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 WAUPACA COUNTY, WISCONSIN.

BY

W. J. GEIB, IN CHARGE, AND CLARENCE LOUNSBURY, OF THE U. S. DEPARTMENT OF AGRICULTURE, 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, 1917.]

WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., June 5, 1919.

SIR: Under the cooperative agreement with the State of Wisconsin a soil survey of Waupaca County was carried to completion during the field season of 1917.

I have the honor to transmit herewith the manuscript report and map covering this work and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1917, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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SOIL SURVEY OF WAUPACA COUNTY, WISCONSIN.

By W. J. GEIB, In Charge, and CLARENCE LOUNSBURY, of the U. S. Department of Agriculture, and MARTIN O. TOSTERUD, of the Wisconsin Geological and Natural History Survey.—Area Inspected by THOMAS D. RICE.

DESCRIPTION OF THE AREA.

Waupaca County, Wisconsin, is situated a little east of the center of the State. Waupaca, the county seat, is 221 miles from Chicago and 146 miles from Milwaukee by rail. The county comprises an area of 759 square miles, or 485,760 acres.

While all of Waupaca County is within the region covered by the late Wisconsin ice sheet, it may be considered as falling into three divisions, on the basis of topography. In the northwestern quarter of the county the surface varies from gently rolling to hilly, and in places there is an abundance of stones and bowlders, some of which range in diameter up to 10 or 12 feet. Over some small areas these bowlders may be so plentiful as to make cultivation impossible. This portion of the county is underlain by granitic rocks, which outcrop frequently.

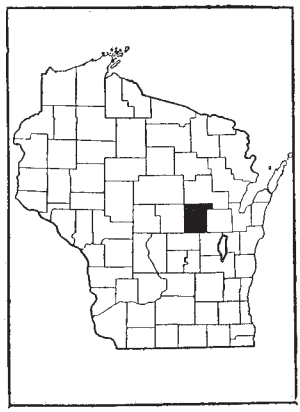

FIG. 1.—Sketch map showing location of the Waupaca County area, Wisconsin.

The southwestern quarter of the county is characterized by extensive sandy terraces and outwash plains. The surface is, for the most part, level, and almost entirely stone free. There are a number of beautiful lakes in this section, chiefly in Farmington and Dayton Townships.

Over most of the eastern half of the county the surface varies from level to gently rolling. This is the lowest portion of the county. The most characteristic feature is the underlying deposit of heavy, red clay, doubtless of lacustrine origin, though reworked to a greater or less extent by glacial action. While the underlying material is clayey and the surface soil also for the most part heavy, there are throughout this region a number of areas of sand, in which the material appears to have been dumped upon the red clay by the action of the ice.

The northwestern part of the county has the highest elevation, and the general slope is from this section to the south and also to the

east. Elevations above sea level at various places are as follows: Iola, 930 feet; Waupaca, 870 feet; Manawa, 828 feet; Northport, 779 feet; New London, 767 feet; and Weyauwega, 779 feet.

Waupaca County lies within the drainage basin of the Wolf River, which flows in a southwesterly direction across the southeastern part of the county. The Embarrass River, one of its largest tributaries, enters the Wolf near New London, a short distance outside of Waupaca County. It traverses the extreme northeastern part of the county. The Little Wolf River, which joins the Wolf near Northport, receives the drainage water from a considerable area in the central and northwestern parts of the county. The Pigeon River, receiving the drainage from the extreme north-central part, flows into the Embarrass River in Matteson Township. The Waupaca River, which flows into the Wolf about 3 miles north of Fremont, drains most of the southwestern quarter of the county. All the drainage passes through the Wolf River into the Fox River, and thence into Green Bay and Lake Michigan.

Scattered throughout the county are numerous marsh areas and some lakes. The most extensive tracts of marsh are found in the southeastern part of the county, along the Wolf River. One very large area almost surrounds Partridge Lake and extends north and northeasterly along the Wolf River for a distance of about 10 miles. Another large marsh area borders and extends north from White Lake. For the most part these marshes are still undeveloped, but in a few instances efforts are being made to reclaim them.

The Wolf River is a very sluggish stream, its rate of fall between Shawano, Shawano County, and the point where it joins the Fox River being less than one-half foot per mile. The Embarrass River is also sluggish. The streams flowing into these two rivers, however, from the west, and rising in the higher parts of the county, have considerable fall and are still deepening their channels. Water power is used in a small way on these streams at Big Falls, Waupaca, Manawa, and Weyauwega, and there is considerable water power still undeveloped. The water supply for stock and farming purposes throughout the county is excellent. In the eastern half of the county there are many flowing wells, and in the western half excellent water can be obtained without difficulty.

Settlement in this territory is reported to have begun in 1843, at the present site of Fremont. By 1849 a number of settlers had taken up lands in the southern part of the county. The county was organized, practically as now existing, in 1851, and claims to the territory were finally surrendered by the Menomonie Indians in 1852.

The earlier settlers were mostly from eastern States, and many of their descendants are still residents of the county. A considerable number of the earlier settlers also came directly from foreign coun-

tries. At present the western part of the county is inhabited quite largely by Scandinavians, mostly Norwegians. In the eastern part of the county a large proportion of the people are of German descent, and in the central part there is an extensive Irish settlement. Various other nationalities are represented.

In 1910 the population of Waupaca County was 23,782, of which 83.7 per cent was classed as rural. The density of the rural population is given as 36.1 persons per square mile.

Waupaca, the county seat, had a population in 1910 of 2,789. New London, with a population of nearly 4,000, is situated on the east county line, partly in Waupaca County and partly in Outagamie County. Among other towns and villages within the area are Clintonville, Marion, Manawa, Ogdensburg, Scandinavia, Iola, Weyauwega, Fremont, Royalton, and Northport.

Three railway systems have lines extending into this county. The main line of the Minneapolis, St. Paul & Sault Ste. Marie between Chicago and Duluth and Superior passes through Waupaca and Weyauwega. The Green Bay & Western traverses the county from east to west, passing through Scandinavia, Ogdensburg, Manawa, and New London. The Chicago & North Western skirts the eastern side of the county, passing through New London, Clintonville, and Marion. These railroads offer good transportation facilities to nearly all portions of the county.

In the southwestern part of the county, and in other regions where the soils are light, the wagon roads are usually of a sandy nature, but elsewhere the roads are good. In many places they have been macadamized, and new and improved highways are constantly being built. Rural mail delivery routes reach all parts of the county, and the telephone is in common use throughout the country districts.

The towns within the county provide markets for considerable farm produce, but most of the produce is shipped to outside markets. Live stock goes mostly to Chicago and Milwaukee, as does also the potato crop. Dairy products find a market throughout the Middle West.

CLIMATE.

The climatic conditions in Waupaca County are fairly representative of those over much of central Wisconsin. The climate is healthful and well suited to a high development of agriculture. While the winters are long and rather severe, the temperatures are much more uniform than farther south. The average snowfall amounts to about 40 inches. The summers are very pleasant and farm crops make rapid growth.

While the topographic features of the county are not altogether uniform, there is probably little variation in the liability to frost in

the different parts of the county, except in the marsh areas. As none of the large, marshy tracts have been reclaimed, their greater exposure to frost is not of much importance at the present time, but it may be stated that in other sections of the State it has been found that frost in the marsh land will occur in any area at about the same time as in the upland a hundred miles farther north.

The table below gives the more important climatic data gathered by the Weather Bureau station at Waupaca. This station has an elevation of about 870 feet above sea level.

Normal monthly, seasonal, and annual temperature and precipitation at Waupaca.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year(1910).	Total amount for the wettest year(1911).
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	20.4	51	−28	1.27	0.80	2.68
January	15.2	51	−38	1.00	.94	.73
February	15.7	53	−38	1.04	.75	1.83
Winter	17.1	53	−38	3.31	2.49	5.24
March	29.4	83	−17	1.90	.10	1.73
April	44.8	88	7	2.55	4.73	1.54
May	56.3	95	20	4.43	1.18	5.78
Spring	43.5	95	−17	8.88	6.01	9.05
June	65.5	103	30	4.12	.89	4.28
July	70.6	104	41	3.70	.97	3.14
August	67.6	100	32	3.42	2.66	3.55
Summer	67.9	104	30	11.24	4.52	10.97
September	57.0	99	18	3.87	6.04	7.28
October	48.7	85	11	2.45	1.31	7.42
November	33.6	69	−13	1.87	1.81	2.69
Fall	46.4	99	−13	8.19	9.16	17.39
Year	44.0	104	−38	31.62	22.18	42.65

A large proportion of the precipitation, which averges 31.62 inches annually, occurs during the growing months, when most needed, but occasionally, especially in July and August, crops may suffer somewhat from the lack of moisture. Storms of a destructive nature are very rare.

The average date of the last killing frost in the spring, as recorded at Waupaca, is May 22, and that of the first killing frost in the fall is September 28. This gives an average growing season of 129 days, a period sufficiently long to permit the maturing of corn. If the period is shortened by early fall frosts the crop may give no grain.

Such was the case in 1917, when little corn matured in Wisconsin. Corn will always mature sufficiently, however, for silage, and a large proportion of the crop is disposed of in this way. The date of the latest killing frost in the spring on record is June 12, and that of the first in the fall, August 27.

AGRICULTURE.

The development of agriculture in this region was preceded by the growth of the lumbering industries. The earliest settlements were made chiefly in the sandy areas of the county, as the forest growth here was largely pine, which was the only timber handled by the early lumbermen. Hardwood in that time had but little value, and where early clearings were made in hardwood regions the timber was usually burned.

The most authentic records available indicate that the first farming operations were begun in Waupaca County in 1849, on an area of sandy prairie in the present town of Lind. The first farms opened after the advance of the lumbermen were small, and often large areas remained in the cut-over stage for a considerable time before being parceled out in small tracts. While farming ventures were at first confined largely to the sandy soils, following the cutting of the pine, the highest agricultural development has been reached in those sections where the soils are heavier. Farming has extended into practically all sections of the county, with the exception of some areas in the northwestern part, which are still in a cut-over state. Even here a number of farms are already in operation. By far the greater proportion of the county is well improved agriculturally.

While practically all the general-farm crops now grown were produced in the early history of the county, the relative importance of a number of the crops has changed to a considerable degree. In 1879 wheat occupied 21,731 acres, which was more than twice the area devoted to oats, and nearly twice as much as was devoted to corn. In 1909 the area devoted to wheat was only 1,150 acres, while there were 38,860 acres in oats and 19,948 in corn. The area in hay, corn, and potatoes has steadily increased since the early history of the county. Rye and barley have changed less in acreage than the other general-farm crops. The development of the potato-growing industry has been marked. In 1879 there was a production of 250,307 bushels, while in 1909 the production amounted to 2,392,213 bushels.

Farming in Waupaca County is based chiefly upon the dairy industry. In the southwestern and western parts of the county potato raising is the leading industry, in connection with dairying. In the eastern part, in the region of the Kewaunee and Superior soils, much less attention is paid to potato growing, and dairying is the leading

industry. In the region of these heavier soils a number of farms do not produce enough potatoes to supply the home table, and grain raising receives more attention than elsewhere.

Practically all the crops grown at present may be considered in part as cash crops, for hay, corn, oats, rye, and barley are sold to some extent directly from the farm. Potatoes are grown mainly for sale, although they are one of the most important subsistence crops. The greater part of the hay, corn, oats, and barley produced is used in feeding live stock, and a large proportion of it finally reaches the market in the form of dairy products, beef, and pork.

Hay is grown more extensively than any other crop. For 1909 the census reports 57,286 acres in all hay crops, with a production of 98,771 tons. By far the greater proportion of the hay consists of timothy and clover mixed. There is a small acreage in timothy, as well as in clover alone. Marsh hay is cut from approximately 9,500 acres, and the rest of the hay crop is made up of alfalfa, millet, grain cut for hay, and coarse forage. The best hay crops are produced on the heavier types of the Kewaunee, Superior, Gloucester, and Merrimac series. As many of the soils in the western part of the county are somewhat acid, alsike clover is sometimes grown in place of red clover. The latter does well on land whose productiveness has been kept up, and succeeds on new land in spite of the acidity.

In 1909 the area devoted to oats was 38,860 acres, which produced a total of 1,153,059 bushels. This crop does best on the fine sandy loams, loams, and silt loams, and does not give good results on the extremely sandy soils in the southwestern part of the county.

In 1909 corn was grown on 19,948 acres, which produced 602,144 bushels. This crop is not grown as extensively as in counties to the south, as the climate does not always permit it to mature. It produces excellent silage, however, and a large proportion of each year's crop is put into silos, which are in quite common use on the dairy farms.

The potato crop is one of the most important, especially in the southwestern quarter of the county, where sandy soils predominate. In 1909 the area in potatoes amounted to 19,810 acres and the production reached 2,392,213 bushels. While the greater proportion of the crop is grown in the extremely sandy sections, the best yields are obtained where the content of clay is sufficient to make the soil somewhat loamy. A large part of the potato crop is stored in dealers' warehouses or in cooperative warehouses until finally put on the market. Dealers usually charge 3 cents a bushel for storage, including insurance, between October 1 and January 1, and 1 cent a month or fraction per bushel for each succeeding month. Many farmers have storage cellars for potatoes, but do not always use them on account of the difficulty in handling the potatoes during extremely

cold weather. The variety most extensively grown is the Rural New Yorker, followed by the Cobbler, Triumph, and Hebron. A gradually increasing number of potato growers are cooperating with the State experiment station in the production of standard varieties. Many of these farmers are treating their seed, are having their fields inspected by representatives of the experiment station, and are producing high-grade, certified seed. Cooperation in storing and marketing is also receiving considerable attention.

Rye was grown on 8,204 acres in 1909, and produced 109,381 bushels. This crop is grown most extensively on sandy soils, on which it gives better results than any of the other small grains.

In 1909 barley was grown on 5,734 acres, with a production of 145,890 bushels. The acreage devoted to barley has increased somewhat during the last few years. Its production is fairly well distributed over the county.

There was a gradual reduction in the wheat acreage from 1880 to 1910, only 1,150 acres being devoted to this crop in the latter year. The average yield amounted to about 20 bushels per acre. Owing to the great demand for wheat at the present time, its acreage has increased since 1910, though it is still very small as compared with the acreage of thirty years ago. The heavy soils of the Kewaunee, Superior, Gloucester, and Merrimac series are well adapted to wheat growing.

The following table shows the acreage and production of the principal crops at the last four census years:

Acreage and production of principal crops, 1880 to 1910.

Crop.	1880		1890		1900		1910	
	Acres.	*Tons.*	*Acres.*	*Tons.*	*Acres.*	*Tons.*	*Acres.*	*Tons.*
Hay	26,995	26,898	37,867	44,368	43,212	66,299	57,286	98,771
		Bushels.		*Bushels.*		*Bushels.*		*Bushels.*
Oats	9,897	272,947	22,963	846,531	34,634	1,186,360	38,860	1,153,059
Corn	11,055	300,122	12,709	435,031	16,075	491,550	19,948	602,144
Potatoes	.....	250,307	11,127	1,261,920	17,498	1,572,554	19,810	2,392,213
Rye	5,904	69,933	7,330	112,069	11,343	167,280	8,204	109,381
Barley	1,724	32,138	1,056	30,731	2,414	62,330	5,734	145,890
Wheat	21,731	252,925	12,564	212,889	12,160	240,400	1,150	21,955

Cucumbers are grown to some extent as a special crop, mostly on the sandy soils. Salting stations are located at several of the towns. In a few localities in the eastern part of the area sugar beets are grown. Most of the crop is shipped to the beet-sugar factory at Menomonie. Cabbage is another crop of some importance, though it is not grown as extensively as in Outagamie County. Minor subsistence crops include mangels, rape, peas, and turnips. Strawberries are

grown to a small extent, as well as raspberries, currants, and other bush berries. Trucking is not developed on a commercial scale, and fruit growing receives little attention. Apples are grown more extensively than any other fruit. Most of the farms have a small home orchard, but apples are not raised on a commercial basis. The census of 1910 indicates that there are somewhat over 60,000 apple trees in the county. Apples do best where the surface is more or less rolling. The heavier soils of the Superior series, for example, are not well adapted to fruit, owing to the prevailingly poor drainage. The 1910 census reported 72 acres in cranberry bog, the production amounting to 39,072 quarts in 1909.

The raising of live stock is an important industry. In 1909 there were 51,536 cattle in the county, of which 31,152 were milch cows. There were 23,672 hogs and 10,457 sheep. During 1909 there were 18,107 calves, 6,340 other cattle, and over 26,000 head of hogs sold or slaughtered. Hogs are raised chiefly in conjunction with dairying and general farming, and hog raising is not as well developed as in sections where corn is more certain to mature. Sheep raising is largely confined to the rougher areas, but it is carried on to some extent in nearly all parts of the county.

The dairying industry is one of the most important in the county. The dairy products sold during 1909 amounted to $1,202,611, exclusive of home use. Holsteins predominate among the dairy cattle, with Guernseys second. A few herds are of Jersey or Shorthorn blood. There are quite a number of purebred herds of registered stock, though most of the herds are being built up from grade stock. Several cow-testing associations have been formed, and cows of poor production are being weeded out gradually. The milk is manufactured into butter and cheese or taken to the condenseries at Manawa and New London, the total production being quite evenly distributed through these three channels. Creameries are located in most of the principal towns, and at some neighborhood centers. One of the most modern and up-to-date creameries is located at Iola. Cream is generally separated on the farm and delivered, either by the producer or hauler, about three times a week in summer and about twice a week in winter. Cheese factories are most numerous in the southeastern and northwestern parts of the county, most of the milk produced in the eastern and east-central part being sold to condenseries. The dairy products are shipped chiefly to Milwaukee and Chicago. Some of the cheese is marketed through Neenah. Most of the cheese factories and creameries are run on a cooperative basis.

Farmers generally recognize the adaptation of crops to certain soils. It is generally known, for example, that rye will do better on the sandier soils than any of the other small-grain crops, and that potatoes can be grown more profitably on these than on heavy types.

Corn is more certain to mature on the light sandy soils than on the heavy clayey areas, as the former warm up more quickly in the spring. The sandy types, however, are not so well adapted to hay crops and to oats, barley, and wheat.

The general farming methods in Waupaca County are about the same as those practiced throughout the general-farming and dairying districts of Wisconsin. Modern machinery is used on all farms. Plowing is usually to a depth of 6 or 8 inches, and on the heavier soils much of the plowing is done in the fall. Disk harrows are frequently used for pulverizing the soil. On some of the sandier types rye is often sown without previous plowing, the seed being harrowed or drilled in following the removal of the preceding crops. On corn fields rye is frequently sown before the shocks are removed. On farms where potatoes are grown, and where the acreage justifies their purchase, horse-drawn planters, diggers, and spraying outfits are used.

Throughout most of the county the farms are equipped with well-built and attractive buildings. This is especially noticeable in the eastern half of the county. Practically every dairy farm has a silo. Many of these are made of wooden staves, but many recently built have been constructed of concrete. Some of the dairy farms are equipped with power milking machines. Improved implements, such as manure spreaders and seeding and harvesting machinery, are in common use. Farm tractors are being introduced in a few places in an experimental way.

A rotation quite commonly followed on the sandy soils consists of small grain, followed by clover, and this by potatoes. The second crop of clover in some instances is plowed under for green manuring. On the extremely sandy types it is desirable to arrange a system so that the ground may be covered as much of the time as possible to prevent drifting, which sometimes causes damage to growing crops. On the heavier soils the usual rotation is somewhat different from those on the sandy types. Corn more frequently takes the place of potatoes, and the land is usually left in hay grasses for two years, frequently being pastured for a year before plowing. On neither the sandy nor the heavy types has the question of crop rotation been given the careful consideration it deserves.

Stable manure is the most commonly used fertilizer in this county. Clover or rye is used as green manure. The practice of green-manuring, however, is not at all common. Commercial fertilizers are used in a few cases, chiefly in an experimental way and mostly on the potato crop. It is probable that their use will gradually increase, since the results obtained on the potato crop in this and other counties are very gratifying. In the vicinity of Weyauwega, on a sandy loam soil, unfertilized, the yield of potatoes was 85 bushels

per acre, while on the same soil where 14 spreader loads of manure were used, supplemented with 500 pounds of a complete commercial fertilizer, the yield amounted to 350 bushels per acre.

Competent farm labor is often somewhat difficult to obtain, but in many cases, especially where the farms are small, the members of the family are able to do practically all of the farm work, extra labor being needed only at the time of haying and harvesting. When labor is hired by the month, the wage ranges from $30 to $50 and board. Day wages, especially in harvesting and potato-digging time, range from $2.50 to $3.50 a day.

Farms usually range in size from 40 to 160 acres, although there are a number of holdings of 200 acres or more. On many of the larger farms there is a considerable amount of unimproved land. The average size of all farms in the county, according to the 1910 census, is 110 acres, of which 58 acres is improved land.

There was a total of 3,794 farms in Waupaca County in 1910. The census reports 90.1 per cent of the farms as operated by the owner. Most of the rented land is in the poorer sandy sections. Farms are usually rented on a share basis, the tenant furnishing the equipment and half the stock and seed, and receiving one-half the farm produce. There are a number of variations in the terms of the leases, but the provisions stated are the most common.

The selling value of lands has been steadily increasing in this county. The better improved farms where well located sell for $100 to $125 an acre. Cut-over lands, mostly in the northwestern part of the county, have a selling value of $15 to $25 an acre. The farms in the sandy regions, where the fertility of the soil is sometimes low and the improvements rather inferior, have a value of about $40 an acre, though the price is extremely variable and dependent upon a number of factors.

SOILS.[1]

Waupaca County, in common with several other counties in the central portion of Wisconsin, owes the general character of its surface materials to several distinct methods of accumulation, namely, glacial, lacustrine, and alluvial. With the lacustrine deposits may be included the accumulation of organic matter in low places, which has resulted in the formation of peat.

All of the county was traversed by the ice sheet of the Late Wisconsin glaciation, but the west half, and especially the northwest quarter,

[1] Waupaca County adjoins Portage County on the east. In certain cases the soils in these counties do not join along the boundary. This is due in part to changes in correlation resulting from a fuller understanding of the soils of the State. The Whitman silt loam in Portage is changed to Dunning fine sandy loam in this area. Gloucester loam in Portage is shown as Gloucester fine sandy loam in Waupaca. This was made advisable because only a small area of the loam was found in Waupaca and it was combined with the fine sandy loam which it closely resembles.

has the most pronounced glacial features. Stream terraces and outwash plains are numerous in the southwestern part of the county, and rather extensive terraces are also found along Pigeon River, in the north-central part. Large areas of alluvial deposits occur along the Embarrass and Wolf Rivers. Potholes, recessional moraines, and drumlins are other evidences of glaciation found in various parts of the county. There are numerous marshes. In general from a geological standpoint the topography of the whole area is young.

In a geological classification based upon the character of the underlying rocks, the county falls into three divisions. The surface rock in the northwestern portion consists of crystalline rock, chiefly granite and gneiss. The line marking the border of this crystalline-rock formation enters the county a little above the center of Iola Township. It extends southeast through the village of Iola, southward to the city of Waupaca, and then southeast to the southeastern part of Waupaca Township. The eastern border of this formation is a north and south line which coincides very closely with the east boundary line of the townships of Wyoming, Helvetia, St. Lawrence, and Waupaca. This line extends approximately through the center of the county from north to south, and the southernmost extension of the formation reaches within about 6 miles of the south county line. Throughout this granitic-rock region outcrops are numerous, and granitic stone and bowlders are plentiful. Many similar bowlders have been carried by glacial action over onto the formations to the south and southwest.

In the extreme southeastern corner of the county, in the southeastern portion of Caledonia Township, there is a remnant of Lower Magnesian limestone which outcrops or comes very near the surface in sections 11, 12, 13, and 14.

All of the remainder of the county, or considerably over half its area, has Potsdam sandstone as the upper formation. As this rock is rather soft there are few outcrops, and in most cases it is covered to a considerable depth by glacial, lacustrine, and alluvial materials.

The soil material throughout the county has been derived in part by glacial action from these underlying rocks, and in part from the beds of heavy lacustrine material which were probably deposited earlier in the glacial period. The granitic-rock formations within the county and immediately to the north have contributed largely to the soils, especially in the western half of the county. The Potsdam sandstone, which is the most extensive formation, has also contributed to the soils, and the material from this formation has been mixed to a greater or less degree with that derived from the granitic rocks. In the eastern half of the county, however, a large proportion of the sandstone formation has been covered by lacustrine material, and while the glacier in its advance reworked this heavy red-

clay deposit, in many places it apparently did not disturb the surface of the underlying sandstone. In other sections, however, the material from the sandstone has been mixed with the red clay or deposited upon it. In the southwestern portion of the county the soils are predominantly sandy, and apparently a considerable part of the parent material was derived from the sandstone formation, but a physical examination of these sandy soils shows a large number of dark-colored particles of igneous rock.

The limestone in the extreme southeastern corner of the county has influenced the soil material in only a very small degree. There is a small area in sections 11, 12, 13, and 14, in Caledonia Township, which, because of the limestone material from which it seems to have been derived, could have been classed with the Miami series, but owing to its extremely small extent it was included with the Kewaunee series.

As indicated above, the rock formations in the county have contributed to a greater or less extent to the glacial materials from which the soils have been derived. By far the greater proportion of the glacial drift has come from areas of crystalline rocks and sandstone. Since its deposition by the ice sheet the material has been modified by running water, by the action of wind, by weathering, and by the accumulation and decay of vegetable matter. In the soil survey of Waupaca County the soils are classified into 10 series, comprising 27 types, and Peat. In two instances, phases have been recognized.

The surface soils of the Gloucester series are light brownish or grayish brown, and are underlain by yellow or yellowish-brown subsoils. These soils are derived by glaciation from crystalline rocks consisting chiefly of granite and gneiss. Stones and bowlders are scattered upon the surface, but usually not in sufficient numbers to prevent cultivation. The topography ranges from nearly level to rolling and hilly, the hills usually being rather high, broad, and smoothly rounded. Only in a comparatively few places are the slopes too steep to allow the use of modern farm machinery. Drainage is usually good and on some of the lighter types excessive. This is one of the most important and extensive series in Waupaca County, especially in the western half. The types mapped are the sand, sandy loam, fine sandy loam, and silt loam.

The Merrimac series includes types with light-brown or grayish surface soils and grayish-brown or yellowish subsoils, usually lighter in texture than the soil. The deeper subsoil consists of stratified sand and gravel. The Merrimac soils occupy glacial outwash plains, glacial terraces, or filled-in valleys. The parent material has been derived largely from crystalline rocks, chiefly granite and gneiss, mixed with

some material from the Potsdam sandstone. Both soil and subsoil are in an acid condition. The surface is level to very gently undulating, but because of the loose subsoil the drainage is usually thorough, and often excessive. In Waupaca County, the types mapped are the sandy loam, fine sandy loam, loam, and silt loam.

The Kewaunee series includes types with brown to light-brown surface soils and heavy red clay subsoils. This clay is a lacustrine deposit influenced to a greater or less degree by glacial action. It is seldom acid, usually containing considerable lime carbonate. The surface of the Kewaunee soils varies from undulating to gently rolling, and their natural surface drainage is good. They differ in this respect from the Superior soils, which are level and frequently somewhat deficient in drainage. The types mapped in the Kewaunee series are the sandy loam, fine sandy loam, loam, and silt loam.

The types included in the Superior series have light-brown soils underlain by heavy red clay subsoils. This clay is part of a lacustrine deposit, and while it has often been influenced to a greater or less degree by glacial action, the surface has been left level or nearly so, so that the natural surface drainage is usually somewhat deficient. The types mapped in the Superior series are the sandy loam, fine sandy loam, loam, silt loam, and clay loam.

The Coloma series is characterized by light-brown or yellowish surface soils and yellow or yellowish-brown subsoils. The soils have been derived largely from sandstone, through glacial action, and are usually of a very sandy nature. The surface varies from gently undulating to rolling, and the natural drainage is good and often excessive. One type, the fine sand, is mapped.

The Plainfield series includes types with light-brown or yellowish-brown soils and yellow or brownish subsoils. The parent material has been derived largely from sandstone formations, but modified by glacial action, and has been deposited through the action of water as stream terraces or outwash plains. Two types in the Plainfield series, the sand and fine sand, are mapped in the present survey.

The Whitman series includes types with dark-brown to black surface soils underlain by drab, bluish, or lighter colored subsoils. The mineral portion of these soils has been derived largely from glaciated granitic material. They occur in low-lying areas along streams, and in ponded valleys or depressions in the upland where there has been a considerable accumulation of organic matter, but not sufficient to form Muck or Peat. While a large part of the material has been derived from granitic rocks varying quantities of sandstone have also been incorporated with it, especially in the region where sandstone is the underlying formation. The surface of the Whitman soils is low and level, and the drainage naturally poor.

Some alluvial material is included with these soils in places. They resemble the soils of the Clyde series as mapped in Wisconsin, but the Clyde soils are not acid, while all the members of the Whitman series are acid. One type of the Whitman series is mapped in Waupaca County, the silt loam.

The Poygan series includes types with very dark brown to black surface soils, and heavy, red subsoils. Between the soil and subsoil there is frequently a layer of drab or bluish material. The subsoil has been derived from lacustrine material of the same origin as the subsoil of the Superior series. The surface is somewhat lower, however, than that of the Superior soils, and the poor drainage has favored the accumulation and decay of large amounts of organic matter, to which the dark color of the soil is due. The types mapped in Waupaca County are the Poygan fine sandy loam, silt loam, and clay loam.

The types grouped in the Genesee series have brown surface soils and brown, yellowish-brown, drab, or mottled subsoils. The material is alluvial and is confined to the present flood plain of streams in the glacial region. The material has been derived from various sources in this county, coming in part from granitic material and in part from sandstone. The soils are of very small extent. Owing to their low position, poor drainage, and liability to overflows they are at present of little value. The types mapped in this area are the fine sandy loam and silt loam.

The Dunning series includes soils with dark-brown to black surface soils underlain by drab, bluish, or lighter colored subsoils. The mineral portion of these soils has been derived largely from glaciated sandstone material, which distinguishes it from the Whitman series, derived from granitic materials. In all other respects this series resembles the Whitman. The Dunning fine sandy loam is mapped in Waupaca County.

In addition to the soils included in the 10 series described above, a large area of Peat has been mapped. This soil consists of vegetable matter in varying stages of decomposition, with which there has been incorporated a small proportion of mineral matter.

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

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Peat	72,128	15.4	Plainfield fine sand	8,640	1.8
Shallow phase	2,624		Superior clay loam	7,744	1.6
Gloucester fine sandy loam	61,248	12.6	Superior silt loam	7,552	1.6
Kewaunee fine sandy loam	50,496	10.4	Merrimac silt loam	6,336	1.3
Kewaunee loam	36,416	7.5	Merrimac loam	6,016	1.3
Plainfield sand	34,176	7.0	Superior loam	5,120	1.1
Gloucester sandy loam	25,856	5.6	Merrimac fine sandy loam	5,056	1.1
Rough phase	1,536		Poygan clay loam	4,480	.9
Merrimac sandy loam	21,440	4.4	Poygan fine sandy loam	4,416	.9
Superior fine sandy loam	21,440	4.4	Kewaunee silt loam	4,096	.8
Gloucester sand	20,032	4.1	Genesee silt loam	3,584	.7
Dunning fine sandy loam	19,584	4.0	Poygan silt loam	3,008	.6
Gloucester silt loam	14,272	2.9	Superior sandy loam	2,880	.6
Coloma fine sand	11,840	2.5	Genesee fine sandy loam	1,152	.2
Whitman silt loam	11,584	2.4			
Kewaunee sandy loam	11,008	2.3	Total	485,760	

GLOUCESTER SAND.

The Gloucester sand to an average depth of about 8 inches consists of a brown or grayish-brown, loose sand. In some small areas the texture approaches a fine sand, while in others the soil is somewhat loamy. In some virgin areas the soil is slightly darker than usual in the surface 1 or 2 inches, because of the accumulation of more organic matter. After a few years of cultivation this usually disappears. The subsoil consists of a yellow or yellowish-brown sand, which in many places becomes lighter colored and coarser textured with increase in depth. In some instances gravel may occur sparingly on the surface, and it is usually more abundant in the subsoil below a depth of 24 inches.

Stones and bowlders of glacial origin are quite commonly scattered over the surface of this soil, but in only a few places are they abundant enough to interfere materially with cultivation. Such areas are indicated on the soil map by symbol. Where the soil is stony there is frequently more variation in texture than over typical areas.

The Gloucester sand occurs most extensively in the southwestern part of Waupaca County. The most extensive areas are found in Dayton Township and in the southern part of Farmington Township. Smaller areas lie in the northwestern part of the county, chiefly in the vicinity south of Big Falls, and throughout the western half of the county.

The surface of this soil varies from gently rolling to somewhat hilly. Most of the slopes are rather gentle and the hills fairly well rounded. Many areas have a gently rolling topography. In the

southwestern part of the county many of the areas stand out in rather sharp contrast to the surrounding level country occupied by the Merrimac soils. Because of the surface relief and the loose, open character of the soil and subsoil the natural drainage is good and in places somewhat excessive.

The Gloucester sand has been derived through glacial action, largely from crystalline-rock formations, although the underlying rock where much of the type occurs consists of sandstone. The ice sheet in its movement carried the material from the region of the granitic rocks out over the sandstone area, so that the resulting soil consists of a mixture of materials from both these sources. No limestone material has entered into this soil, and it is all in an acid condition.

The original timber growth consisted of scrubby oak and some white pine. In the northern part of the county there was some Norway pine, with hickory in a few places. The chief growth at present consists of scrubby oak, hazel brush, and sweet fern.

Probably less than half the Gloucester sand is under cultivation. General farming, dairying, and potato growing are the leading types of agriculture. Potatoes, the most important cash crop, yield from 75 to 125 bushels per acre, with occasional higher yields where the best methods are followed. Corn yields 15 to 35 bushels, oats 15 to 30 bushels, rye 10 to 15 bushels, and hay one-half to three-fourths ton per acre. It is somewhat difficult to get a good stand of clover, and timothy does not succeed very well. Yields depend to a considerable extent upon the amount and distribution of the rainfall and upon the manure or organic matter applied to the soil. The type is quite easily exhausted by continuous or improper cropping, and the methods followed are usually not those best suited to building up the productiveness.

In the improvement of this soil very careful management is necessary. It is low in organic matter and also in the mineral plant-food elements, and in addition is acid. Liming is necessary in growing alfalfa, and very helpful and often necessary in getting the best results with clover. The supply of organic matter may be increased by plowing under green-manure crops, of which the legumes are best. Where the soil is not productive it is often advisable to use commercial fertilizers in getting clover started. Commercial fertilizer may even be used to supplement the small quantities of stable manure available. The fertilizer could well contain 1 to 2 per cent of nitrogen and 10 to 12 per cent of phosphoric acid, and in growing potatoes 1 to 3 per cent of potash may also be included. A rotation well adapted to this soil consists of 1 year of small grain, preferably rye, to be followed by clover, and this by corn. While this sandy soil is usually considered well adapted to potatoes, it has been found by

numerous tests that the yield of potatoes can not be increased as readily as the yield of corn. Potatoes appear to do considerably better on the sandy loam types.

The Gloucester sand has a somewhat lower selling value than most of the other soils of the area, with the exception of the marsh lands. Some of the better improved farms have a value of $70 to $80 an acre, but the average for the whole type is probably between $25 and $40 an acre.

GLOUCESTER SANDY LOAM.

The Gloucester sandy loam, to an average depth of about 12 inches, consists of a brown or grayish-brown sandy loam or loamy sand, of a rather loose and open structure. This grades into a light-brown or yellowish loamy sand which at about 24 inches grades into a gritty sandy clay or, sometimes, a light clay loam. Quite frequently this heavy material consists of a layer 6 to 10 inches in thickness, below which sandy material is again found. In a few instances this heavier layer is entirely absent, or only a few inches in thickness. A small amount of gravel is sometimes found upon the surface and mixed with both soil and subsoil, and the surface frequently is strewn with stones and bowlders. Wherever these occur in sufficient numbers to interfere with farming operations to any marked extent they are indicated on the map by symbol. Over most of the type they are not sufficiently numerous to detract from the value of the land. There is some variation in the type; in a few places it approaches a fine sandy loam in texture.

The Gloucester sandy loam is confined chiefly to the northwestern part of the county. It occurs mostly in irregular areas seldom greater than 1 or 2 square miles in extent. Some of the more important areas are in the vicinity of North Lake and in the stretch of country between Ogdensburg and Big Falls.

The surface ranges from gently rolling to rolling and hilly. The type quite frequently occupies ridges, but modern farm machinery can be used in practically all the areas. On account of the surface relief and the rather open character of the subsoil the natural drainage is well established and often excessive.

This type has practically the same origin as the Gloucester sand, having been derived through glacial action from crystalline-rock material mixed with débris from sandstone rocks. It is probable that it contains a somewhat larger proportion of granitic material than the sand. No limestone material has entered into its formation, and both soil and subsoil show varying degrees of acidity.

The original timber growth consisted largely of oak, with some white pine, poplar, and birch and a small amount of maple and elm in places. At the present time the cut-over areas which are not

cultivated have a second growth of poplar, scrub oak, hazel brush, and some sweet fern.

Probably over half of this soil is under cultivation at present, and where good farming methods are followed the yields are usually quite satisfactory. Dairying and potato growing are the chief lines of farming. Yields average somewhat higher than on the Gloucester sand. Potatoes are better adapted to the sandy loam, and it is more readily improved. The rotation generally followed consists of a small grain, followed by clover, and this by corn or potatoes. Some difficulty is experienced in getting a stand of clover, one adverse factor being the acidity of the soil. In a few cases lime has been supplied, with good results, but on most farms no lime has ever been used.

In the improvement of this soil the supply of organic matter should be increased by supplementing the stable manure with green-manure crops. A fertilizer containing 1 to 2 per cent of nitrogen, 8 to 10 per cent of phosphoric acid, and 1 to 3 per cent of potash is well suited to this soil. Alfalfa has been grown with success, but only where special care has been taken in preparing the soil. Liming is necessary, and the use of special fertilizers is advisable where stable manure can not be applied in liberal quantities.

Improved farms on the Gloucester sandy loam range in value from $60 to $100 an acre.

Gloucester sandy loam, rough phase.—A few areas of Gloucester sandy loam occupy steep slopes which are in most places eroded and stony. These are mapped as a rough phase. The soil is in general less uniform in texture and other characteristics than the typical Gloucester sandy loam.

This phase occurs in several small areas in the southwestern part of the county. It is usually found on or near the stream slopes, in association with the typical Gloucester sandy loam or other types of the Gloucester series. It is difficult, and in many places impossible, to use modern farm machinery on the rough phase, and part of it is too rough for cultivation.

GLOUCESTER FINE SANDY LOAM.

The Gloucester fine sandy loam to an average depth of 8 inches is a brown or slightly grayish brown, mellow, fine sandy loam. The color gradually becomes lighter, being yellowish brown at a depth of 10 to 18 inches. The subsoil is usually a fine sandy loam containing considerable clay and in places approximating a sandy clay loam. The heaviest part of the subsoil usually lies at a depth of 18 to 24 inches. This may sometimes extend to a depth of 30 inches, but in the lower depths the material usually becomes somewhat more

sandy. In some areas the entire subsoil is sandy. A textural variation of this soil is found 4 or 5 miles south of Big Falls, where the material approaches a loamy fine sand.

The Gloucester fine sandy loam as a whole is somewhat stony, though typically the stones are not sufficiently plentiful to interfere materially with agricultural development. Where they are most plentiful, and where they interfere with cultural operations to any marked degree, the areas are indicated on the soil map by symbol.

The greater part of the area shown on the soil map as Gloucester fine sandy loam varies within narrow limits between a fine sandy loam and a loam. Throughout the region north of Iola, Northland, and Big Falls the more loamy variation is the predominant soil. To a depth of 10 to 12 inches it consists of a brown or buff-colored, somewhat gritty silt loam or loam. This is underlain by a brown, compact gravelly sandy loam or sandy clay which changes at 24 to 30 inches into much more sandy and gravelly material. The gravel material is frequently so plentiful in the lower subsoil that boring is impossible. There are some stones and bowlders on the surface and through the soil, but only in a few places are they so numerous as to interfere seriously with cultural operations. Such areas are indicated on the map by symbol. The stones and bowlders have been removed from many fields, and stone fences are seen in many parts of the county. Probably one-third to one-half of this variation has been cleared and placed under the plow. Where not extremely stony, it is one of the most desirable soils in the western part of the county.

Where the Gloucester fine sandy loam extends over steep slopes and rough broken areas, a rough variation has been developed. These areas are frequently very stony as well as rough. The soil is also subject to greater variation than typical, ranging from a fine sandy loam to a silt loam. Over the roughest areas the surface in places has been quite badly eroded. This rough variation occurs in small areas in the northwestern part of the county. It is found on or near the stream slopes, usually in association with the typical fine sandy loam or other soils of the Gloucester series. The greater part of the land is too rough for cultivation, and it is used principally for pasture.

The Gloucester fine sandy loam is confined almost entirely to the western half of the county, and chiefly to the northwestern quarter, where it occurs in tracts ranging from 10 acres to almost 2 square miles.

The surface is undulating to rolling, with a few areas that could be classed as hilly, but modern farm machinery can be used on practically all the type. Owing to the surface relief and the sandy nature of the soil the natural drainage is thorough, but there is sufficient

clay in the subsoil to retain moisture, and crops do not suffer from drought except during periods of extended dry weather.

The Gloucester fine sandy loam has been derived through glacial action chiefly from crystalline rocks, though the rock underlying a portion of the type is Potsdam sandstone. Material from both these formations makes up the soil, but the crystalline material appears to predominate. There is no limestone material in this region, and both soil and subsoil are in an acid condition.

Where the land has been cut-over and not put in farms the present forest growth consists largely of poplar, white birch, and hazel brush. The original growth was chiefly hardwoods, including maple, oak, birch, and some elm, with varying amounts of white and Norway pine.

This is one of the most desirable soils of the county. A considerable proportion of the type is under cultivation and in improved farms. It is devoted chiefly to dairying and general farming, with potatoes as an important cash crop. The type affords excellent grazing, and where stones are most plentiful can be used to best advantage for this purpose. Sheep are raised to some extent, and it would seem that this industry could be materially extended. Corn is grown principally for silage, but when it matures the yield usually ranges from 40 to 60 bushels per acre. Oats yield 35 to 60 bushels per acre and occasionally much more. Barley usually yields 25 to 35 bushels, and rye 15 to 20 bushels per acre. Hay, which consists chiefly of clover and timothy, yields from 1½ to 3 tons per acre. Alfalfa is grown to a small extent, but special treatment of the soil is usually necessary in getting this crop established. Potatoes yield 100 to 200 bushels per acre, and are the most important cash crop. Wheat is grown only to a small extent, but it gives very satisfactory yields. Probably the most common rotation followed consists of a small grain, seeded to clover and timothy, hay being cut for 2 years, after which the land is plowed for corn or potatoes, followed by a small grain. Stable manure is the only fertilizer used to any extent.

In the improvement of this soil one of the most important needs is to increase the supply of organic matter and nitrogen. Field tests made by the State experiment station have shown that the soil responds well to applications of phosphatic fertilizers. A fertilizer containing 1 or 2 per cent of nitrogen and 10 or 12 per cent of phosphoric acid would be well adapted to most of the general farm crops on this soil. Where potatoes are grown this fertilizer might well contain 2 or 3 per cent of potash. Since the soil is acid, the use of lime is necessary in getting best results with alfalfa. While clover usually makes an excellent growth when the land is new, it becomes increasingly difficult to raise satisfactory crops, and the use of lime is frequently necessary for the continued production of clover. Lime

is also beneficial, either directly or indirectly, to practically all the general farm crops, and its more general use would be profitable.

GLOUCESTER SILT LOAM.

The Gloucester silt loam to a depth of about 10 inches is a brown or grayish-brown, friable silt loam. The subsoil consists of yellow or light yellowish brown silt loam, which gradually becomes somewhat heavier to a depth of 16 to 24 inches, where a fine sandy loam, sandy loam, or sandy clay loam, usually containing varying amounts of fine gravel, is encountered. The separation between the silty covering and the coarser material is often quite sharp. The surface material is usually gravel free, while the deep subsoil may contain a considerable admixture of gravel. Bowlders occur irregularly on the surface, and in places in sufficient numbers to interfere with cultivation; other areas are practically stone free.

This soil is confined to the west central part of the county, and few of the areas exceed 2 square miles in extent. Most of the type is mapped north of Waupaca, between Waupaca and Scandinavia, to the west of Scandinavia, and to the west and south of Iola.

The surface varies from gently rolling to hilly, and the natural drainage is good, but there is little danger from erosion except on the steeper slopes, which should be kept covered with a growing crop as much of the time as possible.

This soil has been derived largely from crystalline rocks through glacial action. Nearly all of the bowlders are of such rocks. There is no calcareous material in either soil or subsoil, and both are acid.

The original timber growth on this soil consisted largely of maple, birch, hemlock, basswood, oak, and elm, with some white and Norway pine. All the pine has been removed, and the best of the hardwood has also been cut, but small tracts of merchantable timber still remain.

A considerable proportion of the type has been cleared and put under cultivation, and is in highly improved farms. It is an excellent soil for general farming and dairying, to which it is largely devoted. The chief crops are the small grains, corn, and hay. Potatoes are produced on a commercial scale on some farms. Sugar beets give good results, but they are not grown to any important extent at present. Peas are grown to a small extent. Corn can always be grown for ensilage, but the crop does not always mature.

While this is one of the most desirable soils of the county, there is still room for improving its productiveness. The supply of organic matter is low and should be increased by plowing under green-manure crops, of which the legumes are best. The soil is acid, and while clover does well on new land, on older fields there is some difficulty in getting a stand, and liming is necessary. Liming in fact

will be profitable for practically all the general-farm crops. The use of phosphate fertilizer has also been found profitable. Where the supply of manure is limited a fertilizer containing both nitrogen and phosphoric acid can be used with profit, and when potatoes are grown potash should be added to this.

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

Mechanical analyses of Gloucester silt 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.*
312639	Soil	0.3	1.4	1.2	4.0	28.7	56.9	7.2
312640	Subsoil	.6	5.6	6.2	17.1	23.6	38.6	8.2

MERRIMAC SANDY LOAM.

The Merrimac sandy loam, to an average depth of 8 to 10 inches, consists of a brown or slightly dark-brown sandy loam, of medium texture. This is underlain by a yellowish-brown sandy loam or a yellowish loamy sand, which at 18 to 24 inches contains sufficient clay to be somewhat sticky when wet. Gravel and stones are often numerous enough in the subsoil to make boring difficult. Gravel is also found in places on the surface, and along the margins of some areas bowlders are quite plentiful.

The largest areas of this type, several square miles in extent, are found west of Waupaca. Smaller areas occur in various parts of the county, though chiefly in the western half, associated with the Gloucester soils. The small patches which occur in the eastern part of the county contain less gravel than those in the western part.

The surface of the Merrimac sandy loam is level or nearly so, but because of the coarse material present the drainage is frequently excessive. The type, however, is not as subject to drought as is the Plainfield sand, as the small amount of clay in the subsoil greatly assists in retaining moisture.

The sandy loam has the same origin as the other soils of the Merrimac series, consisting of alluvial material deposited as outwash plains and valley fill by glacial waters. The soil is a mixture of crystalline-rock and sandstone drift. No calcareous material is present, and both soil and subsoil are acid.

The original forest growth was chiefly oak and white pine. All the merchantable timber has been cut, and about 75 per cent of the type is improved. All the general farming crops are grown, in connection with dairying. Rye gives good results, but other small

grains do not yield as well as on the heavier types. Corn and potatoes yield better than on the sand types of the county, and clover can be grown with less difficulty. Potatoes could well be included in a 3-year rotation consisting of clover, potatoes, and rye. Some alfalfa is produced, but liming is necessary to obtain a good stand. This soil is deficient in organic matter and the mineral plant-food elements.

MERRIMAC FINE SANDY LOAM.

The surface soil of the Merrimac fine sandy loam consists of a grayish-brown fine sandy loam, with an average depth of 8 inches. Below this the color gradually becomes lighter with depth, and at 14 to 16 inches a yellowish-brown color may prevail. A small percentage of clay is present in the lower depths. In some areas there is a gravel deposit at about 30 inches, and moderate quantities of gravel may be distributed through the soil section. In the eastern half of the county the type is usually free from gravel, being underlain by fine sand instead.

The Merrimac fine sandy loam is of small extent. Several areas are found in the vicinity of Waupaca and northeast of Big Falls, along the Shawano County line. Smaller areas are widely scattered throughout the county. The surface is level or only very slightly undulating, and the natural drainage is good.

This soil consists of alluvial sediments deposited as outwash plains. The materials have come largely from crystalline rocks, but in the central and eastern parts of the county there is considerable material from sandstone. No calcareous rocks have contributed to the types, however, and both soil and subsoil are in an acid condition.

The greater part of this type has been cleared of the original growth of maple, birch, hemlock, and pine, and is under cultivation. It gives good yields of all the general farm crops. It is an excellent potato soil and is also well suited to truck crops, but its location with respect to markets is unfavorable for the extensive growing of vegetables at present.

MERRIMAC LOAM.

The surface soil of the Merrimac loam extends to an average depth of 10 to 12 inches, and is a brown or grayish-brown loam or friable, light silt loam. This is underlain by a lighter colored, compact loam or silt loam which below 14 to 16 inches becomes quite gritty, and at about 24 inches grades abruptly into gravel or sand. As in the case of the silt loam, the depth of the underlying coarse material is variable. Frequently some gravel may occur on the surface and through the soil section. A few granitic bowlders, probably deposited by floating ice, are found in places.

This soil is of small extent. It is developed chiefly in the northwestern part of the county, northeast and west of Scandinavia, north

and northwest of Iola, and north of Northland. The surface is level or very nearly so, but the natural drainage is good except in a few small sags or potholes.

This soil has the same origin as the Merrimac fine sandy loam. It supported a similar growth of timber, which has been removed. The type forms very valuable farming land, and is highly improved. It is used for general farming, and is well adapted to all the common crops.

Results of mechanical analyses of samples of the soil and subsoil follow:

Mechanical analyses of Merrimac 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.*
312637	Soil	1.8	14.2	11.2	22.2	11.8	31.7	7.1
312638	Subsoil	1.2	12.2	11.6	30.0	13.2	23.1	8.5

MERRIMAC SILT LOAM.

The Merrimac silt loam, to an average depth of 8 to 10 inches, consists of a grayish-brown silt loam, which in many places approaches a loam in texture. The material is naturally rather compact, but it can be worked into a good tilth very readily. The upper subsoil consists of light-brown, compact loam or silt loam, which at 14 to 16 inches grades into a slightly yellowish-brown silty clay loam. Below 24 inches the subsoil changes abruptly into a bed of sand and gravel containing very little clay. This gravelly stratum in places lies less than 1 foot below the surface and in others may not be reached above 3 feet.

In general this soil is free from large stones and bowlders except along the margins of the areas. Stones from 4 to 8 inches in diameter may also occur in small numbers.

The Merrimac silt loam is found chiefly in the west-central part of the county in the vicinity of Sheridan, about 2 miles north of Waupaca, south of Scandinavia, and between Scandinavia and Iola.

The surface varies from level to very slightly undulating, but because of the underlying coarse material the natural drainage except in a few small sags or potholes is good.

This type consists largely of crystalline glacial débris deposited as outwash material or valley fill. None of the soil-forming material is calcareous and the type shows varying degrees of acidity.

The original timber growth, which has largely been removed, consisted chiefly of maple, birch, and hemlock, with a small amount of pine. The Merrimac silt loam is an excellent soil, and most of it

has been cleared and is in prosperous farms. Its freedom from stones makes it more desirable than some of the upland types. It is well adapted to small grains, grasses, potatoes, and various root crops. Corn produces large yields of silage, but can not be depended upon to mature every season.

The use of lime will be found beneficial in growing clover, and liming is necessary where alfalfa is to be grown. It will also increase the yields of other crops. The organic content of the soil should be increased by supplementing the stable manure with green-manure crops.

KEWAUNEE SANDY LOAM.

The Kewaunee sandy loam, to an average depth of 10 inches, consists of a brown, rather loose sandy loam which in places becomes as light as a loamy sand. The surface soil is usually underlain by several inches of lighter colored sand or loamy sand, and this grades quite abruptly into a heavy-red or pinkish-red clay. A small amount of gravel may be found on the surface and in some localities granitic bowlders occur, though seldom in sufficient numbers to interfere with cultivation. The depth of sandy material over the clay is somewhat variable, but rarely more than 2 feet. The surface soil is rather low in organic matter, except in some of the lower places where moist conditions have resulted in a heavier growth of vegetation.

This type is confined chiefly to a belt extending north and south through the central part of the county, where it is associated with other soils of the Kewaunee series and with the Superior soils. It also lies in many places adjacent to the Merrimac soils. Important areas are situated south of Weyauwega and in the vicinity of Readfield. A few smaller areas are mapped in the central part of the county.

The surface of the Kewaunee sandy loam varies from gently rolling to rolling, and in a few places to rather hilly. The drainage is naturally thorough.

The material forming the subsoil of this type is lacustrine in origin, but since its deposition it has been modified somewhat by glacial action. The surface material doubtless is largely of glacial deposition, coming in part from sandstone and in part from crystalline rocks. The surface soil is usually slightly acid, but the subsoil usually is high in lime carbonate.

The original tree growth on this soil consisted chiefly of oak, maple, and hickory, with some pine in places. Approximately half of the type is cultivated, the remainder being in second-growth timber or in pasture. This is a desirable soil. While it is devoted chiefly to general farming, it is doubtless better adapted to an intensive

system of agriculture, such as trucking. All the crops common to the region are grown. Corn usually does better than on the heavier types, because it begins growth earlier. The soil is easier to cultivate and responds readily to good farming methods. While stable manure is about the only fertilizer now used, commercial fertilizers can be used with profit. A complete fertilizer analyzing 2 per cent nitrogen, 10 per cent phosphoric acid, and 2 per cent potash is well suited to general farm crops on this soil. For potatoes the fertilizer should include more potash, while for most truck crops there should be a larger proportion of nitrogen.

The following table gives the results of mechanical analyses of the soil and subsoil of the Kewaunee sandy loam:

Mechanical analyses of Kewaunee 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.*
312661	Soil	1.4	14.1	5.6	45.6	7.2	14.6	1.4
312662	Subsoil	.5	5.5	6.6	31.1	14.1	29.2	13.0

KEWAUNEE FINE SANDY LOAM.

The Kewaunee fine sandy loam, to an average depth of about 10 inches, consists of a grayish-brown fine sandy loam. The color becomes somewhat lighter in the lower part of the surface section, owing to the smaller content of organic matter. The subsoil usually begins quite abruptly, as a pinkish-red compact clay or clay loam. It usually extends to a depth much greater than 3 feet, but thin layers of fine sand may occur in the lower part of the 3-foot section, and the clay is often lighter colored at this depth. The depth to the clay is variable, but seldom exceeds 2 feet. A small amount of gravel may occur on the surface, and small stones may be present throughout the soil section. Over part of the type granitic bowlders also are plentiful, being sufficiently numerous in places to interfere with cultural operations. In many fields the bowlders have been removed and placed in piles along the fence rows. Much of the type, however, is practically stone free.

The Kewaunee fine sandy loam is confined almost entirely to the eastern half of the county, where it occurs in many tracts ranging from less than 1 square mile to 3 or 5 square miles in extent. The type is associated with other soils of the Kewaunee series, with areas of Peat, and with soils of the Superior and Merrimac series.

The surface ranges from gently sloping to gently rolling and in some cases rolling, and drainage is well established. In no place is

the type too broken for cultivation, and erosion is not serious, but in the more rolling areas there is some danger of washing when the fields are bare, especially during the heavy spring rains when the ground becomes saturated.

As in the case of the other Kewaunee soils, the subsoil was first laid down as a lacustrine deposit, probably during interglacial times, and later modified to a greater or less extent by glacial action. The sandy surface material probably comes largely from crystalline and sandstone glacial débris. Most of the gravel, stones, and bowlders are of crystalline rock. The surface soil frequently is slightly acid, but the red clay subsoil usually contains enough lime carbonate to be neutral or alkaline in action.

The original timber growth on this soil consisted of maple, oak, elm, hickory, some walnut, and varying amounts of pine. Most of the merchantable timber has been removed, but there are numerous farm woodlots which contain valuable timber. By far the greater proportion of this soil is cleared, under cultivation, and highly improved. It is devoted to general farming and dairying, and practically all the common crops are grown. It is an excellent general farming soil, and includes some of the most highly improved farms in the region. The surface soil is sufficiently sandy to make cultivation easy, while the subsoil is heavy enough to retain moisture and to prevent loss of fertility through leaching. The surface is uneven enough to insure good drainage, but never too steep to permit the use of farm machinery. The type occurs in good-sized tracts, and many farms include no other soils. The leading crops are corn, oats, barley, rye, wheat, clover, timothy, alfalfa, potatoes, and various root crops. Some truck is grown, and the soil is well suited to such crops, but trucking has not been developed on a commercial scale in any part of the county. The farming methods on the whole are adapted to a gradual improvement of the soil. The rotation most commonly followed consists of corn, small grain, and hay. The field is usually left in hay for 2 years, and possibly pastured for a year in addition, making a 4 or 5 year rotation. A number of farmers have begun to use commercial fertilizer, with very good results, and since the supply of manure is seldom sufficient, dependence should not be placed on this alone. The soil responds well to phosphatic fertilizers, and the addition of nitrogen is also profitable, especially in small amounts to stimulate the early growth of small grains. For general farm crops a mixture analyzing 2 to 3 per cent of nitrogen and 10 or 12 per cent of phosphoric acid is well suited to this soil. For potatoes the mixture should also contain potash. The supply of organic matter is rather low, and should be increased by growing legumes as green-manuring crops. The plowing down of a second crop of clover will produce a marked increase in the yields of succeeding crops.

Where an acid condition exists and where it is desired to grow alfalfa the soil should be limed. When the roots reach to the subsoil they will find an abundant supply of lime, but the surface soil is deficient in lime carbonate.

KEWAUNEE LOAM.

The Kewaunee loam to an average depth of 8 to 10 inches consists of a dark-brown or grayish-brown loam, usually somewhat gritty. The material in most areas becomes somewhat lighter in color and more compact in the lower part of the surface layer and continues quite loamy ordinarily to 14 or 16 inches, and in some places to nearly 2 feet. There is in most places an abrupt change to the heavy pinkish-red clay subsoil, which generally lies at 14 to 20 inches below the surface. This heavy clay stratum extends to a depth of more than 3 feet, and may be many feet thick. In the lower part the 3-foot section in places becomes lighter in color and may contain a few thin sandy layers. Granitic stones and bowlders originally occurred on the surface in many places, and in some areas bowlders are still present in quantities sufficient to interfere with cultivation. Gravel and small stones are frequently present in the soil and subsoil, especially in the more westerly areas of the type, where it borders the Gloucester soils. In many places extensive areas are almost entirely stone free.

As a whole this soil is quite uniform, the chief variation being in the stoniness. There is an exception to this, however, in sections 13 and 14, Caledonia Township, where the subsoil is not red but of a yellowish-brown color, and rests upon limestone rock, which occurs within the 3-foot section in places. This variation really represents the Miami loam, but because of its limited extent it is included with the Kewaunee. The Kewaunee loam is generally associated with other soils of this series and with the Superior soils. It is confined to the eastern half of the county, where it is an important soil. It is most extensive in the southeastern part of the county, and there are numerous areas southwest of Marion and east of Symco.

The surface ranges from gently rolling to rolling, with a few areas that are merely undulating. Drainage is generally well established except in sags and in the draws between hills. Where the type borders the Superior soils or soils of the Poygan or Whitman series there is frequently a narrow strip which would be improved by tile drains. The type is seldom damaged by erosion, but unprotected fields are washed to some extent during heavy rains.

The subsoil of the Kewaunee loam has the same origin as the Superior clay, having been laid down as a lacustrine deposit and later influenced by glacial action. The surface soil may be in part of the same origin, but much of it doubtless is crystalline-rock material.

Part of it, especially the more sandy areas, probably contains material from sandstone. In a few places the surface soil shows slight acidity, but the subsoil is not acid, usually containing considerable lime carbonate.

The native forest growth on this soil consisted chiefly of maple, oak, ash, hickory, walnut, and pine. By far the greater part of the merchantable timber has been removed, but there are still many farm woodlots containing the original growth.

A large proportion of the Kewaunee loam is cleared and under cultivation, and it is known to be one of the best soils for general agriculture in the county. All the common crops are grown successfully, but the predominating type of agriculture is general farming, with dairying as the chief branch. Small grains, corn, and hay are grown most extensively. While most of the hay is clover and timothy, alfalfa is coming to be an important crop and is being grown with success on many farms. Potatoes are grown for home use on all farms and on a number commercially. The most common crop rotation consists of a small grain, hay, and corn, to which may be added a year of pasture after one or two years of hay. Stable manure is the chief fertilizer used, but commercial fertilizers containing nitrogen and phosphoric acid are being tried by some farmers, with marked success. Where potatoes are grown the fertilizer should contain potash. The organic-matter supply can be readily increased by growing green-manure crops, of which the legumes are best.

KEWAUNEE SILT LOAM.

The Kewanuce silt loam, to a depth of about 8 inches, consists of a brown silt loam, containing only a moderate amount of organic matter. This is underlain by a gray silt loam or silty clay loam which gives way at 14 to 16 inches to the typical pinkish-red, heavy clay subsoil. The clay stratum in most areas extends to a depth much greater than 3 feet, though frequently in the lower part of the 3-foot section there may be thin layers of fine sand. A lighter color may also exist at this depth. The soil as a whole is quite uniform except in stoniness, some areas being entirely stone free, while others have many bowlders on the surface.

This type is of small extent and therefore of minor importance. The largest areas lie southeast and southwest of Marion and north of Manawa. The surface is gently rolling to rolling, and the drainage good except along some of the lower slopes.

The original timber growth on this soil was the same as on the loam and fine sandy loam types, but most of the merchantable growth has been removed. This is an excellent farming soil, and

the greater part of it is well improved. It is easier to work than a clay loam, but sufficiently heavy to retain moisture well and to prevent fertilizing materials from being leached away. The same crops are grown as on the Kewaunee loam, the same methods are followed, and the same means of improvement can be used.

Mechanical analyses of samples of soil and subsoil of the Kewaunee silt loam gave the following results:

Mechanical analyses of Kewaunee silt 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.*
312613	Soil	0.4	3.8	3.6	24.2	14.4	44.2	9.2
312614	Subsoil	.8	2.4	3.2	12.6	11.0	47.9	22.0

SUPERIOR SANDY LOAM.

The Superior sandy loam, to a depth of 10 to 12 inches, consists of a brown or grayish-brown, loamy sand to light sandy loam. Below this there is usually a few inches of light-brown or yellowish loamy sand, underlain at about 18 inches by a dense, compact, pinkish-red clay, which extends to 36 inches or more. In some places there is a substratum of yellowish sand, usually water saturated, at about 30 inches. The depth of the sandy material over the clay subsoil is quite variable, but the heavy subsoil is always found at 2 feet or less.

This soil covers a total area of only about 4 square miles, and is confined chiefly to the southeastern part of the county, south and southeast from Fremont. It is also found north of Weyauwega, and a few scattered areas occur farther north in the central part of the county. The type is usually associated with areas of Superior clay loam. The surface is level or gently undulating, but except for a few sags the drainage is fair to good.

The original timber growth consisted of oak, maple, birch, elm, and in the wettest places a little willow. Some pine also grew on this soil.

This is a valuable soil for general farming, and most of the crops common to the region are successfully grown on it. Where the drainage is thorough it is a first-class potato soil. It is easy to cultivate, and retains moisture well. Where the shipping facilities are convenient this soil could well be used for more intensive farming, such as trucking, owing to its light surface texture.

SUPERIOR FINE SANDY LOAM.

To an average depth of 10 inches the Superior fine sandy loam consists of a grayish-brown fine to very fine sandy loam, containing

a moderate amount of organic matter. In low places the surface material is darker than typical, owing to a greater accumulation of vegetable matter. The subsoil consists of a pinkish-red clay loam which may extend without change to 3 feet or more, but which frequently gives way to fine sand at about 30 inches. In the lower depths the color is also lighter. The depth of the surface soil over the clay is variable, ranging from 6 inches in some places to 16 or 18 inches in others.

This soil is found in scattered areas in the eastern half of the county, where it is associated with other soils of the Superior series and with the Kewaunee soils. Of the larger areas may be mentioned the one north of Bear Creek and those between Clintonville and Embarrass. The total extent of the type is comparatively small.

The surface of the Superior fine sandy loam is level or merely undulating, but except in the lowest places and in depressions the natural drainage is fair to good.

The original timber on this soil was chiefly maple, elm, oak, birch, and some poplar, with now and then a white pine. The greater part of the type has been brought under cultivation. The lower and more poorly drained areas are devoted chiefly to hay and pasture, but the rest of the type is used in the production of the general farm crops, of which good yields are obtained. The soil is not difficult to cultivate and a good, mellow seed bed can be readily worked up. Corn, small grain, hay, and potatoes are the most important crops. The type is much better adapted to potato growing than the heavier soils of the series. Alfalfa is successfully grown in some places.

In the improvement of this soil drainage of the lower spots is a factor which should be considered, since these break up many fields. It would be well gradually to increase the organic content of the soil by the use of legumes to supplement the stable manure. It will also be found profitabe to enrich the manure with acid phosphate, and where a good supply of manure is not available a mixed fertilizer containing nitrogen, phosphoric acid, and potash could be used with profit, especially on such crops as potatoes. For general farm crops, such as corn and small grains, the potash could be omitted.

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.*
312605	Soil	0.9	3.9	6.8	25.6	14.4	40.3	8.1
312606	Subsoil	.2	2.5	4.0	15.6	11.8	45.4	19.9

SUPERIOR LOAM.

The Superior loam consists of 8 inches of grayish-brown, mellow loam containing relatively large proportions of fine and very fine sand, underlain by a compact, pinkish-red clay or clay loam which continues to a depth of more than 3 feet. Usually the color becomes deeper red, and the structure somewhat more plastic with depth. In places there is a small quantity of gravel on the surface and mixed with the soil, but as a whole the type is stone free and uniform.

This soil is confined to the eastern half of the county. Areas lie in the vicinity of Nicholson, and other small tracts near Symco and New London. The surface is level to undulating, but drainage is fair or even good, except in the lower places, being better developed than on the clay loam and silt loam types of the series.

The loam has the same origin as the Superior clay loam and silt loam, the materials forming it having been deposited in quiet waters and later modified to some extent by glacial action.

The original tree growth consisted chiefly of oak, hickory, and some elm. Most of the type has been cleared and placed under cultivation, and is in a high state of development. It is an excellent soil, well suited to the general farm crops commonly grown in the region, and is used chiefly in the production of small grains, corn, and hay. Potatoes are also grown, but usually only for home use. The soil is easier to cultivate than the clay loam, and on the whole is a somewhat more desirable soil. Stable manure is almost the only fertilizer used at present, though commercial fertilizers have been tried and found profitable. The soil responds especially well to phosphatic fertilizers.

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

Mechanical analyses of Superior 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.*
312615	Soil	0.4	2.8	3.4	19.0	16.4	46.8	10.9
312616	Subsoil	.6	2.4	2.6	14.8	14.8	43.5	21.2

SUPERIOR SILT LOAM.

The surface soil of the Superior silt loam, which has a depth of 6 to 8 inches, consists of a light-brown, friable silt loam, containing a moderate quantity of organic matter. In some of the lower places

where the soil is somewhat darker more organic matter is present. The subsoil is a light-reddish or pinkish-red, heavy, compact clay loam which extends to a depth of over 3 feet. Upon drying, large cracks are formed in both soil and subsoil, especially in uncultivated places, and a cross-section of the soil shows light-colored streaks which represent crevices into which some of the surface silt was washed. This soil is quite uniform. It closely resembles the clay loam except that the surface soil is somewhat more silty.

The Superior silt loam is confined to a few areas in the eastern half of the county, principally east of Clintonville, north and northwest of Manawa, and east of Waupaca. The surface is level or only very gently undulating, and because of this and the heavy nature of the subsoil the natural drainage is deficient. Where the type borders the Kewaunee soils, into which it merges very gradually, it is frequently difficult to place the boundary line, as the only difference between the two soils is in topography.

In origin this type is identical with the Superior clay loam. It is derived from lacustrine beds, deposited probably during interglacial time, subsequently modified to a small extent by glacial action.

The original tree growth consisted largely of hickory, elm, and oak, with some ash and willow in the wetter places.

Most of this soil has been cleared and is used for some agricultural purpose. Where drained it is mostly under cultivation, and excellent yields are usually obtained. Where not drained it is used chiefly for hay or pasture land, to which purposes it is very well suited. The chief crops grown are small grains, corn, and hay.

In the improvement of this soil the establishing of thorough drainage in the poorly drained areas is the first need. The addition of organic matter is in most cases advisable, and the use of commercial fertilizers, especially those containing phosphate, will result in marked increases in yields. At present stable manure is practically the only fertilizer used, and the supply is insufficient to meet the requirements of the soil.

SUPERIOR CLAY LOAM.

The Superior clay loam, to an average depth of 6 to 8 inches, consists of a grayish-brown to light chocolate brown clay loam or silty clay loam. The subsoil is a heavy, compact, pinkish-red clay, which in most places extends to a depth greater than 3 feet, although the material below 30 inches may become somewhat lighter in color and coarser in texture. Upon drying, large cracks are formed in the surface soil and to a considerable depth in the subsoil, and the thin ashy gray streaks which appear throughout the subsoil probably mark the location of former cracks subsequently filled with the silty surface material. In some areas waterworn gravel and a few small stones

are found upon the surface and mixed with the soil. In places a stratum of medium to fine sand occurs in the deep subsoil, but it is seldom more than a few inches in thickness and underlain by red clay similar to that of the upper subsoil. Such areas occur chiefly east of Fremont.

The Superior clay loam is confined to the eastern half of the county, and occurs chiefly in the southeastern part, within the valley of the Wolf River. The most important areas are found in the vicinity of Fremont and Weyauwega. A few small bodies lie near Clintonville and Northport, and others are scattered through the eastern part of the county.

The surface of the Superior clay loam is level or nearly so, and owing to this and to the heavy subsoil the natural drainage is deficient. On many of the farms open ditches have been dug or the fields have been laid out in narrow lands so that the dead furrows would serve as surface drains. Some of the better improved farms have tile drains, and it is only a question of time until underdrainage will be applied to practically all the type.

This soil is similar in origin to the other Superior soils. It also contains considerable carbonate of lime, especially in the subsoil. The surface material for the most part is not acid, though in some places a slight acidity has developed.

By far the greater part of the original timber growth of hickory, oak, elm, birch, maple, and poplar has been removed, and a considerable proportion of the type is used for farming. The better drained areas are cultivated, and the others used for hay and pasture. When thoroughly drained this is an excellent soil, though somewhat difficult to handle because of its heavy texture. It is devoted to the general-farm crops, principally hay, small grains, corn, and potatoes. Considerable fall plowing is done, and in general up-to-date methods of cultivation are practiced.

In the improvement of this soil drainage is the foremost need. Organic matter should be added by growing legumes. A commercial fertilizer containing a small percentage of nitrogen and a liberal percentage of phosphoric acid will give very good results on this soil. Where there is a good supply of freshly decaying organic matter a sufficient amount of potash will be made available for most general farm crops, but for potatoes potash may well be added to the mixture suggested above.

COLOMA FINE SAND.

The surface soil of the Coloma fine sand, to an average depth of 6 inches, consists of a brownish-yellow, loose fine sand, containing only a small amount of organic matter. The surface 2 or 3 inches has a somewhat darker color than the material immediately below. The

subsoil consists of a loose, yellow fine sand which extends to a depth of at least 36 inches, and in most areas to a much greater depth. In a few places traces of red clay are found a little below 3 feet. This is the same material that makes up the subsoil of the Kewaunee and Superior soils.

In two areas, 2 miles south of Manawa and 2 miles west of Royalton, the surface layer, 6 to 8 inches thick, is a brownish-yellow, medium sand, and this is underlain by yellow sand to a depth of more than 3 feet. A small quantity of gravel is found upon the surface and mixed with the soil.

The Coloma fine sand is confined to the eastern part of the county. The areas east of White Lake, south of New London, and around Clintonville are the most extensive.

The soil has a gently rolling surface, which in a few places becomes nearly hilly. It usually occupies the more elevated positions, exposed to the prevailing winds, and where the surface is not protected the material is sometimes blown into dunes. In a few small areas wind action has made the land unfit for cultivation. Because of the loose, open character of the soil and the surface relief the natural drainage is very thorough and in places somewhat excessive.

This soil has been derived largely from glaciated sandstone material. No limestone has entered into its formation, and both soil and subsoil are in an acid condition.

The original timber growth consisted chiefly of scrub, white, and black oak, poplar, and pine. Approximately 75 per cent of the type has been cleared and is used for some agricultural purpose. The range of crops grown is more restricted than in the case of the heavier soils. Corn and potatoes are grown most extensively, but the average yields are low. Clover and grasses do not do especially well. Small grains are grown, of which rye is the most important, but the yields are low. Buckwheat is a crop of minor importance. Cucumbers are grown in places and frequently produce very satisfactory yields.

In the management of this soil it is important that the surface should be covered as much of the time as possible, to prevent drifting. Where difficulty is encountered in getting clover started a commercial fertilizer may be used to advantage. Experience has shown that corn can be more readily increased in yield than potatoes, and a rotation well suited to this soil consists of small grain, clover, and corn. The second crop of clover should be plowed under to supply organic matter.

Farms on this type have a relatively low selling value—$40 to $50 an acre.

PLAINFIELD SAND.

The Plainfield sand, to an average depth of 8 to 12 inches, consists of a loose, rather incoherent sand of medium texture. It has grayish-

brown or yellowish-brown color at the surface, indicating a low content of organic matter. The upper subsoil is rusty brown sand, but grades into a yellow sand, which in places contains a small quantity of fine gravel. Gravel and a few small stones also occur here and there on the surface and in the soil.

The Plainfield sand is a comparatively extensive soil. Its principal development is in the southwestern part of the county, in the town of Dayton. Smaller areas occur elsewhere, but mostly in the western half of the county. In the northeastern part it is found in the vicinity of Embarrass and along the Pigeon River between Clintonville and Marion.

The surface is level to very slightly undulating. In a few places there are potholes or sags, but these are always of small extent. Such slight relief as exists is due chiefly to wind action, and there are a few typical sand dunes.

Because of the loose, open character of the material the natural drainage is excessive, except where the water table lies close to the surface.

This soil, which is of alluvial origin, has been deposited as outwash plains and stream terraces, the material having been derived from both crystalline and sandstone glacial drift. In the western and north-central parts of the county dark-colored crystalline grains are quite abundant, while in the eastern part there is a larger proportion of quartz grains. There is no calcareous material present, and both soil and subsoil show varying degrees of acidity.

The original timber growth consisted of scrub oak, jack pine, and white pine, with hazel brush and sweet fern quite abundant. Most of the type has been cleared and placed under cultivation, but because of its low productiveness and droughty condition some farms have been abandoned, and it is not uncommon to find fields that have lain idle for several years.

Probably 75 per cent of this type is under cultivation more or less regularly, and some of the farms are highly improved and prosperous, but a larger number are in a depleted state. The chief crops are potatoes, rye, corn, and hay. Clover does not do well unless special attention is given to it. Rye does better than other small grains, but the average yields are low.

Potatoes are the chief cash crop, and a considerable acreage is grown on nearly every farm each year. Some dairying is carried on, and this is a good means of building up the soil, but the difficulty of obtaining good yields of forage crops handicaps the dairy industry.

While it is generally considered that sand soils such as this are well suited to potato culture, the results of recent careful experiments[1] show that it is easier and more profitable to increase yields of corn on

[1] Bul. 299, Wis. Agr. Expt. Sta.

the Plainfield sand than of potatoes. An extension of the acreage in corn will also make possible the keeping of more stock, which in turn will provide more manure for building up the soil. Commercial fertilizers can well be used in the improvement of this soil. Where it is difficult to get clover started, the soil should limed to correct the acidity, and mineral fertilizers could well be used to insure a good, vigorous growth of the young clover plants. A good stand of clover means a big step forward in soil improvement.

A rotation well suited to this soil consists of clover, corn, and rye, with the second crop of clover plowed under for green manure. Under careful management for a period of years profitable yields can be maintained, but under careless methods the fertility of the soil is quickly reduced to a point where yields are not profitable.

PLAINFIELD FINE SAND.

The surface soil of the Plainfield fine sand consists of a brown or yellowish-brown fine sand, 8 inches deep, underlain by a yellow fine sand extending to a depth of over 3 feet. Considerable gravel occurs in places, but the type is usually free from gravel as well as stones. Some deep-well borings reveal a red clay, and it is possible that most of the type may be underlain by such material.

This soil is confined chiefly to the eastern half of the county, where it is often associated with the Coloma fine sand. The surface is level or very gently undulating, but where the water table is not close to the surface the natural drainage is excessive.

The Plainfield fine sand is of alluvial origin and has been deposited as outwash plains or valley fill. A large proportion of the material came from glaciated sandstone, but a part from crystalline rocks.

The native timber growth consisted chiefly of oak and white pine, with some poplar. A large proportion of the type is cultivated, but because of its small extent and low agricultural value it is not of much importance. The general farm crops are grown, and cucumbers and buckwheat are produced to some extent. Dairying is the leading industry.

As with the other members of the Plainfield series, this soil is deficient in organic matter and this must be supplied if marked increases in yields are to be obtained. The soil also responds well to applications of commercial fertilizers. In general the methods of improvement suggested for the Plainfield sand can be applied equally well to this soil.

WHITMAN SILT LOAM.

The Whitman silt loam to a depth of 10 to 18 inches consists of a dark-brown or black loam to silt loam, containing a large amount of organic matter. In many places there is a layer of peat or muck on

the surface, but this is never thick enough to justify classing the type with the cumulose soils. The subsoil consists of a black or dark-brown, heavy loam or silty clay loam, which at 18 to 24 inches becomes gray or bluish in color, with numerous yellow and rusty mottlings. In the lower part of the 3-foot section the texture becomes lighter, in many places a fine or very fine sandy loam. The type is subject to considerable variation in texture, in depth of the black soil over the bluish subsoil, and also in the sandy layer in the deep subsoil, but it is uniform in being rather heavy, dark colored, high in organic matter, and poorly drained.

This type occurs in two distinct situations, in depressions or sags in the upland, and in low areas bordering the streams. The latter areas are by far the most extensive. The largest body lies along the Wolf River just north of Fremont, in the southeastern part of the county. Smaller areas occur along the same stream in the northeastern part, and also along the Embarrass and Pigeon rivers. A few scattered areas of the type occupying depressions occur throughout the county.

The surface of this soil along the streams is level or slopes gently toward the channel. Its natural drainage is everywhere deficient. Practically all the type along streams is subject to overflow, and much of it is under water for some part of each year.

Those areas of the type adjacent to the streams are largely of alluvial origin, with a large accumulation of organic matter in the surface layer. The material has come largely from the crystalline-rock region, although within the county much of the type directly overlies sandstone formations. The areas which are not adjacent to streams are largely of glacial origin and occur chiefly in shallow potholes or slight depressions where the drainage is deficient and where there has been an accumulation of organic matter. In most cases there is no lime carbonate in the soil, and it shows varying degrees of acidity.

The native vegetation on this soil consists of willow, elm, ash, soft maple, and poplar. There are quite extensive tracts which are treeless and which at present have only a dense growth of coarse marsh grasses.

The chief use of this soil is as pasture and hay land, but much of it is too wet for even these purposes. Artificial drainage would be very difficult, since much of the type lies but little above the level of the water in the Wolf River. If suitable drainage could be provided the soil would be found very productive, and adapted to most of the general farm crops.

POYGAN FINE SANDY LOAM.

The surface soil of the Poygan fine sandy loam consists of a black or very dark brown fine sandy loam or loam, high in organic mat-

ter. This material extends to a depth of about 12 inches, where it changes, becoming lighter in color and heavier in texture. At about 18 inches a drab, gray, or bluish somewhat gritty silt loam or loam occurs, and this continues to a depth of 2 to 3 feet, where in most areas heavy red clay, similar to that forming the subsoil of the Superior series is encountered. It is probable that this clay occurs under all the type, although not always within reach of the soil auger. The lower subsoil is quite variable and may be a sticky sandy loam or loam of a bluish color. In a few places it is a fine sand.

The Poygan fine sandy loam is chiefly in the northeastern part of the county. Several small areas occur east and west of Embarrass, 3 miles north of Bear Creek, and about 2 miles northwest of Clintonville.

The surface is level and low lying, and the natural drainage very poor. The type is associated with the other Poygan soils and is frequently developed in belts bordering marshes.

The red subsoil has the same origin as the material giving the Superior soils, but it is probable that the sandy surface stratum may have been washed in from the higher lying lands adjoining. The dark color is of course due to the growth and decay, under moist conditions, of a rank vegetation.

This soil in its native state supports a growth of elm, ash, willow, and alder, with a carpet of coarse grasses and other moisture-loving vegetation. Little of the type has been cleared and placed under cultivation, because of the poor drainage. Most of it is pasture or hay land, although some is still in timber and is not used for any purpose. When thoroughly drained this will be an excellent soil for general farming crops, as well as for various truck crops, where other conditions are favorable for the development of intensive farming operations.

Small areas of Poygan loam have been mapped with this type. It is characterized by 8 to 12 inches of dark-brown to black, mucky loam, often somewhat sandy. This passes into a drab or bluish, plastic sandy clay loam which is generally more or less mottled. From 18 to 24 inches streaks of pinkish red are found, and the texture gradually becomes heavier. Below 2 feet there is a heavy, red, plastic clay, the same as is found under the Superior soils.

POYGAN SILT LOAM.

The Poygan silt loam, to an average depth of about 12 inches, consists of a dark-brown or black silt loam, containing a very large proportion of organic matter. While the surface layer is generally a silt loam, the type is somewhat variable, and many of the areas

approach a loam in texture; there is also some fine sandy loam included with the type.

The subsoil consists of a gray or bluish silt loam which continues to 24 to 30 inches, where the red clay typical of the Superior clay loam is encountered. At or near 3 feet beds of sand or fine sand are frequently found. The upper subsoil is subject to some variation. It may be no heavier than a loam, and mixed with more or less gritty material. In some places the red clay is entirely lacking.

The Poygan silt loam is found in numerous small areas throughout the northeastern and southeastern parts of the county. It in many places borders marshes, and is associated with the Superior and Kewaunee soils.

Owing to the low position and the level surface, the type has poor natural drainage, but most of it is so situated that it can be tile drained.

The material forming this type is largely lacustrine, but since its deposition there have been added to it large accumulations of organic matter through the growth and decay of a rank vegetation. The material, especially in the subsoil, is calcareous, and the type is very seldom in an acid condition.

The original tree growth on this land consisted chiefly of elm, soft maple, ash, willow, and alder, with coarse grasses and other water-loving vegetation. Because of the naturally poor drainage, only a small part of the type has been placed under cultivation. It is a rich, productive soil, and when thoroughly drained makes excellent farming land. Most of it is now used as hay and pasture land.

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

Mechanical analyses of Poygan silt 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.*
312623	Soil	0.0	1.1	1.2	17.6	21.3	42.8	15.9
312624	Subsoil	.0	.3	.5	9.1	18.8	49.8	21.4

POYGAN CLAY LOAM.

The Poygan clay loam consists of 8 to 10 inches of dark-brown silty clay loam to silty clay, underlain by a light-brown, drab, or bluish silty clay, in many places mottled with brown and yellow. At 14 to 20 inches the material changes to a plastic clay streaked or spotted with pinkish red and bluish gray and at 20 to 24 inches to a dense, pinkish-red clay similar to the subsoil of the Superior soils.

This type occurs in many small, widely scattered areas throughout the eastern half of the county. It is found mostly in small pockets or sags, less than 100 acres in extent. The largest area mapped lies north of Bear Creek.

The surface is flat or saucer-shaped, and the natural drainage is poor, water frequently standing on the surface in the spring and after heavy rains. Before the land can be used for cultivated crops drainage is necessary. This soil is largely of lacustrine origin, though it has doubtless been modified to some extent by glacial action. There has also accumulated at the surface a large amount of organic matter, which accounts for its dark color. The soil is seldom acid, and the subsoil contains considerable lime carbonate.

The native timber growth consisted of elm, ash, and willow, with coarse grass and other water-loving vegetation. This is naturally a strong, productive soil when drained, but only a very small proportion of it has been placed under cultivation. Where cleared it is being used chiefly for the production of hay and for grazing.

DUNNING FINE SANDY LOAM.

The surface soil of the Dunning fine sandy loam consists of a dark-brown to black fine sandy loam extending to a depth of 8 to 12 inches. In some places the texture approaches a sandy loam, while in others it is nearly a very fine sandy loam. In all cases it contains a large amount of organic matter, and there is frequently a thin covering of peaty or mucky material over the surface, though this is not deep enough to be classed as shallow Peat. The subsoil consists of a gray or grayish-brown fine sandy loam or gritty sandy clay loam, containing considerable silt in places. The deep subsoil is often mottled, especially where there is the most clay present. The texture of the type is quite variable, but it is always somewhat sandy and high in organic matter.

This soil is rather widely distributed throughout the county, mostly in small bodies and narrow strips along water courses. In few instances does a single area exceed 1 square mile in extent. The type is most extensive in the eastern half of the county, and especially in the southeastern quarter, where it is associated with other low-lying soils along the valley of the Wolf River. Smaller bodies occur along the Embarrass and Wolf Rivers in the northeastern corner of the county, and other streams.

The surface of this soil is level and low lying, and the natural drainage is very deficient. Much of the type is subject to overflow, and parts of it are under water for some time each year.

Areas adjacent to streams are largely alluvial in origin, while those more distant from streams, occupying old lake or pond beds, are

largely glacial. The materials have come in part from crystalline rocks, and in part from sandstone. In most cases the soil is acid.

The native vegetation on this soil consisted of elm, willow, ash, soft maple, some poplar, and coarse marsh grasses. Many areas are treeless and support only a growth of coarse grasses.

The Dunning fine sandy loam is used chiefly as hay and pasture land, but much of it is too wet most of the year for even such use. Some of the better-drained areas have been placed under cultivation, and in seasons of light rainfall good crops are produced.

The greatest need of this soil is drainage, but where it occurs adjacent to streams its reclamation would be very difficult in most cases, since it is but little above the normal level of the water.

Below are given the results of mechanical analyses of samples of the soil and subsoil of the Dunning fine sandy loam:

Mechanical analyses of Dunning 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.*
312607	Soil	0.1	2.0	5.4	36.0	14.0	30.7	11.8
312608	Subsoil	.1	1.2	5.6	65.0	10.2	14.5	3.3

GENESEE FINE SANDY LOAM.

The surface soil of the Genesee fine sandy loam consists of a brown or dark-brown fine sandy loam, 8 to 10 inches deep. The subsoil is a lighter brown fine sand, somewhat loamy, with thin layers of red clay. In the lower depths there is usually found some fine sand. The type is somewhat variable in texture, ranging from a fine sand to a very fine sandy loam or loam, but these variations could not be separated because of their small extent.

The Genesee fine sandy loam occurs mainly in the valley of the Wolf River, at and below New London, with a few patches along the Little Wolf near Manawa. The surface of the type is level, and the drainage very deficient.

The material, which is all of alluvial origin, has come in part from sandstone and in part from crystalline rocks.

The native vegetation consists of elm, ash, willow, coarse marsh grasses, and other water-loving plants.

Since the type is all subject to overflow, only a very small part of it has been brought under cultivation. In New London this soil is being farmed to some extent to truck crops, and good returns are obtained when floods do not interfere. Most of the soil is used for pasture and for hay, to which in its present condition it is doubtless best adapted.

GENESEE SILT LOAM.

The Genesee silt loam to a depth of 10 inches consists of a brown or frequently dark-brown, rather compact silt loam. The subsoil is a silt loam or silty clay loam of lighter brown color with a suggestion of red in places, containing here and there lenses of fine sand. The deep subsoil is in many areas a fine sandy loam or very fine sand. The type as a whole is subject to considerable variation, and is still in process of formation.

Most of this soil occurs in association with the fine sandy loam along the Wolf River, a strip of fine sandy loam ordinarily lying between the silt loam and the river.

The type is subject to annual overflow. The surface is level and low lying and the natural drainage very poor.

The timber growth consists of ash, elm, willow, and soft maple, with a carpet of coarse grasses and other water-loving vegetation. In a few places attempts have been made to cultivate the land, but the danger of floods prevents any extensive development. The soil is very fertile, and if the drainage could be perfected this would be a valuable type for farming. Under present conditions it would not be practicable to attempt to drain the land. The use of dikes, and possibly pumping plants, would be necessary, and this at present would not be profitable.

PEAT.

The areas mapped as Peat consist of vegetable matter in varying stages of decomposition, with which there has been incorporated a small quantity of mineral matter. Where raw and fibrous, and only slightly decomposed, the peat has a brown color, but where more completely decayed it becomes darker and in places black. It is light in weight as compared with other soils, and naturally loose and spongy. The surface material is often lighter brown than that at a depth of 2 feet or more, especially in the timbered marshes. In some instances the more thoroughly decomposed material occurs at the surface and the raw, fibrous, peaty matter is found at lower depths. This appears to be the case most frequently where the marshes were originally treeless.

The organic material in the Peat areas ranges in depth from 18 inches to over 3 feet. Where its depth is less than 18 inches it is mapped separately as a shallow phase. In some instances the Peat is known to be over 10 feet deep. The material underlying the Peat is variable. Where the surrounding soils are sandy it is usually underlain by sand, and where the upland bordering the marsh is heavy the underlying material of the Peat is usually heavy, also.

Peat is the most extensive soil mapped in the county. It exists in practically all parts of the county, the areas varying in size from a few acres to several square miles. Among the more extensive areas are the one 5½ miles southwest of Clintonville, one 2½ miles east of Manawa, and another immediately northeast of White Lake. East of Embarrass there are several smaller bodies and numerous less important ones are scattered throughout the county. The Gloucester, Kewaunee, and Superior soils are in many places separated by areas of Peat.

The surface of the areas is low and level, and the soil is water soaked and poorly drained. Before farming can be carried on it must be reclaimed by some system of drainage. A small proportion of the type has been drained more or less thoroughly by open ditches, which in some cases have been supplemented by tile drains.

The nature of the crops that can be grown on Peat depends upon two factors the drainage and the danger from frosts. When only a main outlet and lateral ditches have been installed hay crops alone can be safely grown in the great majority of cases, and the character of the hay crops will also depend a good deal on the drainage. In the case of peat underlain by sand, well-constructed and sufficiently deep ditches 40 to 80 rods apart will, in some cases give adequate drainage for hay, but when the peat is underlain by silt or clay the ditches must not be more than 20 rods apart, and the water in the ditch must be 4 or 5 feet below the surface during part of the growing season. When tilled crops are to be grown, such as corn, cabbage, or potatoes, or a small grain, the drainage must be still more thorough, and over most of the peat this means a comprehensive drainage system in the form of either open lateral ditches or tile drains not more than 10 and often not more than 5 rods apart on the average. Tile drainage is the more satisfactory, but the cost amounts to $20 to $30 per acre after the main outlets have been put in.

It is well known that frosts frequently occur on the Peat marshes when there is no frost at all on the higher land adjoining. This is partly because the cold air tends to collect in low places, but also in part to the incapacity of the loose, spongy Peat soil to conduct the noonday heat to as great a depth as do the earthy upland soils, and since the heat left in the surface inch or two is rapidly lost at night by radiation, the freezing point is frequently reached when it would not be on a sandy loam or clay loam soil. This difficulty can be overcome to some extent by compacting, and it will also decrease as the Peat decomposes and takes on more of the character of Muck. Nevertheless, it must always be expected that the marsh land will be more subject to late spring frosts and early fall frosts than the upland, and it may be stated as a general guide that killing frosts

will occur at about the same time as in upland regions about 150 miles farther north, or 2 weeks or more earlier than on hilltops in the same latitude, so that such crops as corn and potatoes, while safe for the upland region, should not be depended on as the chief crops on peat.

The native vegetation on the Peat marshes consists chiefly of coarse marsh grasses, sedges, and phagnum moss on the open marshes, with willow, alder, some poplar, and tamarack in the timbered tracts. By far the greater proportion of the Peat is still unreclaimed, but some tracts have been cleared and are being used for hay and pasture. The hay is made from the coarse marsh grasses, which have a considerably lower feeding value than the tame grasses. Wire grass from some marshes is marketed for making rugs and matting. In a few instances patches of Peat have been drained and used for planted crops. Part of the area north of Waupaca is used for growing potatoes, cabbage, celery, onions, and other garden truck, and it is well suited to these crops. There is no reason why a larger proportion of the Peat lands of this county should not be reclaimed and used for these and other cultivated crops, as well as for hay and pasture.

Peat, shallow phase.—The Peat, shallow phase, is not nearly so extensive as the typical Peat, although it is fairly well distributed throughout the county. It often forms the border between the highland and areas of deep Peat, but some tracts are made up entirely of the shallow phase. It differs only in having a depth of 18 inches or less, while the typical Peat is usually over 3 feet deep. As in the case of the typical Peat the subsoil is variable, conforming quite closely with that of the adjoining upland. The shallow phase probably contains somewhat more mineral matter than the typical, but none of the areas could be mapped as Muck.

Very little of the shallow Peat is under cultivation. It is used to some extent for hay and pasture, but only a few small areas have been reclaimed for cultivation.

In the improvement of the Peat lands of Waupaca County the first step, of course, is drainage. With the exception of the marshes immediately along the Wolf River it is probable that much of the Peat can be drained and successfully cultivated. It will be necessary to use commercial fertilizers for a period of years, since this soil is deficient in both potash and phosphoric acid. It is abundantly supplied with nitrogen and organic matter, so that stable manure can better be used on upland soils where the nitrogen of the manure is needed. The use of a heavy roller to compact the soil is desirable. With thorough drainage, cultivation, and fertilization the Peat soils

will produce good yields of such crops as onions, cabbage, celery, alsike, and timothy. Soy beans can also be grown successfully, and they supply an abundance of nutritious feed.

SUMMARY.

Waupaca County, Wisconsin, is situated a little to the east of the center of the State. It comprises an area of 759 square miles, or 485,760 acres. The surface varies from level to rolling or hilly, with the greater part of the county gently rolling. Elevations of the towns along the railroads range from 767 to 930 feet above sea level. All of the county lies within the drainage basin of the Wolf River.

The first settlement in Waupaca County was in 1843, at the present site of Fremont. The county was organized in 1851. In 1910 the total population was 23,782, of which 83.7 per cent was classed as rural. The population is fairly well distributed throughout the county. The largest tracts of unimproved land are in the northwestern part.

Waupaca County is traversed by the main line of the Green Bay & Western Railroad and the St. Paul, Minneapolis & Sault Ste. Marie, and the eastern side of the area is skirted by the Chicago & North Western Railway.

The mean annual rainfall is approximately 32 inches, and the mean annual temperature 44° F. The winters are long and severe, with a snowfall of about 40 inches, but the summers are warm and all crops make rapid growth. There is an average growing season of 129 days free from killing frosts.

The agriculture of the county shows all stages of development. The southwestern portion of the area has considerable sandy soil, some of which is of low value for farming purposes. There are also some sandy spots in other parts of the county, but not of such great extent. There are many highly improved farms within the area, and this is one of the leading potato-growing districts of the State.

The principal crops grown are hay, oats, potatoes, corn, rye, and barley, with some wheat and buckwheat. General farming is the prevailing type of agriculture, with dairying and potato growing as the most important special industries. The average size of farms is 110 acres, and approximately 90 per cent of the farms are operated by their owner.

The soils of this county range in texture from sand to clay, with a large area of cumulose soil. The material forming the soils has been derived largely through glacial action from crystalline and sandstone rocks. The underlying rock in the western part of the county is largely crystalline, while the eastern half is chiefly sandstone. There is also considerable lacustrine material in the county, but since its deposition by water it has been influenced by glacial action.

The soils are classified into 10 series, comprising 27 types exclusive of Peat.

The Gloucester series includes a number of extensive, desirable soils. About one-half their total area is under cultivation. They are used chiefly for general farming, dairying, and potato growing.

About 75 per cent of the total area of the Merrimac soils is improved, and practically all the timber has been cut. These soils are productive and held in high esteem.

More than half the area of the Kewaunee soils is under cultivation, devoted mainly to general farming. All the common crops of the county are grown successfully on these soils.

The Superior soils are characterized by a heavy subsoil, and they need artificial drainage in places, but they are naturally productive soils.

About 75 per cent of the Coloma fine sand has been cleared, and a considerable proportion of the type is used for crops, but it has the disadvantage of drifting before the wind in places.

The greater part of the area of the Plainfield soils has been cleared and placed under cultivation, but part of the land has been abandoned because of the generally low productiveness and tendency to drought.

The Whitman, Poygan, and Dunning soils are similar in having generally poor drainage and in being used mainly for hay and pasturage.

Practically the entire area of the Genesee soils is subject to overflows and only a small part of their area is cultivated.

Peat consists of numerous low-lying, marshy areas in which the soil consists of organic matter in varying stages of decomposition. Little of the Peat area has been reclaimed and used for farming.

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[PUBLIC RESOLUTION—No. 9.]

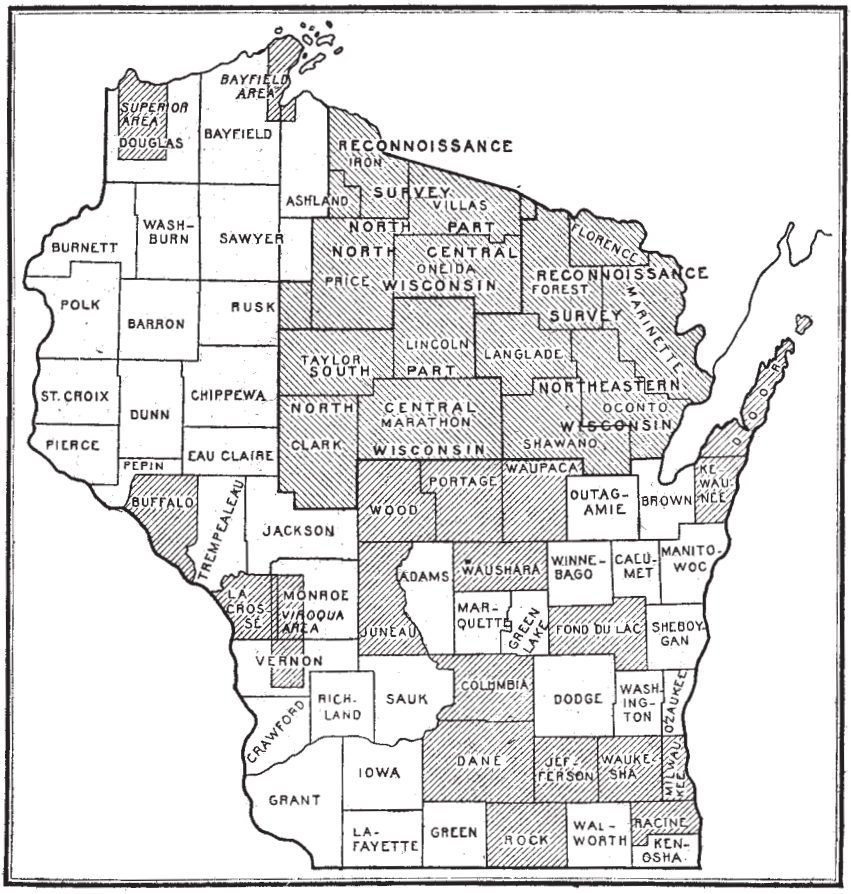
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

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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