Miami fine sandy loam consists of about 10 inches of brown to grayish-brown, mellow fine sandy loam. The subsoil becomes somewhat lighter in color and usually a little coarser textured with depth, and at 20 to 24 inches it is in most places a yellowish fine sand or fine sandy loam, often carrying considerable fine gravel and limestone particles.

The surface soil is somewhat variable, but in most areas can be classed as a fine sandy loam. In a number of places, indicated on the map by symbol, there is considerable gravel on the surface. Areas in which bowlders occur on the surface in sufficient numbers to interfere with farm operations are also shown by symbol. There is some variation in the subsoil, material of a loam or clay loam texture occurring in places in the lower part of the 3-foot section. The largest area with this character of subsoil is found near the center of the county 3 to 7 miles southwest of Blackcreek, in the towns of Black Creek, Bovina, and Ellington. The total area is approximately 10 square miles. There are numerous similar, scattered areas of small extent.

The surface of the Miami fine sandy loam ranges from undulating to gently rolling, and in a few places it is somewhat irregular or bumpy. In a small number of areas the underlying rock occurs

rather close to the surface, as, for example, on the hill directly north of Stephensville, the core of this elevation consisting of limestone. Because of the uneven surface and the rather open subsoil the type is well drained.

This soil has been derived from glacial debris, a part of which has come from the underlying limestone. Some of the bowlders found on the surface, however, are of granitic origin, indicating that a part of the material has come from regions farther north where the underlying rock is largely granite. In some places where the soil is somewhat shallow a heavy, reddish residual material is encountered directly over the limestone.

The original forest growth on this soil consisted of maple, beech, oak, hickory, basswood, and a small amount of pine. Practically all the timber has been removed, and most of the type is now in well-improved farms. The soil is easily cultivated, and makes fair to good farm land. All the common crops are successfully grown, the yields comparing favorably with those obtained on the Kewaunee fine sandy loam. The general farming methods and the means by which the soil could be best improved are practically the same as in the case of the better soil.

MIAMI LOAM.

The surface soil of the Miami loam is a brown or dark-brown, friable, mellow loam, with a depth of about 8 inches. The subsoil consists of a fine sandy loam carrying a small amount of fine gravel. In many places the bedrock—a limestone—lies at a depth of 15 to 30 inches, and immediately above the rock there may be a layer of reddish heavy material, which is probably residual. This soil is quite variable, ranging from a silt loam to a fine sandy loam, in places somewhat gravelly. The subsoil is also variable in texture, ranging from a sandy loam to a loam or even a clay loam.

This type is of very small extent. Probably the most important area is that near the center of Freedom Town. Only a few other scattered areas are encountered. The surface is gently rolling, and the natural drainage is adequate. The soil is of glacial origin. It originally supported a forest growth similar to that on the Kewaunee soils. The type is an excellent agricultural soil, but few if any farms are located entirely upon it. In productiveness and general value it compares very favorably with the best soils of the Kewaunee series.

WHITMAN FINE SANDY LOAM.

The Whitman fine sandy loam, to a depth of 4 to 7 inches, is a dark-brown to black, loose, friable fine sandy loam, free from stones and gravel and carrying a high percentage of organic matter. The subsoil grades abruptly into a pale-yellow very fine sand which continues to 3 feet or more.

This type occurs in small areas scattered throughout the northern part of the county. The largest of these bodies are in the eastern half of Maine Town.

The level surface and low position of the type are responsible for the poor natural drainage. The water table everywhere lies close to the surface, and part of the type may be covered with a few inches of water during much of the year.

This soil is similar in origin to the Clyde fine sandy loam, being in part alluvial and in part lacustrine. The parent material has come from glacial débris of granitic and sandstone origin. Much of the type is acid, and this is the chief difference between it and the Clyde soils.

The original forest of alder, quaking aspen, birch, maple, elm, and black ash has practically all been removed, and a dense second growth covers most of the type. Very little of its area is under cultivation. The principal crops are oats, timothy hay, and marsh grass. On small areas which have been properly drained, cabbage and onions are grown successfully.

The surface soil of this type is usually shallow, and considerable care must be exercised in tilling it. Where sufficient stable manure is not available it is well to turn under a green crop at least once in every five years.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Whitman fine sandy loam:

Mechanical analyses of Whitman fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
312911	Soil	0.3	1.1	0 7	51.7	20.8	17.9	7.4
312912	Subsoil	.0	.0	.3	34.2	50.1	12.4	3.0

WHITMAN LOAM.

The surface soil of the Whitman loam extends to a depth of about 7 inches, and is a dark-brown to black, mellow, friable loam, rich in organic matter. It carries considerable silt, and sometimes a fairly large proportion of very fine sand. It is free from stones and gravel. The subsoil rapidly becomes lighter in color and coarser textured, and at about 15 inches is a yellowish-brown to pale-yellow very fine sand, which continues to a depth of more than 3 feet. In some places the subsoil is a sandy clay, having a mottled drab, yellow, and brown color, but such areas are very small.

This type occupies a total of less than 10 square miles. The largest two areas occur in Bovina Town, one west and the other north-

east of Shiocton. Smaller areas are scattered throughout the northwestern part of the county.

The surface is level, and with the low position of the type causes poor drainage. The water table is usually within a few feet of the surface, and during the spring the soil is almost completely saturated. At times part of the type is several inches under water. In some places open ditches have been dug to carry off this excess water.

This type is similar in origin to the Clyde silt loam. It occupies low, flat areas and depressions representing old lake swamps and ponded valleys, and contains an admixture of alluvial material along present streams. The dark color is due to the accumulation of organic matter, resulting from the decay of vegetation in the presence of moisture. The parent material came largely from granite rock, but partly from sandstone; both soil and subsoil are acid, differing in this respect from the Clyde soils, which normally are not acid.

The original forest consisted chiefly of willow, alder, quaking aspen, birch, elm, black ash, and some maple. Most of the trees have been removed, only a scattered growth remaining.

About half the type is under cultivation. Where this soil has been properly drained, general farm crops are grown and excellent yields are obtained. Of the special crops cabbage, beets, and onions do well, and celery has been successfully grown. The undeveloped part of the type is valuable only for pasture and for the marsh hay which may be cut.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Whitman loam:

Mechanical analyses of Whitman loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
312909	Soil	0.1	0.7	0.5	25.7	44.7	23.8	4.1
312910	Subsoil	.0	.0	.3	16.8	64.4	17.0	1.5

CLYDE FINE SANDY LOAM, TILL PHASE.

The surface soil of the Clyde fine sandy loam, till phase, consists of a dark-brown or nearly black fine sandy loam extending to a depth of about 8 inches. The subsoil to 3 feet or more is a fine sand or fine sandy loam, a little lighter in color than the surface soil. It may be gray, yellowish, or mottled.

This soil covers less than 2 square miles. It is found in small scattered areas, chiefly in the towns of Bovina, Osborn, and Ellington. The surface is low and level, and drainage is very poor. The soil has the same origin as the Clyde silt loam, and supported practically the same type of forest.

Very little of this land has been improved, because of its poor drainage. When reclaimed it will be adapted to practically the same crops as the Clyde silt loam, till phase. At the present time its chief use is for pasture.

CLYDE SILT LOAM, TILL PHASE.

The Clyde silt loam, till phase, to a depth of about 8 inches, consists of a black, friable silt loam high in organic matter. The subsoil is a dark-colored silt loam, which at a depth of 12 or 14 inches becomes somewhat coarser textured and lighter in color, which commonly is grayish or bluish. The subsoil is quite variable, but it is generally a sandy loam below 18 inches. In a few instances it consists of a very fine sand, and is mottled in color.

There are some variations in this soil. The most important consists of areas in which the surface material is really a clay loam and the subsoil a heavy, bluish silty clay loam, containing lenses of sand in the lower part. These included areas could be classed as Clyde clay loam, till phase, if more extensive.

The Clyde silt loam, till phase, is of small extent and of minor importance. It occurs in a number of widely separated areas. One of these, probably the largest, occurs in sec. 15 in the town of Osborn. Others are found in secs. 22, 23, and 24, in the town of Ellington, and in sec. 6 in the town of Center. Several small areas occur in Dale Town.

The surface of this soil is level or only gently sloping, and owing to this and to its low position the drainage is so poor, that artificial drainage is necessary before the land can be used for cultivated crops.

This soil has been formed in old lake beds or ponded valleys, where there has been a rank growth of vegetation, the partly decayed remains of which cause the high organic content and the dark color of the soil. As there is considerable limestone in surrounding upland soils, the material is not acid.

The original vegetation on this land consisted chiefly of elm, ash, willow, and soft maple, with a growth of coarse grass and other water-loving vegetation. Very little of the land has been cleared and placed under cultivation, owing to the poor drainage. The best timber has been removed, and some areas are used for pasture. Where it is possible to provide artificial drainage this can be made an excellent soil. A large part of it can be drained, and when this is done the land will be well suited to the growing of hay crops, corn, sugar beets, cabbage, and small grains. Small grains, however, will be more apt to lodge than on the upland soils, and the quality of the grain will not be quite as good.

GENESEE VERY FINE SANDY LOAM.

The surface soil of the Genesee very fine sandy loam consists of about 8 inches of brown, friable very fine sandy loam. The subsoil is a little darker in color, but the texture usually remains the same to below 3 feet. In some places, however, very fine sand is encountered at 18 to 24 inches. Small areas of fine sand and of shallow Peat are included in the type as mapped, none of these variations being extensive enough to indicate on the soil map.

The Genesee very fine sandy loam is confined chiefly to the valley of the Wolf River, where it occupies low flats bordering the stream. The type is subject to annual overflow, and is usually wet during the spring and early summer months. In dry periods, when the stream is low, the soil is well drained. The surface is level, except where interrupted by old stream channels.

The material forming this soil is of alluvial origin, having been deposited in its present position by the stream which it borders.

The original forest consisted chiefly of elm, basswood, maple, ash, beech, and willow, with some birch, poplar, and alder. The more valuable timber has been removed, but there still remains a good stand of trees, with a dense undergrowth in many places. All this type is subject to overflow, and little attempt at improvement has been made. Aside from the pasturage it affords and the marsh hay that may be cut from certain areas, it has very little agricultural value.

GENESEE SILT LOAM.

The surface of the Genesee silt loam consists of about 8 inches of brown, friable silt loam, containing much organic matter. The subsoil is a light-brown loam to silt loam, which becomes lighter in color with depth until at 24 inches it is pale yellow to yellowish brown.

This type is subject to considerable variation in texture and depth. Some small areas of shallow Peat and fine sand are included, but none of these variations occurs in developments large enough to be indicated on the soil map. The subsoil is sometimes sticky, although it often carries large quantities of fine sand, and it may grade into fine sand at depths of 2 to 3 feet. In some places a relatively large percentage of the soil material consists of very fine sand.

The Genesee silt loam is developed most largely in the valleys of the Embarrass, Wolf, and Shioc Rivers, but areas are found along practically all the streams in the northern and western parts of the county.

The surface is level except where dissected by old stream channels. It lies only a little above the normal level of the streams and is subject to annual overflow. During the spring and early summer the land

is ordinarily wet, but later, when the streams are low, it is fairly well drained.

The material forming this soil, which is of alluvial origin, has been derived from sandstone and granitic rocks.

Swamp oak, elm, basswood, maple, ash, and willow are the more common trees in the forest on this soil. The best of the timber has been removed, but there is still a good stand of trees over most of the type. There is in places a dense undergrowth, in which alder is abundant.

All this type is subject to overflow, and little attempt at improvement has been made. Marsh hay is cut from parts of it, and it affords some pasturage; otherwise it has little agricultural value.

If protected from overflow this would be a desirable soil. A proposed canal, designed to carry the excess waters of Wolf River across the northern part of the county into Duck Creek, if brought into successful operation, would remove to a large degree the difficulty which has been encountered in attempts to improve this and associated alluvial soils.

PEAT.

The type mapped as Peat consists of vegetable matter in various stages of decomposition. Much of the material is still in a very raw, fibrous condition, showing quite plainly the structure of the vegetable growth from which it is derived. In this condition the material is brown, but with decomposition it becomes darker, and where thoroughly decayed it is very dark brown or black. Mineral particles may be incorporated with the organic matter, but seldom in sufficient quantities to appreciably affect the texture. In the more extensive areas of Peat there is little or no mineral matter except about the margins, where the proportion is frequently sufficient to form Muck.

The depth of the organic layer is variable. Areas in which it is less than 18 inches in depth are separated as a shallow phase. In some places the organic deposits are more than 10 feet deep, and in practically all the swamps with an area of 1 square mile or more the depth is more than 3 feet. The peaty layer is generally deepest in the center of the areas, and shallowest about the margins.

In large swamps and marshes, where the material is still raw, there is very little difference in character between the surface material and that several feet below the surface. Where conditions have favored rapid decomposition, the material at the surface is frequently darker, but where the accumulation of vegetable matter on the surface has been rapid, that at the lower depths is more decomposed and darker in color. A vertical section may consist of 8 to 16 inches of slightly decomposed to well-decomposed, brown to dark-brown vegetable matter, underlain by similar material which may be more decomposed, or may be in a very raw condition.

The material underlying the peaty matter is variable, ranging from sand to silt loam or clay loam. In general, its texture is determined largely by that of the surrounding upland soil. In the regions of silt loam soils the underlying material is usually heavy and of a grayish to dark-brown color. In the regions of sandy soils the peaty material in most cases is underlain by grayish to nearly white sand or very fine sand.

In some places small "islands" of Muck, sand, or other soils are included with the Peat, such areas being too small and unimportant to be separated on the map.

Areas of Peat are distributed through all parts of the county, but are most extensive in the northern half. The largest areas occur in the towns of Black Creek, Bovina, Liberty, and Hortonia.

Practically all the Peat areas are level, or have only a very gentle slope, nowhere sufficient to provide drainage without the aid of ditches. Most of the areas are wet the greater part of the year, and there is often a few inches of water over the surface in the spring, when heavy rains occur.

Most of the marshes in which Peat occurs have sufficient slope to be successfully drained. In a few instances drainage districts have been organized, and rather extensive reclamation projects are being developed. At present, however, very little of the Peat is under cultivation, and its agricultural value is very low.

The native trees on the Peat areas were chiefly tamarack and cedar. Some of the marshes support no trees, or at most only a scattered growth. In most places where trees are lacking the original growth has been destroyed by fire, but a few marshes apparently have always been treeless. On some of the open marshes there is a growth of coarse grass which is cut for hay, but in most cases the vegetation consists of moss, blueberry bushes, and other moisture-loving plants.

Owing to the peculiar composition of Peat soils they are unbalanced in the elements of plant food. They are extremely high in nitrogen and relatively low in phosphorus and potash. On account of this lack of mineral elements, it is practically always the experience in developing Peat soils that while they may produce two or three good crops after thorough drainage without fertilization, they soon show marked need of fertilizers containing phosphoric acid and potash. These can be supplied in heavy applications of stable manure, but under ordinary conditions can be more profitably supplied in their commercial forms. The amount of these fertilizers necessary will depend to a considerable extent on the crops to be grown, larger applications being needed for crops making a heavy rank growth, such as sugar beets and cabbage, than for hay or small

grain. Owing to the fact that nitrogen need not be supplied, the expense for fertilizing need not be any greater than for the upland soils.

The method of handling Peat soils is important. On account of their very loose, spongy character, many crops do not get a good foothold, and the heat from the sun is not readily conducted downward from the surface. To improve this condition, thorough disking and compacting by the use of a heavy roller are necessary to get good results.

The crops adapted to this land depend to a considerable extent on the degree of drainage and on the thoroughness with which the seed bed is prepared. A much less expensive drainage system would be necessary to fit this land for tame-hay crops, such as timothy and alsike clover, than would be needed to fit it for corn, sugar beets, and other cultivated crops. For its highest development agriculturally, a tile-drainage system in which the laterals are not more than 8 to 10 rods apart would be essential. With adequate drainage, fertilization, and compacting of the soil, this type should produce good crops of corn, sugar beets, cabbage, and onions, as well as hay and other crops generally grown in this section of the State. It is not so well adapted to small grains on account of their tendency to lodge. There is somewhat more danger from frost than on the higher ground, partly because heat is not conducted readily to the soil and is quickly lost by radiation at night.

Peat, shallow phase.—The shallow phase is differentiated from the typical Peat solely on the basis of thickness of the peaty deposit, the maximum depth in areas of the phase being 18 inches, and the range being from 6 to 18 inches. The underlying material is variable, and usually corresponds quite closely to the soil of surrounding uplands, just as is the case with the typical Peat. Small islands of other materials noted in the typical soil occur likewise in the shallow phase.

Though not very extensive, small areas of the phase are scattered throughout the county. The forest growth is practically the same as on the typical Peat, except that tamarack is found in only a few places.

The production of marsh hay is the chief use made of this soil at present, though it is used to a small extent for grazing. In its present condition it has a low agricultural value, but when drained it will be adapted to the same crops and types of farming as the typical Peat, and in most cases it is easier to improve the shallow phase, as it may be more easily drained and requires less compacting to make a good seed bed.

SUMMARY.

Outagamie County is situated in the east-central part of Wisconsin, between Lake Winnebago and Green Bay. It has an area of 646 square miles, or 413,440 acres.

All of the county drains directly or indirectly into Green Bay. The southeastern corner is traversed by the Fox River, which flows directly into Green Bay. The western part of the county is crossed by the Embarrass, Shioc, and Wolf Rivers, the waters of which find their way into Lake Winnebago, and then through the Fox River into Green Bay. The first-named streams are rather sluggish, but the Fox River in a distance of 35 miles has a fall of 170 feet. Many large manufacturing establishments use power developed from this stream.

Farm operations in this county followed closely upon the removal of the timber. All parts of the county are well improved. The northwestern part, which contains considerable areas of Peat marshes and some tracts of sandy soil, is least developed.

In 1910 the county had a population of 49,102, of which 54.6 per cent was classed as rural. Appleton, the county seat, had a population in 1910 of 16,773. Kaukauna is the second largest place, with a population of 4,717.[6]

All parts of the county are well supplied with railroads, and the wagon roads throughout the county are generally in good condition. Under a State highway improvement law many gravel and crushed-rock roads are now being constructed. A system of concrete roads, which will ultimately connect the county seat with practically all towns in the county, is one of the more important road projects.

The climate of Outagamie County is representative of a large section of eastern Wisconsin. The mean annual rainfall is 32.7 inches. The average length of the growing season as recorded at New London is 138 days.

Agriculture in this county consists chiefly of general farming, with dairying as the most important branch. The chief crops grown are hay, oats, corn, barley, and rye. Smaller acreages are devoted to such crops as potatoes, cabbage, sugar beets, and buckwheat.

Dairy products find their way to market chiefly in the form of butter and cheese. In 1917 there were produced in this county over 9½ million pounds of cheese. There are 21 butter factories and 86 cheese factories in the county.

Holstein cows are most numerous in the dairy herds, and all the dairy stock is gradually being improved.

In 1910 there were a total of 3,650 farms in the county, of an average size of 92 acres. About 91 per cent of the farms were operated by the owners.

[6] See footnote on page 7.

Well-located and highly improved farms have a selling price at present of $150 to $250 an acre. Rather sandy soils of lower agricultural value have a selling price of $20 to $50 an acre, depending upon the location, improvements, soil conditions, and other factors.

The soils of Outagamie County have been derived from glacial, lacustrine, and alluvial material. In addition, there are large deposits of Peat, consisting of partly decayed organic matter. The soils are classified into 10 series and 24 types, exclusive of Peat.

The Kewaunee series include light-brown soils with heavy, red clay subsoils, occupying areas where the surface is sufficiently rolling to insure fair or good drainage. The Kewaunee fine sandy loam, loam, silt loam, and clay loam are mapped in this survey.

The Superior series is similar to the Kewaunee except that the surface is level and the natural drainage somewhat deficient. The types mapped are the Superior fine sandy loam, loam, silt loam, and clay loam.

The Poygan series consists of dark-colored, low-lying, poorly drained soils having heavy, red clay subsoils. In this county the fine sandy loam, silt loam, and clay loam are mapped.

The Coloma series includes the light-colored, light-textured soils which have been derived through glacial action largely from sandstone. The Coloma very fine sand and fine sandy loam are mapped in this county.

The Merrimac series consists of light-colored soils which occupy outwash plains or stream terraces where the material has come mainly from crystalline rocks. The types mapped in this survey are the very fine sandy loam and loam.

The Plainfield very fine sand is similar to the Merrimac soils except that it has been derived largely from sandstone material.

The Miami fine sandy loam and loam are light-colored upland soils derived chiefly from glaciated limestone material.

The Whitman series is similar to the Merrimac except that the soils are dark colored and contain much larger amounts of organic matter. They are often acid. The types mapped are the fine sandy loam and loam.

The Clyde series consists of low-lying, dark-colored soils occupying old lake beds or stream valleys where the soil material has come largely from glaciated limestone. They are similar to the Whitman soils except that they contain considerable lime carbonate and are very seldom acid. The members of the Clyde series mapped are the fine sandy loam, till phase, and the silt loam, till phase.

The Genesee series consists of brown soils which occupy first bottoms along streams in the glaciated region. They are subject to

overflow. The very fine sandy loam and silt loam are mapped in this county.

In addition to the above soils extensive areas of Peat are mapped in Outagamie County. Peat consists of decaying vegetable matter with which there has been incorporated a very small amount of fine mineral particles.

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[PUBLIC RESOLUTION—No. 9.]

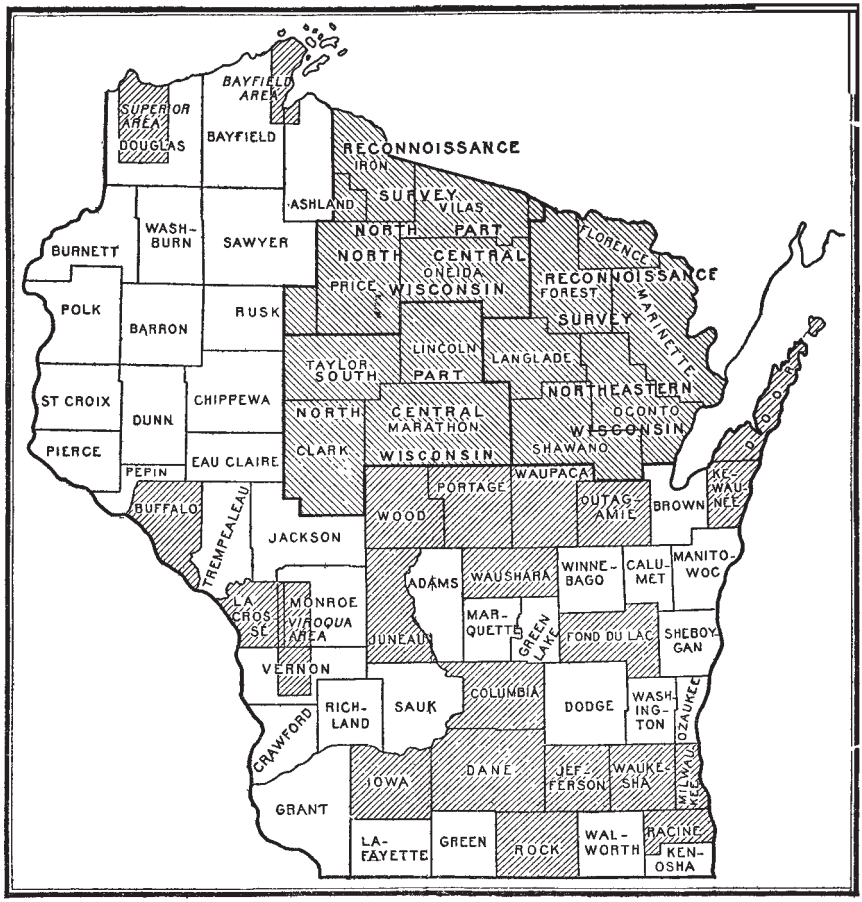
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for, there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Wisconsin.

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